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UPDATE ON BIOSECURITY ON-FARM STRATEGIES FOR A LOW DAIRY PAYOUT
AGRITOURISM IN NEW ZEALAND **CONSERVING PLANT GERMPLASM RESOURCES**
CANTERBURY IRRIGATION UPDATE

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NZ Institute of Primary Industry Management

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STEPHEN MACAULAY CEO

CEO's comment

Dare to dream

In reflecting upon the conference, I have been constantly drawn to comments and insights shared by our keynote speaker, Robert Easton of Accenture. Robert's topic was on flourishing and driving change in organisations needing to evolve in new markets and business environments. What struck me during the presentation were his insights on the amount of time and focus we apply to problem solving in our daily and professional life. It would appear that we are hardwired to focus on deficits, negatives and weaknesses. It's an evolutionary response and it's part of our problem solving DNA.

But does focusing on problem solving necessarily yield the results we desire or lift the potential capability in individuals or organisations we are associated with? How often do we go into meetings or other forums with the sole purpose of solving a problem or fixing a weakness, only to be disappointed in the outcome or the inertia that follows soon after.

This is what makes the Appreciative Inquiry change management model so interesting. By definition Appreciative Inquiry is the systematic discovery of what gives 'life' to a living system when it is most alive, most effective and most constructively capable in economic, ecological and human terms. It involves the art and practice of asking questions that strengthen a system's capacity to heighten positive potential.

It also focuses on leveraging an individual or organisation's core strengths that enable them to be resilient, open to learning and able to take action in a positive direction rather than seeking to overcome or minimise weaknesses. So what might this look like for the Institute and New Zealand's primary industries?

On the evening before the conference Robert joined us for dinner. As we were finishing up he gave us some homework to do on 'what our dream is for the New Zealand primary industry in 2020'. After some iterations, the following statement was presented to conference delegates the next morning:

"By 2020 NZ's primary industry is regarded as a highly flourishing industry system of high quality precision producers, manufacturers and marketers of high valued branded natural food and fibre products, which is known for: (1) having co-created a collective industry vision across the value chain (farmers – processors – manufacturers – marketers – consumers and the environment and communities) which has led to the creation of remarkable value and profitability for the all stakeholders; (2) its trust based collaborative relationships operating across the industry; (3) the high levels of innovation and creativity arising from within and outside the industry, including adaptation and use of leading digital technology across the value chain (from farm to the marketplace); and (4) products that are highly sought after and desired by consumers across the globe for the values and quality they represent.

"Quite simply we are an industry recognised as being aspirational and dynamic, one which people and organisations are proud of, and want to bring their whole selves to bear to make the industry better because it feels good, is functioning well, and is doing good in the world. By 2020 we will stand out as the industry that transformed by caring enough to work together to elevate the strengths that always resided within the primary industries of New Zealand to a level we could only have imagined."

The real power is in identifying the positive core of New Zealand primary industries, the strengths we can elevate, and bringing our whole selves to take action in a positive direction across the value chain.

So what image of the New Zealand primary industries inspires you and how do you intend to construct a better future and implement positive change both personally and in your capacity as rural professionals? J

ROGER MORRIS

Biosecurity in New Zealand – are the bugs winning?

The global disease situation has changed very substantially in recent years, with major implications for biosecurity in New Zealand.

Changing international disease scene

Emerging diseases

Consider the diseases which have attracted major global public and media attention – acquired immune deficiency syndrome (AIDS), severe acute respiratory syndrome (SARS), the Nipah virus, bovine spongine encephalopathy (BSE) and its human equivalent variant Creutzfeldt–Jakob disease (CJD), avian influenza H5N1 (and more recent influenza viruses, notably the currently circulating H7N9), the Ebola virus and the Zika virus.

They are all emerging diseases, unheard of until recent decades. They are all zoonotic (come from animals), and were transferred into human populations unexpectedly. They all cause serious disease in people, but vary greatly in their effects in animals – from sub-clinical infection to uniformly fatal. Wildlife species play a role in all of them. Apart from BSE, they can all spread within new countries as a result of movement of people into a country, not just movement of animals or products.

All these diseases have also spread long distances from the point where the initial transfer from animals to people took place. They are all very different from each other in their epidemiology, so we cannot predict much about future disease outbreaks from experience of past events, except that they will be unexpected in several ways. For most, but not all of them, the global social and economic impact has been disproportionately large in relation to the scale of the human case numbers. However the effect on infected individuals has typically been very severe, and in many cases fatal, so the level of concern by at-risk communities is justifiably high and exacerbated by fear of a largely unknown danger.

What we have not seen since the 1918-1919 influenza global pandemic is a disease which both has severe effects in infected people and spreads rapidly to affect a substantial proportion of the world's population. While we all hope that will never happen again, we have to prepare for such an event so that we can mitigate its effect. The 1918 influenza virus spread rapidly round the world, despite the fact that air travel did not yet exist, infecting over the course of a year about one-third of the world's population and killing 10-20% of those who became infected (or around 5% of the world's population). Current estimates are that it killed 50 to 100 million people, higher than earlier estimates because they only included deaths in developed countries. An economic study has found that if an epidemic of influenza with similar characteristics occurred again, the economic effect in the United States alone would be of the order of $100 billion, so the global effect would be many times this size and the spread with modern travel would be far faster.

Even relatively limited outbreaks of emerging diseases have substantial effects on travel and trade, and tend to produce irrational responses in some countries because of uncertainty about how they can spread and ways of preventing their arrival.

Even relatively limited outbreaks of emerging diseases have substantial effects on travel and trade, and tend to produce irrational responses in some countries because of uncertainty about how they can spread and ways of preventing their arrival. While these diseases are more likely to start in areas of the world where there is close interaction between people, domestic animals and wildlife, such as sub-Saharan Africa and several areas of Asia, they can begin anywhere in the world. Although New Zealand does not have all of the factors which would make it a high-risk location for the emergence of new zoonotic diseases, it is not immune. A decade ago a novel strain of *Salmonella enterica* Brandenburg emerged in the South Island. It caused extensive disease in sheep and affected a range of other animal species, but it also caused a local epidemic of human cases, particularly in people who had an occupational exposure to sheep. The source of this strain is unknown, and it is unlike other strains of this organism found elsewhere in the world.

Another New Zealand example was the discovery of a human case of *Brucella suis* infection in 2002 following a hangi where pork and other foods were consumed. This organism occurs in pigs, but is exotic to New Zealand,

Diseases emerge in Asia where there is mixing of different animal species, especially when domestic animals are in close contact both with wildlife and with people

and a detailed investigation was therefore undertaken in an initially unsuccessful attempt to determine the source. No evidence of infection was found in New Zealand pigs. However the mystery was eventually solved when a detailed investigation of the bacterial isolate by an overseas laboratory showed that it was a rare strain of marine origin, and the person had become infected from consuming seafood at the hangi rather than pork.

While these examples demonstrate that diseases can emerge in New Zealand and could potentially cause serious trading difficulties, it is far more likely that this country will suffer outbreaks of emerging diseases due to the entry of disease agents from other countries as a result of breaches in our biosecurity.

Traditional diseases of concern

Because New Zealand has had a generally favourable status with respect to internationally significant animal diseases, and exports of animal products provide a core part of the national economy, it has always been concerned about the possibility of an outbreak of a disease which could disrupt normal trading arrangements. International reporting of animal diseases is managed by the World Organisation for Animal Health (OIE), and until recently the OIE categorised diseases into List A and List B. Diseases on List A had to be reported immediately and were considered the most serious and rapidly spreading, whereas those on List B were normally only reported once a year and were considered less of a risk to international trade. The categorisation had become increasingly outdated and inconsistent with current scientific knowledge in various respects, and has now been replaced by a single disease list and changed conditions for disease reporting.

Foot and mouth disease (FMD) was on List A and has figured prominently over many decades as a disease of high priority in international disease reporting and international trade. It remains a major focus of New Zealand biosecurity strategy. FMD causes far less mortality than many other diseases, and most of the animals which die are young, so their economic value is lower than adults. There are several reasons why FMD is given so much prominence. The first is that it is the most contagious disease known and can spread very rapidly by local contact between animals, on wind, and on inanimate objects of many kinds. There are six different types of FMD viruses which all produce the same clinical signs, but each requires a different vaccine because there is no cross-protection between the different viruses.

The disease infects several different species of animals, which each contribute differently to the epidemiological behaviour of the disease. The main effect of the disease is to make it difficult for animals to eat and move around, and dairy cows can become very difficult to milk because of loss of skin from the teats. Infected animals recover, but some suffer long-term effects. The disease is very damaging economically in areas of dense dairy and/or pig production with high-producing animals, where it can spread rapidly and affect many herds.

Whereas some of the diseases which traditionally influenced international trade have declined in importance, pathogens which adversely affect food safety have grown in importance because health risks associated with food products cause a high level of community concern.

However in many areas of Asia and Africa FMD is not a top priority disease because it kills few animals and most infected animals recover with limited loss of productivity. Hence the disease has been largely eradicated from countries with efficient livestock production systems, but remains endemic in those where smallholder and subsistence livestock production is the norm. These countries have limited motivation to control the disease effectively. When the disease is transferred from an endemic country to a free country, it can spread very rapidly and cause serious disruption of livestock production. While it can be controlled by vaccination, the vaccine must match the field strain and it is very much slower to achieve control by vaccination than by slaughter of infected herds. In many situations where the population of animals is fully susceptible, far more herds will be infected if vaccination is used than if a slaughter policy is adopted, and trade will be affected for much longer.

Countries with large highly-productive livestock populations are therefore fearful of the introduction of FMD and adopt strict policies to avoid its introduction. Hence the consequences for New Zealand of an introduction of FMD would be principally due to trade restrictions and rapid control would be essential. Largely as a consequence of the outbreak of FMD in the United Kingdom and other European countries in 2001, however, there is a progressive shift of thinking towards the increased use of vaccination in the event of an outbreak because of the high social and economic costs of a large-scale slaughter policy, and the move over recent decades from many small herds to fewer larger herds, which changes the epidemiological behaviour of the disease and the costs and benefits of alternative control strategies. It can be expected that FMD will decline in importance as a biosecurity issue in coming decades, particularly in comparison with zoonotic diseases that cause direct human effects, but this will be a slow process. Attitudes concerning control policies for a number of other diseases that affect only animals have already shifted towards a focus on the cost-effectiveness of policies and the increasing use of control methods such as vaccination.

Food safety as a biosecurity issue

Whereas some of the diseases which traditionally influenced international trade have declined in importance, pathogens which adversely affect food safety have grown in importance because health risks associated with food products cause a high level of community concern. The botulism scare in New Zealand in 2013 was a clear illustration of how disruptive food safety risks can be. The mere fear of food contamination is sufficient to cause serious damage, and is at least as difficult to manage as an actual contamination, since in fact there is in reality no contamination problem to solve.

It can therefore be expected that food safety concerns related to pathogenic organisms will represent a growing proportion of biosecurity incidents which affect New Zealand in the future, and will require a significantly different approach to dealing with both national control and international trade consequences.

Changing methods of disease introduction

Biosecurity measures place strong emphasis on the risk of travellers bringing infected material into the country in their baggage. While this is undoubtedly a risk, other mechanisms have grown considerably in relative importance in comparison with food products carried in baggage, and profiling plus detector dogs are highly effective in dealing with this particular mechanism of introduction, especially at airports. Non-food items carried by passengers, such as recreational equipment, are a growing mechanism of introduction for organisms which can have an adverse effect on our environment. The introduction of didymo (*Didymosphenia geminate*) and its subsequent spread in the river network of the South Island provides a disturbing example of this threat, which is much more difficult to manage than food items in baggage.

Because of the growing occurrence of emerging zoonotic diseases described above, the most serious risk which travellers now represent is the possibility that they are infected with a zoonotic disease not currently present in New Zealand, and which could spread to both people and animals while the traveller is in this country. This risk is much more difficult to manage than items in passenger baggage, especially if the person does not show signs of severe disease when passing through the point of entry. The Zika virus illustrates this problem. It was first discovered in Uganda in 1947 and remained geographically restricted for decades prior to its recent spread to Latin America, Asia and the Pacific and its rapid dissemination within these regions. It will continue to spread worldwide with travellers, although subsequent wide dissemination within a region (as in Brazil) will only occur in areas where the mosquito vectors are present.

With the major changes that have occurred in both the scale and the diversity of product imports into New Zealand, this route now represents by far the most risky activity causing breaches of our biosecurity protection. It is also the most challenging to manage. The introduction of PSA (*Pseudomonas syringae pv actinidiae*) to New Zealand and its major effect on kiwifruit production is a recent notable example. Other recent examples include

As climate change modifies our environment, we will face an increasing risk of the arrival of new pathogens from Asia, due to new insect species becoming able to survive here and carrying viruses which can cause serious disease.

the introduction of the Ikeda strain of *Theileria orientalis*, with severe effects on cattle herds, and the post-weaning multi-systemic wasting disease of pigs (PMWS).

As climate change modifies our environment, we will face an increasing risk of the arrival of new pathogens from Asia, due to new insect species becoming able to survive here and carrying viruses which can cause serious disease. There have already been cases of the establishment of undesirable insect species in New Zealand, and insect vectors of diseases of concern may arrive with product imports as stowaways on ships or aircraft, or potentially in some cases by being carried by wind. Long distance movement on high-level wind currents of some insect vectors of diseases has been clearly demonstrated and it may be possible for such insects to reach New Zealand in this way. So far this country has been largely protected from this possibility by the fact that such insect vectors cannot successfully overwinter in New Zealand, but rising winter temperatures may change this situation. Diseases of concern include those of animals (bluetongue viruses are present in Australia and throughout Asia), and zoonoses such as Japanese encephalitis, which is widespread in Asia and has reached northern Australia in the past.

Strengths and weaknesses of NZ biosecurity system

No biosecurity system can achieve a perfect record in preventing and managing incursions of pests and diseases. However there have been multiple failures of the New Zealand system in recent times, as measured by incursions of animal and plant diseases and pests, the introduction of environmentally-damaging organisms such as didymo, and the establishment of a number of undesirable invertebrates such as ant species. Of the 40 ant species present in New Zealand, 29 are accidental introductions. Recent introductions have not been limited to pests and diseases of mammals and birds, and the introduction of *Varroa destructor*, a parasitic mite of honey bees, was a serious biosecurity failure.

It could therefore be argued that the bugs are winning to a greater degree than is compatible with the national interest. Clearly there are weaknesses in the biosecurity system, since several of the incursions have been due to organisms on the Ministry for Primary Industries' unwanted organisms list, while others have been due to organisms which deserved a place there. The most plausible explanation for most of the introductions is that they arrived in legally imported product consignments.

Among the strengths of the biosecurity system is the organisational structure whereby all components of biosecurity are managed through an integrated approach within the Ministry for Primary Industries. This includes measures in relation to human diseases, which in most other countries are dealt with separately, thereby reducing the effectiveness with which countries can deal with emerging diseases.

A second strength is the investigation and diagnostic structure, which is set up within the Ministry for Primary Industries, with specialist epidemiological investigators for animal diseases located at Wallaceville in Wellington able to respond promptly and comprehensively during the early phase of any investigation of a suspected biosecurity breach. This is supported by co-located laboratory services, which are in the process of being very substantially upgraded to provide comprehensive facilities for the diagnosis of animal diseases, with an adjacent laboratory for investigation of human diseases operated by the Institute for Environmental Science and Research (ESR Limited). Laboratories for plant pests and diseases are located in Auckland and Christchurch and diagnostic services for marine and freshwater organisms are provided principally by the National Institute for Water and Atmospheric Research (NIWA). Disease investigators dealing with animal diseases manage around 40,000 diagnostic samples per year, while plant investigators deal with approximately 1,000.

There are a number of areas of biosecurity which justify enhancement. The first is the scope of surveillance activities within New Zealand. The nature of current and emerging risks described above means that it will never be totally possible to generate a list of high-priority organisms for which specific surveillance activities should be undertaken. At present there is too much reliance on reporting of unusual events, which makes the assumption that possible biosecurity breaches will fit past patterns, whereas in fact the most troublesome incursions are likely to be those which are different in nature and are detected too late for corrective action to be effective. There is therefore a need for both scanning and targeted surveillance and the level of investment in these activities needs to be increased. Targeted surveillance is the easier of the two forms to design and manage, because it has a specific objective and a specific way of achieving that objective.

A good example has been surveillance for Queensland fruit fly in northern parts of New Zealand, which is conducted using pheromone-baited traps distributed through risk areas and checked regularly for the presence of the flies, which are strongly attracted to these traps.

This strategy has detected six incursions of the flies in the last few years and led to prompt implementation of control measures where necessary. This program represents a model of the kind of targeted surveillance we need to move towards for specific known biosecurity risks. However there is a need to apply this approach to a wider range of organisms and to develop new techniques for undertaking surveillance. This requires scientific advances in biosecurity methods, and at present there is substantial under-investment at the national level in the scientific research required to upgrade disease surveillance to the level required. If savings had to be made to achieve this, they would best be done through a reduction in expenditure on passenger screening at points of entry, counter-intuitive though this may seem to many people.

Scanning surveillance does not focus on specific known organisms with known characteristics, but rather aims to detect changes in patterns of health-related events in people and animals, which would suggest that an unusual situation is developing that needs further targeted investigation. This is a field of active exploration at present, using techniques such as syndromic surveillance, and taking advantage of new methods of investigation such as detecting local spikes in Google searches for specific types of health information. New Zealand could benefit from strengthening its efforts in evaluating the potential of various forms of scanning surveillance.

The second major area of weakness in biosecurity is the lack of adequate separation between trade facilitation and biosecurity protection. In recent years this boundary has become very blurred, and the low weighting given to biosecurity protection in import policy decisions gives cause for concern. The highly controversial decision to allow the importation of raw pig meat known to contain the exotic virus porcine reproductive and respiratory syndrome (PRRS) was a recent example, where the assessment by the Ministry for Primary Industries that the changed policy would result in an outbreak of the virus less frequently than once in every thousand years was inconsistent with both scientific evidence and global experience of the movement of this virus around the world. There is a need for the Ministry to obtain a wider range of objective critical scientific reviews of its proposed policies that involve a significant biosecurity risk, and to weigh such considerations more heavily in comparison with trade facilitation, in making its decisions. There should be total separation of these two functions.

NZ contributions to global biosecurity

In recent years New Zealand has been making a range of important contributions to global biosecurity. Personnel from the Ministry for Primary Industries and universities have made substantial contributions to global policy development in relation to biosecurity, and the approach adopted by international organisations in this area has improved considerably in recent decades.

An exercise in China testing the management of a suspect human case of the highly infectious H5N1 avian influenza

There have also been notable contributions to biosecurity from universities. The Lincoln University Bioprotection Research Centre has been very active in plant biosecurity, while Massey University has contributed substantially in animal biosecurity. In cooperation with the World Bank and European Commission, Massey University has been involved together with spin-off companies in enhancing global capacity to detect and manage emerging diseases. It has provided postgraduate training to over 100 doctors, veterinarians and wildlife specialists in adopting a unified 'one health' approach to the challenge posed by emerging diseases. Participants have come from countries across Asia, from Afghanistan to China and Mongolia. It has also been involved with partners in the development of procedures and software tools to support the development of surveillance systems for these diseases. Currently this work is being extended to the development of improved surveillance systems to detect future outbreaks of the Ebola virus disease in West Africa.

Conclusion

New Zealand is heavily reliant on effective biosecurity in order to maintain and expand its sale of food to the world. The number of breaches in biosecurity in recent years gives cause for concern, and would justify careful independent scrutiny of current systems and areas for improvement. While the bugs are not winning overall, they have found more gaps in the protection than would ideally be the case, and it is time to ask hard questions about how to redress the balance.

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DAVID TEULON AND STEPHEN GOLDSON

Brown marmorated stink bug on apples in the USA, and which MPI is on the lookout for in NZ with the assistance of the public.
Photo source: Catherine Duthie

Future-proofing New Zealand's border biosecurity system – the role of Biosecurity 2025

STRATEGIC DOCUMENT LAUNCHED

In the last week of July 2016 the Hon. Nathan Guy launched the strategic document 'Biosecurity 2025' for public consultation. The Minister is adamant in emphasising that biosecurity is his top priority and, likewise, industry has consistently placed the maintenance of our world-leading biosecurity system as their number one issue (KPMG Agribusiness Agenda, 2011-2016). Biosecurity also figures prominently in New Zealand's recently developed Biological Heritage National Science Challenge. Thus, overall, there is overwhelming consensus that biosecurity is a critical issue for New Zealand.

The biosecurity challenges we face are intensifying with increasing and changing trade and tourism, as well as climate change. Even if we were to stop all trade and tourism (and return overseas trips by Kiwis), we would still be hit by a number of wind-borne pests and diseases from Australia.

What is 'Biosecurity 2025'?

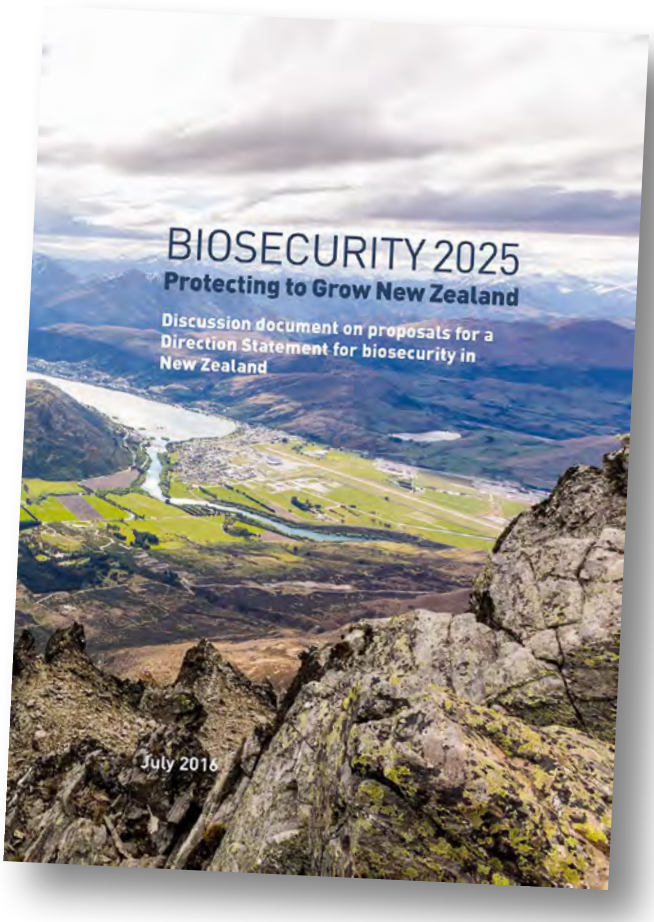
'Biosecurity 2025' re-emphasises our incontrovertible need to reduce the cumulative impact of invasive alien species on New Zealand's valued productive sector and natural ecosystems. Such a necessity is an unavoidable imperative that all New Zealanders must rise to. This country's relative isolation has provided us with a natural advantage in our fight to avoid the ravages of many pests and diseases of our important plant and animal species. Thus we are able to grow crops and trees, farm animals and forage without many of the chemical interventions required in other countries. This plays a very large part in us being able to market premium quality products to the rest of the world.

Notably, though, biosecurity is not just about keeping our plant and animal systems healthy. It is also about ensuring access to international markets for our agricultural, horticultural and forestry products, as well as providing the confidence needed for future investment in innovative plant and animal systems. Nor is it just about trade. Amongst other things an outbreak of foot and mouth disease would have a colossal impact on tourism. Finally, and not least, our unique indigenous ecosystems and species (taonga) have immeasurable scientific, ecological, recreational and cultural significance to Māori and non-Māori people alike. Biosecurity is also about protecting human health, e.g. keeping vectors of human disease such as particular mosquito species.

Despite the reasonable claim that New Zealand has one of the best biosecurity systems in the world, it cannot create perfect biosecurity, so there is an ongoing need to do better. The biosecurity challenges we face are intensifying with increasing and changing trade and tourism, as well as climate change. Even if we were to stop all trade and tourism (and return overseas trips by Kiwis), we would still be hit by a number of wind-borne pests and diseases from Australia. Localised 'sleeper' pests may also become more problematic as they increase their abundance and distribution. In short, the biosecurity threat is changing almost daily and we need to respond accordingly. 'Biosecurity 2025' will help in fulfilling this by providing the strategic platform for us all to move forward over the next 10 years – and science must play a key role.

Five strategic priorities

'Biosecurity 2025' has proposed five strategic priorities, which impinge on the New Zealand cross-sectoral, multi-partner research collaboration called 'Better Border Biosecurity' or 'B3' (www.B3nz.org). B3 is a cooperative science collaboration that researches ways to reduce the entry and establishment of new plant pests, diseases and weeds in New Zealand. B3 integrates investment and expertise from five research organisations (AgResearch, the Bio-Protection Research Centre, Landcare Research, Plant & Food Research and Scion) and three end-user partners (the Ministry for Primary Industries, the Department of Conservation and the New Zealand Forest Owners Association). Other sector interests are currently represented on an observer basis. B3 is aligned to New Zealand's Biological Heritage National Science Challenge.



Cover of Biosecurity 2025 discussion document

From this perspective the authors are able to make the following high-level comments on 'Biosecurity 2025's strategic priorities:

1. A biosecurity team comprising all New Zealanders.

It is clear from the magnitude, complexity and sheer importance of the biosecurity challenges we face that everyone in New Zealand needs to be active in dealing with them. Whether this is filling out the biosecurity arrival forms accurately, or responding positively when a biosecurity officer asks to strip backyard fruit trees during a fruit fly incursion, these things are all vitally important. There has recently been clear evidence of effective public participation in our biosecurity system, with local residents providing a valuable role in searching for great white butterflies during the recent Nelson city eradication programme. Similarly, the public is now participating in the lookout for the brown marmorated stink bug and calling the Ministry for Primary Industries' 0800 number (0800 80 99 66) when

Last instar caterpillar of the great white butterfly, a pest undergoing eradication in Nelson.
Photo source: Richard Toft, Entecol Ltd

The ongoing challenge for all in the biosecurity community is to support fit-for-purpose research that informs and adds to the effectiveness of biosecurity at the border.

they find something dubious. This is currently helping to reassure all parties that the bug is not established in New Zealand.

Having a well-informed public involved in this way in biosecurity surveillance and response is most worthwhile and new initiatives to engage them further can only be valuable. In exactly the same way, growers and pastoral farmers are increasingly more vigilant in looking out for specific threats to their sector. To this end a quiet revolution is occurring in the area of biosecurity readiness and response, with the Crown and several primary production sectors recently signing (separately) the GIA or Government Industry Agreement. The GIA provides a means for sharing decision-making and costs in the event of an incursion. The National Biosecurity Capability Network is another great example of New Zealanders working together. This volunteer army, coordinated by the Ministry for Primary Industries and AsureQuality, is brought together during a biosecurity outbreak. It numbers over 60,000 people from 144 organisations and they come from all walks of life such as central and local government, industry and iwi. The expertise from these different sources provides a potent pool of talent that can make all the difference during a biosecurity response.

2. **A toolbox for tomorrow.** New Zealand's biosecurity system is multi-layered, reflecting the complex and evolving challenge at hand. Based on multi-national and bi-lateral agreements it includes: (i) assessment of the pests and diseases of risk to this country; (ii) an analysis of the pathways these organisms might use to get to New Zealand and how to close or manage these pathways; (iii) the development and use of diagnostic systems and methods to categorise or identify these

There are steps currently underway to include biosecurity topics within the school curricula.

species; (iv) surveillance to detect and intercept any incursions as early as possible; and (v) tools to eradicate and manage them, should they establish.

Also research and development advances are now being underpinned by the very rapid advances in computational analysis, molecular biology, remote sensing, chemical ecology, application technologies and social science, to name a few. It is these sorts of disciplines that will ensure that New Zealand's biosecurity is up to the mark. The ongoing challenge for all in the biosecurity community is to support fit-for-purpose research that informs and adds to the effectiveness of biosecurity at the border. New initiatives in 'Adoption and Practice Change' and 'Research, Technology & Innovation Practice' within the science community and the Ministry for Primary Industries reflect such a requirement.

3. **Free-flowing information highways.** Biosecurity is a numbers game. There are tens of thousands of potential risk organisms throughout the world that threaten New Zealand's ecosystems (and public health). A certain number of these risk organisms reach our border where many are intercepted and destroyed. Indeed, some may breach the border and some are then eradicated. Of those that do manage to establish within New Zealand, some may be of insignificant impact and yet others may turn out to be serious pests. While some of these pests may indeed be able to be brought under control, doing so may well disrupt existing biologically-based pest management systems and will result in intensified pesticide use. Further, while some newly-established species may cause little damage to New Zealand systems, their mere presence can inhibit access to sensitive international markets for our products.

   Such biosecurity complexity occurs within the context of the numerous different modes of entry for pest organisms, compounded by New Zealand's different climates and the variety and value of the different plant and animal systems. Thus the numerical complexities and biosecurity challenges are very apparent. Nevertheless there is a real opportunity to better understand the functioning of our border by the better collection, synthesis and analysis of the component parts of the biosecurity system. In essence, this is the basis of an 'information highway' that will benefit hugely from new and sophisticated data management and computational systems to respond better to prevailing and emergent threats.

4. **Effective leadership and governance.** The Ministry for Primary Industries provides overall leadership for this country's biosecurity system. Given the simple structure of New Zealand's governmental structures compared to other countries where federal systems often operate, there is real opportunity for getting things right. These features include focus, integration and agreement across the government, industry, public and science communities. There is the potential for timely implementation of measures, including initiatives such as the GIA and the recently-created National Science Challenges.
5. **Tomorrow's skills and assets.** It is clear that the biosecurity challenge is only going to increase and that we will need to rely more and more on the skills of well-trained biosecurity professionals. We will also need to continue to develop a biosecurity ethos across the whole of New Zealand society. There are steps currently underway to include biosecurity topics within the school curricula and there is an ongoing pressure to encourage this further. The Bio-Protection Research Centre at Lincoln University is working closely with B3 and the Biological Heritage National Science Challenge, and these organisations have been and are working at the forefront of training biosecurity graduates. It is encouraging to note that such developments are in the context of several other initiatives created by other New Zealand universities to increase their focus in this area. However such ongoing momentum requires consistent and predictable government and industry commitment to offer meaningful careers in the area of border biosecurity.

Ambitious objectives

'Biosecurity 2025' has ambitious objectives which rightly reflect the challenges New Zealand faces to protect valued productive sectors and natural ecosystems from invasive pest species. As well as extensive public involvement, New Zealand needs to be alert to the need for research and innovation combined with excellent leadership and effective organisational structures for border biosecurity operations.

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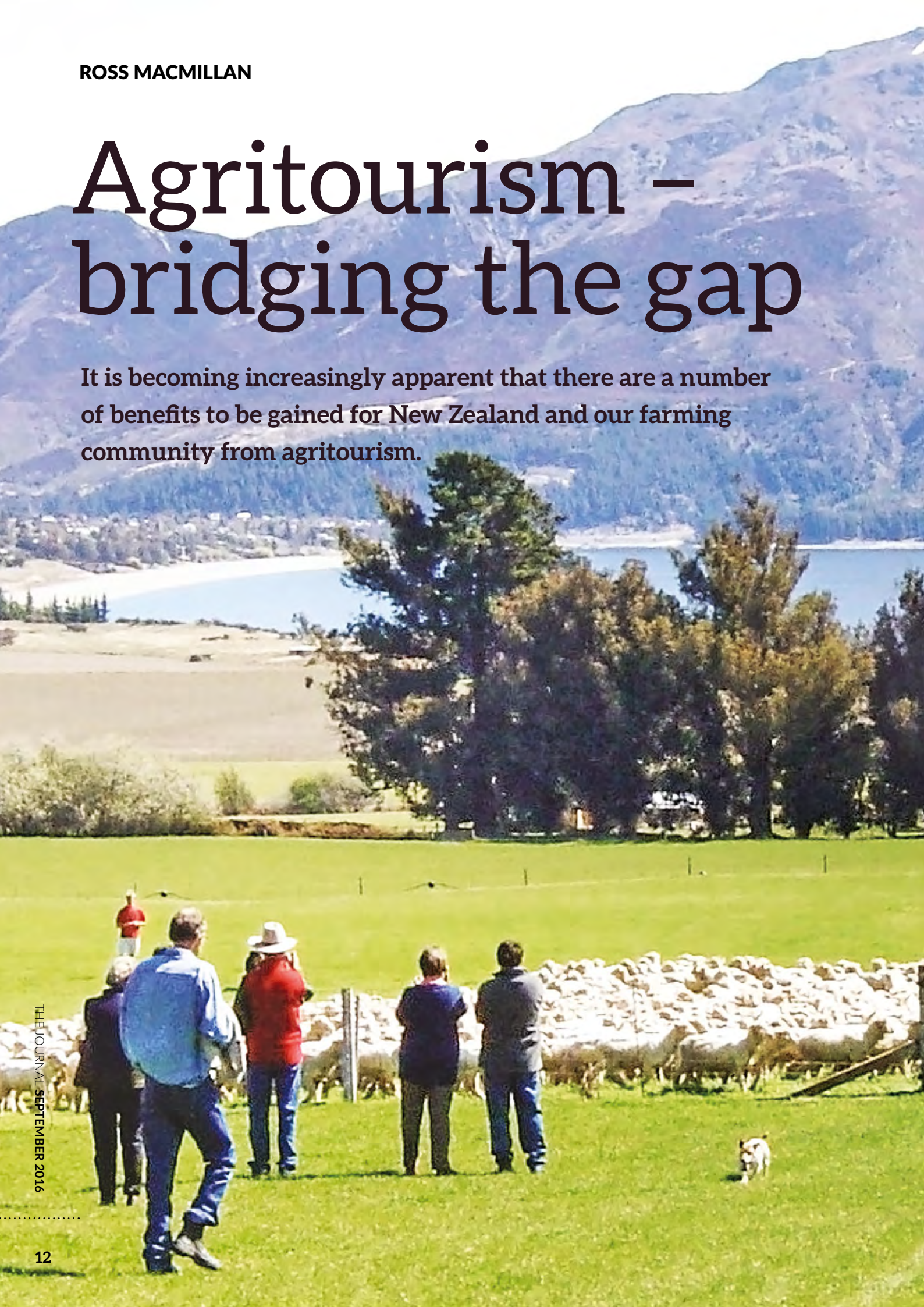
ROSS MACMILLAN

Agritourism – bridging the gap

It is becoming increasingly apparent that there are a number of benefits to be gained for New Zealand and our farming community from agritourism.



International visitor group looking at merino sheep and Lake Hawea in Central Otago

Benefits for New Zealand

Agritourism is a broad term that means different things to different people, but the concept varies in different parts of the world. Generally it is the marrying together of the agricultural and tourism industries, usually with commercial goals in mind. It is becoming increasingly apparent that there are a number of benefits to be gained for New Zealand and our farming community from agritourism. Some of these benefits include:

- An additional income stream for farmers and rural businesses from hosting visitors
- The opportunity for visitors to experience and understand New Zealand farming
- A greater appreciation between involved parties of international cultures
- The chance to promote and sell New Zealand produce
- The opportunity for feedback on a rural experience and the products we produce.

Elements of agritourism, opportunities, further benefits and pitfalls are outlined below.

Rural and urban divide

Throughout the developed world, urban dwellers are now far more numerous than those in rural communities. In China, for example, there has been a significant drift from the country to the cities with urban dwellers having trebled in the last 50 years or so. With this global trend, people have become increasingly distanced from farm life and where their food comes from – not to mention becoming out of touch with related issues such as food safety, animal welfare and environmental impacts.

Although in New Zealand the gulf between town and country may be less pronounced than in other parts of the world, it has increased in recent decades and there appears to be a growing interest in bridging this gap. Agritourism provides a vehicle to do this and, with increasing numbers of mainly urban-based tourists visiting this country, the demand to see, learn and experience country and farm life is likely to increase.

Agritourism operations

Some facets of agritourism are already well established in New Zealand and familiar to most. In addition to farmstay accommodation there are day visits or tours to farms, activities such as A&P shows, the National Fieldays and Southern Field Days, plus places like the Agrodome, farm parks and rural museums which also bring town and country people together.

Corporate events are a less obvious form of agritourism where businesses organise social gatherings, team bonding and strategic meetings in rural settings. Being in a less familiar rural environment can generate a fresh look at relationships and the future direction of a business. These various agritourism activities have been popular for many decades, as are activity-based ventures such as horse or mountain bike riding, walking or hunting.

We need to look for more opportunities to sell our high-quality and added-value farm produce to wealthy, discerning customers at sustainable prices to the producers.

There are many farmers, organisations and rural businesses that have set up very successful agritourism operations in New Zealand to cater for domestic and international visitors alike. However opportunities abound where particular circumstances and the special abilities of the farmer or agribusiness hosts tie in with the potential needs of paying customers, resulting in market opportunities.

Our place in the world

To understand the potential and further develop agritourism we need to think about New Zealand's place in the world: how we are perceived internationally and what we can offer visitors. We are renowned for our scenic beauty, warm hospitality and country way of life – not for bright lights, a bustling nightlife, historic castles or ancient monuments.

We are essentially an isolated country producing meat, dairy products, wool, wine, logs, vegetables, fish and fruit for export. Many of these products are sold internationally as commodities in a relatively undifferentiated form and, as such, attract modest returns on world markets. A small number of New Zealand companies and co-ops handle and control most of our agricultural exports and our farmers' and country's fortunes are largely a reflection of their success or otherwise.

On our international tours, New Zealand meat and dairy companies are sometimes accused by our host farmers of coming in and undercutting the local market prices. It is an argument hard to defend and, as a Kiwi, something I get no pride from.

There is little light ahead for selling low-value commodities to the world. New Zealand farms are generally well stocked and well managed compared to many other countries. There is less opportunity than in many other parts of the world to substantially increase our physical production, certainly without negative affects on our environment or other sectors of our community. For this reason, and looking to the future, we must become smarter by adding value to our farm products to improve revenues rather than produce more of the same.

Forget about feeding the world – rather we should maximise the opportunity to produce, export and sell more specialised and branded products to those wealthy enough to pay good money for them. Currently there is a disconnect between our farmer producers and consumers and so little, if any, recognition or premium paid for the fact it is quality produce from New Zealand. To do this we need to tell the story behind our products, especially as this country has a great story to tell.

We are relatively clean and green, egalitarian and produce and trade our farm products with integrity. The world needs to recognise this and that is where agritourism – bridging the gap between rural producers and urban consumers – can help us better promote and sell premium products to the world.

Some sectors leading by example

There are many sectors of our rural economy doing well and New Zealand's wine industry is a good example of an industry going places with exports. Our 'bottled sunshine' is strongly branded, easily identified by its origin, and with a great story it is sold to the world at premium prices. There are other exports doing well such as manuka honey, aquaculture and specialty meat and dairy products. However for the most part we need to look for more opportunities to sell our high-quality and added-value farm produce to wealthy, discerning customers at sustainable prices to the producers.

Country hospitality at a sheep and cattle farm in Marlborough

Bridging the gap with agritourism

As well as helping our own urban population better understand where their food comes from, agritourism is a vehicle to help promote our farm products and bring about a closer connection between our farmers and overseas visitors to New Zealand. If visitors have a great agritourism experience they will tell several others and spread the message. If, for example, our three million annual visitors tell 10 others of their positive experience then this could extend to 30 million people around the globe. By the same token, a bad experience travels a long way too so it is crucial that we do it very well.

Farm accommodation

The farmstay business is well established in New Zealand and many farmers are doing an excellent job. The homestead (or perhaps farm cottage) accommodation needs to be well located, well presented and managed to appeal to international visitors. The hosts must be very hospitable ('people people'), well organised, open-minded and able to relate to other cultures. Most visitors prefer to interact with the family and enjoy meals together so they can chat and share a memorable experience, rather than be isolated and expected to fend for themselves. Of course, there are exceptions where people prefer to be completely independent.

Based on international trends, there is scope for rural accommodation facilities to be larger to cope with the ever-increasing numbers wanting to spend time in the country. These should be professionally run businesses capable of hosting 20 to 40 visitors in accommodation of comparable quality to good 4 star motels. With the rapid expansion in inbound visitor numbers to New Zealand, there is a current and growing dearth of good-quality, reasonably-priced hotel accommodation. As such, it seems there is the opportunity to develop more farm-based accommodation facilities to help cope with these growing numbers of travellers, especially in key country locations near main tourist routes. Such enterprises will require substantial capital investment and adequate staffing to be run as serious commercial businesses, not just a sideline to farming.

Farm restaurants

Farm restaurants are very popular overseas, especially in Europe. These often go hand-in-hand with accommodation facilities and provide the opportunity to serve quality local and seasonal produce from their farm or other local sources. The farmers are very proud of what they produce and see it as an opportunity to serve and celebrate their farm products, including added-value food products from local co-ops or companies they supply. Likewise, diners enjoy knowing the story behind what is served on the plate and it leaves a positive and lasting impression. If we could develop farm restaurants here, it would be an opportunity to showcase and promote quality New Zealand produce, especially our lamb, beef, venison, cheeses, fruit, vegetables, wines and beers.

There is a general trend worldwide for buying local and even 'slow food', especially in the United Kingdom, Europe and Scandinavia. The fresher and more natural the product, the closer the consumer feels to the supplier. Unfortunately this goes against the New Zealand situation where we need to export food to reach our markets – so not local food but certainly slow.

Many wineries, orchardists and boutique cheese producers already embrace agritourism by bringing customers to their door. New Zealand could benefit from having more on-farm shops, which may or may not be run in conjunction with farm accommodation or restaurants.

Farm shops and outlets

Many wineries, orchardists and boutique cheese producers already embrace agritourism by bringing customers to their door. New Zealand could benefit from having more on-farm shops, which may or may not be run in conjunction with farm accommodation or restaurants. Such stores can sell local and farm-related foods, beverages and handcrafts genuinely made in New Zealand. Far too many visitors leave our country with cheap souvenirs made offshore and not representative of the true quality products we Kiwis know and enjoy.

It helps for on-farm stores to be near the main tourist routes where it is easier to attract potential customers. Visitors are interested not only in the products on offer, but the story behind them. It gives the farmer producer the opportunity to promote their brand and sell their products directly, usually at a premium price, cash up front, and with less hassle about grading and quality standards.

When in the United Kingdom last year I visited an on-farm butcher shop. While being hosted by the farmers, we saw an endless stream of customers to the shop where they were selling home-produced beef and lamb, pork, home-made meat pies and small goods. There is the opportunity for some well-located New Zealand livestock farmers to look at on-farm shops to take their products direct to the customer. Regulations about health and safety are no doubt potential barriers to such enterprises, especially with perishable products. However if these can be overcome, it is a means of getting close to consumers to sell both the produce and their story while hopefully developing new and regular income streams.

Cow barn and Ku Cafe (cow cafe) in Austria

Added value proscuitto hams air curing in Austria

A few years ago, I recall taking a group up a steep mountain in Switzerland to visit a farmer set up for milking his 25 Simmental cows on the mountain pastures. As the winter snow receded, the herd moved further up the hill to graze the fresh grass. He had two or three barns at different altitudes, with a basic mobile milking plant to milk this handful of cows then directly convert the 500 litres daily of milk into around 50 kg of local-styled cheese. This was nicely packaged up and sold at seemingly high prices to the tourists who passed through the village at the bottom of the valley. The returns from this small herd and cheese-making facility were comparable to the returns in New Zealand at the time from a herd of 300 cows supplying the local company.

A recent group touring Austria visited a Ku Cafe (cow cafe) where the farmer housed and milked around 70 Simmental cows with a robot. Attached to and overlooking the barn was a modern cafe. Customers could observe the cows going about their daily business, including trips to the robot that were visible on the cafe's TV screen. They are not only earning additional money from general visitors, but also from coach loads of school children and other interested parties who wanted to get closer to country life. Some were even keen to visit the farm to pick up antibodies to enhance their immunity to disease. Perhaps some New Zealand equivalents to this cafe could be set up.

We also visited a 150 sow pig unit in Europe, which grows out baconer-sized pigs for slaughter. The meat is cured, air-dried and processed on-site with over 6,000 prosciutto hams plus other small goods for sale through their shop. After about a year, when they are fully cured, hams are sold at around €300 each. The farmer commented why would he sell pork to the supermarket at €1.25/kg when he gets €30/kg when processed in this way? He added – why sell barley if you can produce whiskey? Perhaps thought should be given to turning some of our annual lamb crop into a specialty, high-value prosciutto lamb as an export product?

With our population of around four-and-a-half million, and three million annual visitors a year, we have a potential market of seven-and-half million people. Agritourism opportunities should therefore be exploited more.

This multi-million dollar pig business was located on just 12 ha and created employment for 50 people, not the two or three it would normally take to produce this quantity of pork at a more conventional enterprise. A great example of added value and the story being told through agritourism.

There are also examples closer to home such as an astute New Zealand dairy farmer with an on-farm milk vending machine. Selling his regular clientele pasteurised (but not homogenised) milk through this automated system at the farm gate, he obtains 80% of his income from 20% of the milk he produces.

These are just a few examples of agritourism enterprises where the farmers and the customers are closely linked, the story is told and value added. With our population of around four-and-a-half million, and three million annual visitors a year, we have a potential market of seven-and-half million people. Agritourism opportunities should therefore be exploited more.

Farm tours and hosting groups

Farm and agricultural tours usually encompass several days' travel and generally include transportation, accommodation, meals, guiding, translation, farm visits and other arrangements. In recent years there has been a trend away from the large coach loads to smaller groups, often like-minded people with a shared interest. They may be farmers looking at a particular subject, such as dairying, or general visitors wanting a more touristic experience with a rural visit thrown in to meet farmers and better understand country life.

A group farm visit can be something for urban-based visitors, particularly as rural New Zealand represents such a dramatic change from the bright lights of the large cities where they may live or work. Things as simple as touching a sheep, seeing stars or watching a sheep dog at work can intrigue people.

Day visits can be disruptive for working farmers and make no sense if the visitor payment does not cover the opportunity cost of the farmer's time. It is generally uneconomic to host independent travellers for a few hours, but if a group is 20 to 40 strong it may be a more viable business opportunity in relation to the effort involved. If the hosts provide additional services, such as a meal, it can add to the visitor experience and to the potential earnings to the farmers involved. To be successful the hosts must find it an enjoyable, refreshing and profitable experience while satisfying the curiosity and wishes of the visitors.

There are many components to successful farm tours and hosting groups and it boils down to the organisers having a unique set of skills. Paramount is an interest in people, sound organisational and communication skills, an in-depth knowledge of agriculture, and an understanding and tolerance of international cultural nuances.

Other agritourism opportunities

There are some other interesting trends in agritourism bringing people into the country to experience first hand what it has to offer. Walking, biking, horseriding and hunting experiences represent another avenue for 'getting away from it all' in a rural setting. As previously mentioned, on-farm weddings or corporate events are other avenues being developed. Upmarket camping or 'glamping' in scenic rural locations is on the increase and on-farm campervan parks may represent another opportunity for some. As with any potential business it means looking at what unique resources there are by way of location, facilities or personal attributes to attract paying customers.

Summary

Agritourism provides a window to the world of how things are 'down on the farm'. As outlined above, there are many forms of agritourism and the potential to help rural businesses and the New Zealand economy as a whole. We are fortunate to have a beautiful country, attractive farmland, friendly people and well-developed systems of food production. We are also attracting increasing numbers of visitors who want to experience our country, taste our food, drink our beverages and meet local people, including farmers in a rural environment.

We need more rurally-based accommodation, farm restaurants, farm shops and country-based activities and cultural experiences. We need more science and an entrepreneurial spirit to create diverse, specialised and added-value farm products which attract premium prices from those who can pay us well. We need more people overseas promoting and selling our products relative to those on the farm currently producing mainly lower-value commodities.

The more we showcase rural New Zealand, the more we can exhibit, promote and sell our high-quality farm products to visitors and their families and friends around the globe. We need to develop strong new brands and products to further enhance our unique and globally admired brand, 'New Zealand'.

Agritourism is a way forward to bridge the gap between the farmer and the city dweller; the producer and the consumer. Now is a great time to get out there and take advantage of the opportunities agritourism offers.

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DAN STEELE

AGRITOURISM – A FARMER'S FRIEND OR FOE?

Agritourism is an opportunity that is coming to New Zealand landowners like a freight train. As a destination we are becoming more accessible and popular, with more than three million international visitors per annum and 10% year-on-year growth.

Tourists horse trekking at Blue Duck Station in Owhango

Win-win for farming

Agritourism can be a win-win for New Zealand farming, bringing in more income from the same assets while promoting what the land has been traditionally producing. This can be either an individual farmer's produce, if they are selling direct, or having a brand, or New Zealand produce as a whole.

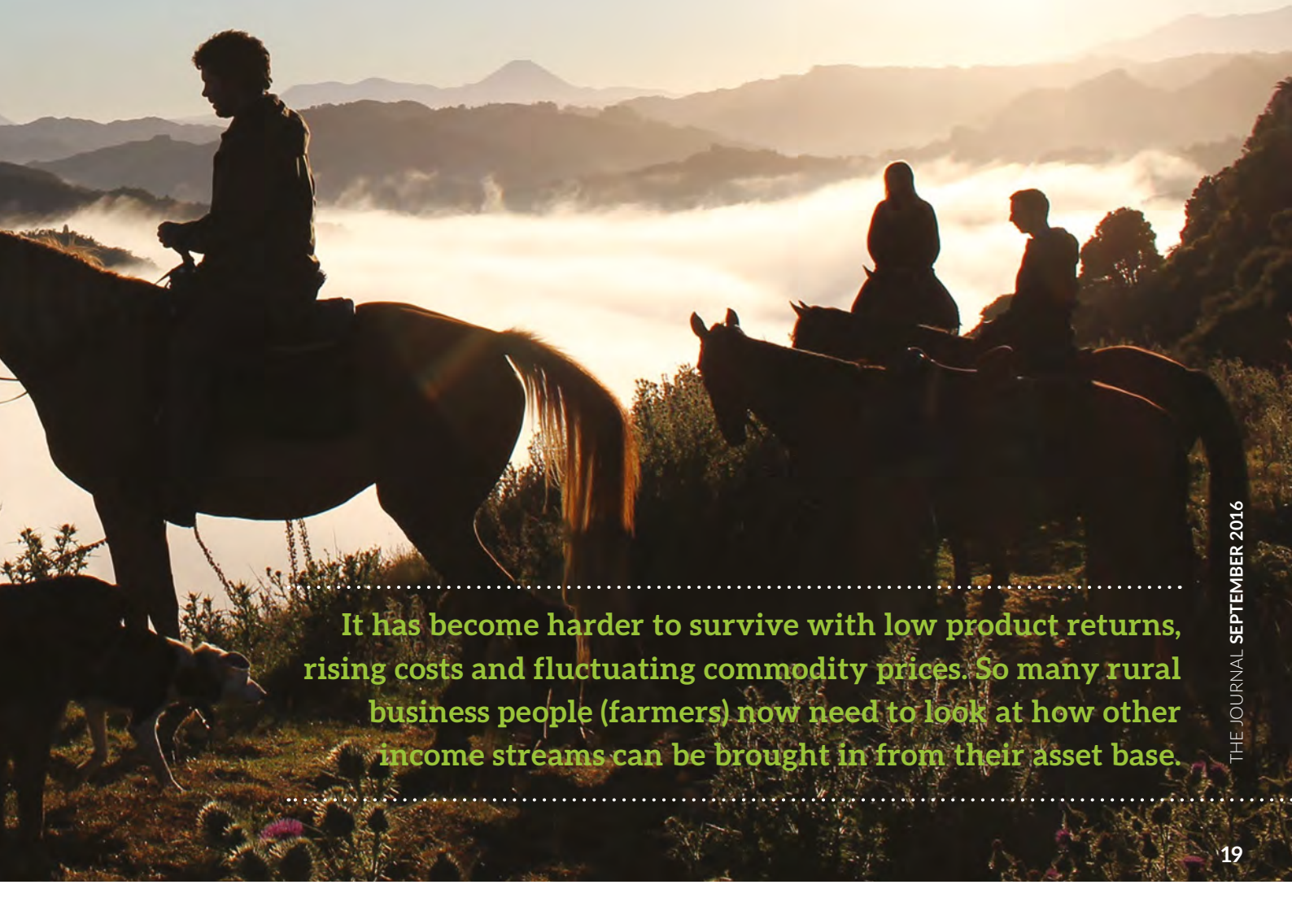
In 2016, after 150 years of hard work by New Zealand farmers, we are struggling to get adequate returns for much of what we grow from the land, mostly our main products of lamb, wool, beef and dairy. Some specialised products are doing very well such as wine, kiwifruit and manuka honey. Part of the reason for this in the law of the economic theory of supply and demand is that we have concentrated on becoming very good at supplying while assuming what we are growing will be needed or wanted.

Put simply, we have neglected to create sufficient demand for our products. The world is not short of food, with 40% of what farmers grow being wasted and 25% of the global population becoming obese. So we must now rethink what the world wants, tailor our production accordingly and create demand for our produce. Agritourism can have an important role to play here, helping to link our growing number of guests to our people, our land and produce. Fortunately the world is short of New Zealand.

What is agritourism?

Agritourism is where visitors stay, play or dine within a working farm or horticultural business. It is fast becoming a necessary diversifying option for many landowners in rural New Zealand. It has become harder to survive with low product returns, rising costs and fluctuating commodity prices. So many rural business people (farmers) now need to look at how other income streams can be brought in from their asset base. The reason that tourism is becoming the logical option for many farmers has been the very strong growth in international tourism numbers to New Zealand and the increase in the different ways for these guests, and our domestic tourist market, to experience the back country.

Some of these ways include our Great Walk network, New Zealand Cycle Trails and the Te Araroa Walkway from Cape Reinga to Bluff. All of these initiatives are gaining great momentum. With New Zealand also becoming more urbanised, many of our town cousins are travelling to the countryside to stay and play. These people are getting out into the 'back blocks'. However unless they want to tent, and eat noodles and nuts, they need some services in rural communities, mainly on farms, including accommodation, food, activities and observing everyday farming life.



It has become harder to survive with low product returns, rising costs and fluctuating commodity prices. So many rural business people (farmers) now need to look at how other income streams can be brought in from their asset base.

Tourism, and particularly agritourism or back country tourism, is one of the only bright lights helping to address rural de-population.

Tourists as NZ ambassadors

The opportunity for Kiwis is to use this international and domestic tourism growth as a smart marketing strategy for our primary produce. We need to ensure these visitors become customers of our produce while they are here enjoying our scenery. We can use agritourism to better connect travellers with our land and our people so that when they return home they continue to buy our products and become our ambassadors, telling our story on our behalf. Word of mouth is still the best form of advertising in the world and stories and experiences are always better told in the third person.

Environment and traceability

Our scenery, remote location, unique environment and a safe place to travel are our biggest drawcards for international guests. As is the case with increasing farm production and the larger environmental footprint trade-off, so it is with bringing more and more travellers through our remote and sometimes sensitive landscapes. Because we have an ecosystem with many endangered flora and fauna, putting more people into the back country is a strain on the environment. However, to quote David Attenborough, 'No-one will protect what they don't care about, and no-one will care about what they have never experienced.'

We need people out seeing and experiencing the New Zealand back country to fully appreciate and understand the issues and how we must manage these. We are world leaders in some types of conservation such as bringing species back from the brink of extinction, setting up sanctuaries for native flora and fauna, and the control of introduced pests. We should quickly become world leaders in farm environmental management and can use agritourism to showcase our work and help tell our stories.

Education and advocacy

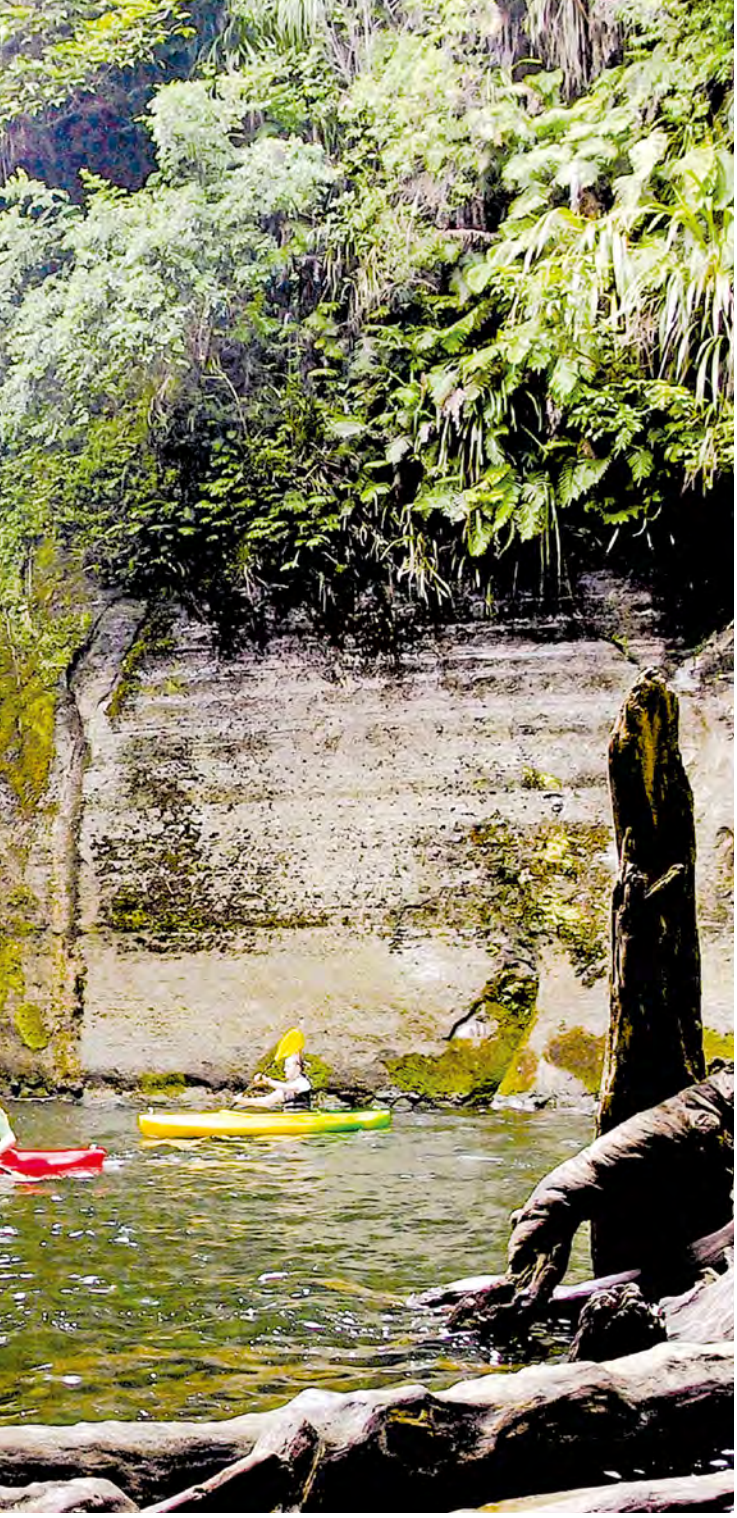
There is a growing disconnect with many people and their food, with a lot of consumers not really understanding (connecting to the farmer or animal) what they are buying in the supermarket. Agritourism plays an important role in connecting people to the land and educating them about how their food is produced.

Re-enlivening rural communities

Tourism, and particularly agritourism or back country tourism, is one of the only bright lights helping to address rural de-population. This is a worldwide issue facing rural communities, where people are leaving the land for large urban centres and the countryside becomes more isolated and fragmented. Rural communities lose infrastructure such as schools, halls and sports clubs as well as community spirit. Many of our rural towns are becoming ghost towns, with far more empty shops than full. Tourism is not only bringing people into these rural towns, but is also creating employment, which in turn creates community.

Agritourism can also create on-farm communities that make it very appealing for staff to belong to. On Blue Duck Station, for example, the team consists of New Zealanders and internationals. We have farmers, gardeners, guides, housekeepers, conservationists, a chef, a mechanic and more children for the local primary school. So there is a diversity of jobs and personalities that keeps things interesting for the team, fresh ideas coming, and makes it fun as well as educational for everyone.

Tourists kayaking at Kaiwhakauka Falls on Blue Duck Station in Owhango



Marketing

Farmers can sometimes be disconnected and not fully understand their end market and consumer. Having guests who are from New Zealand's consumer markets stay on the farm allows them to understand their wants and needs far better. This can help us to change our farms and systems to better meet the demands and expectations of our consumers. Farmers can set up to sell their products direct to the guests while they are with them. Selling a product to one person can benefit a farm or a business, but showcasing, telling and selling our story can have everlasting benefits for an entire industry. If we use tourism as a means and a reason to improve our environment this story, partly told through agritourism, can help New Zealand's position as a producer of environmentally-friendly, healthy, natural and free-range products.

Land use

Agritourism can also make better use of farm assets. It allows value to be attributed to retired or regenerating areas, better utilises some farm vehicles and tracks, and essentially means that the land becomes a 100% effective production area.

Vision for the future

Agriculture and tourism are our two main industries and both require a lot of the same attributes of New Zealand to be successful. First and foremost is our good reputation. Agritourism is a vital link between these industries. We cannot be an agricultural exporting nation without tourism to directly connect people to our land, our stories and our products. We must also commit to the constant improvement of our environment so that our clean green image can be a trusted selling point. Today word of mouth can be conveyed through social media to the world instantly – this is a huge opportunity to market ourselves and tell our story. It is also a big risk with the potential for bad news stories travelling much faster than good ones, but this is the world we live in and the risks must be managed.

It would be great to see Beef+Lamb, DairyNZ and Hort NZ marketing our produce at the airports – as visitors come through arrivals there could be healthy, tasty food options. When they leave New Zealand it could be the last experience they have. Currently, the first and last impressions that international visitors have are of fast food stores.

We need to find the common ground between agriculture and tourism and build a strategy that helps link and improve both industries. Farmers own most of New Zealand and their customers are coming here for a look around and hoping for a great experience. We are on show and need to perform or accept that low and volatile prices are the new normal.

Healthy agriculture, for the people and the planet, is surely one of this country's biggest opportunities. The world is looking for answers to all sorts of problems from climate change to cancer. Many are realising that human health and environmental health are inextricably linked, so if we can position ourselves as the health food store of the world people will fall over themselves to get here and buy our healthy produce. Agritourism can and should be a very important link to the world and its people.

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NICOLA KLOETEN AND JAMES ALLEN

Impact of volatile milk prices on progression

In the past five years there has been significant fluctuation in global milk prices, which has had a flow-on effect to the farmgate milk price paid to New Zealand dairy farmers. This volatility has created additional problems for farm owners and sharemilkers alike.

Sharemilking has long been considered a cornerstone of the New Zealand dairy industry, providing a viable progression pathway for young dairy farmers to build experience and wealth, and traditionally aiming to achieve their ultimate goal of farm ownership. This pathway has been under increased pressure in recent years, with the number of herd owning sharemilking (HOSM) positions steadily declining due to a variety of factors.

This article provides a summary of the report 'Dairy Progression Pathways and the Impact of Volatility' (Allen & Kloeten, 2016), which explores the latest trends and statistics relating to sharemilking and examines the issues the current milk price volatility is creating. Finally, it provides some thoughts on how the industry may need to react to ensure viable progression pathways continue.

Background

In 2011, the report 'Ensuring a Viable Progression Path in the Dairy Industry' (Allen & Waugh, 2012) was completed following a period of high milk prices, which saw the industry concerned about a drop in HOSM due to a perception of inequality of financial returns between the farm owners and sharemilkers. However since this time the milk price has varied from record high milk prices to the lowest milk price since 2000.

The number of HOSM positions has continued to decline at an average rate of 50 positions per year. Federated Farmers and DairyNZ are concerned about what this might mean for the industry and the ability of people to progress by building enough wealth to reach farm ownership, and initiated this study.

Methodology

A variety of methods were used to collate the data for this report including:

- Literature review
- 'What are our options?' workshops for farmers
- Survey of farm owners and sharemilker/contract milkers
- Rural professional meetings
- Presentation to the Federated Farmers Sharemilkers and Owners Council.

The volatility in the New Zealand dairy industry over the past five years has added another level of complexity to the pathway of progression. It has led to some significant gains in equity in some years and significant losses in others.

Trends

The volatility in the New Zealand dairy industry over the past five years has added another level of complexity to the pathway of progression. It has led to some significant gains in equity in some years and significant losses in others. This has emphasised the importance of timing of each step in the progression pathway. It has also led to many farm owners reviewing their management structures due to the difficulty in ensuring returns are fair for all parties.

Sharemilking statistics

The number of dairy farms in New Zealand steadily declined from 1995/96 to 2007/08. Since 2007/08, there has been a slight increase due to conversion of land into dairy farming. At the same time the average size of the herds has been steadily increasing, with the average herd in 2014/15 over 419 cows, 100 cows more than 10 years ago (**Figure 1**).

The total number of dairy farms has declined by more than 2,600 over the past 20 years and the number of HOSMs has declined by 1,564 over this same period (**Table 1**). This has resulted in only 17% of farms in the 2014/15 season having a HOSM compared to 23% in 2004/05. However there has not been the same decline in variable order sharemilkers (VOSM) and contract milkers, which has remained at around 15% since the early 2000s.

Table 1: Trend in number of dairy farms and sharemilking positions over the past 20 years

	1995	2005	2010	2015	2020* (est)
All farms	14,597	11,883	11,691	11,970	11,000
All sharemilkers	5,016	4,260	4,041	3,879	3,500
HOSM (average drop in positions/yr)	3,614	2,719 (-90/yr)	2,303 (-80/yr)	2,050 (-50/yr)	1,800 (-50/yr)

** The estimate for 2020 is based solely on the author's expectation of the number of dairy farms in New Zealand, combined with an extrapolation of the current trend in the decline of HOSM agreements*

Even though there are 2,050 HOSM positions, the contracts are typically for a three-year period. Therefore, on average, only 680 of these may come up for renewal every year. Many of these positions are family sharemilking for family, which tends to result in the sharemilkers being in the position for the long term. Also more and more HOSM are remaining on the same farm for six, nine or 12+ years, as opposed to growing their sharemilking business or purchasing their first farm. As a result, there are few opportunities for new people looking to get into HOSM in any one year.

This decline has been more marked in the South Island compared to the North Island, with only 13% of dairy farms in the South Island having a HOSM in 2014/15 compared to 19% in the North Island.

Volatility

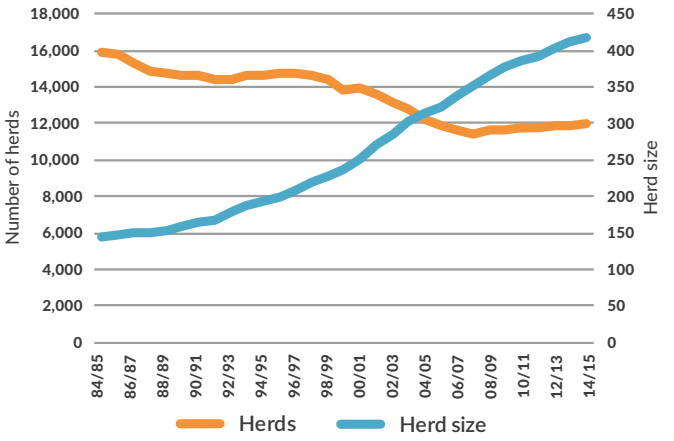
Major fluctuations in the milk price is causing significant variation in financial returns for sharemilkers and farm owners, as well as impacting on herd values, which in turn is a key determinant of sharemilker equity. This highlights the importance of timing of entry and exit into sharemilking arrangements, particularly for HOSMs.

Over the past decade there has been a significant increase in the volatility in the globally traded whole milk powder price (**Figure 2**).

This volatility directly impacts on the farmgate milk prices received by New Zealand farmers. Although volatility in the milk price is not new, the inter-season volatility has increased significantly over the past decade. **Figure 3** shows the opening farmgate milk price each season, followed by any inter-season changes and the resultant final milk price.

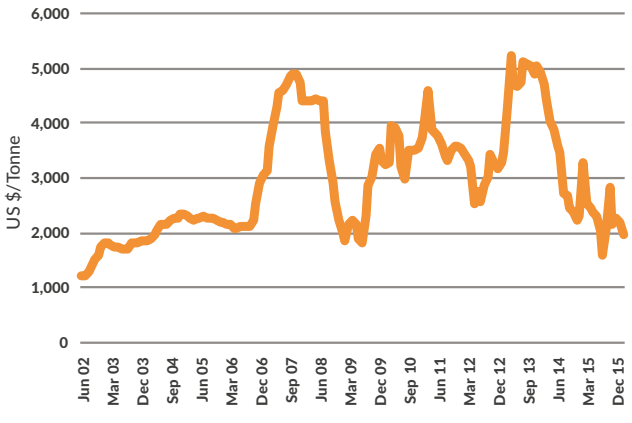
This shows the significant shifts to the within season milk price, such as in the 2014/15 season where there was a drop of $2.61/kg MS from the opening to the final milk price.

Figure 1: Number of dairy herds and average herd size over time



Source: NZ Dairy Statistics 2014-15

Figure 2: Whole milk powder prices (USD) over the past 13 years



Source: DairyNZ Economics Group

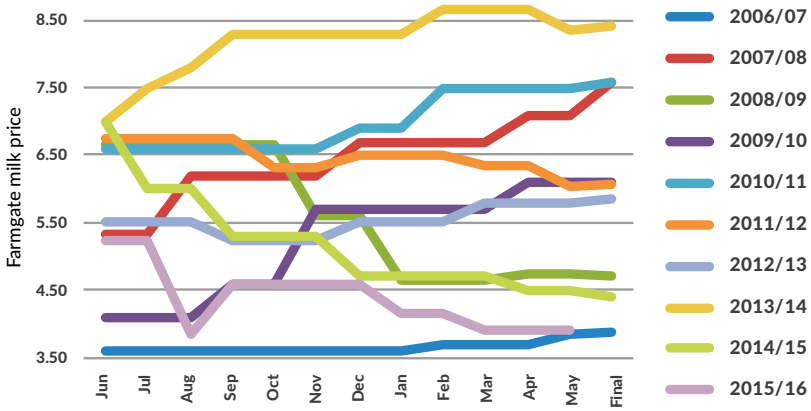


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Figure 3: Within season volatility of the farmgate milk price from 2008/09 to current milk price for the 2015/16 season

The price of cows is strongly correlated to the milk price (**Figure 4**), thus the value of a HOSM's business is particularly exposed to this price. High debt levels will exacerbate the issues of available equity.

Viability

There is little difference in financial return for a farm owner with a manager or with a VOSM. However there is a significant reduction in operating profit and return on asset if the farm owner employs a HOSM. The three-year average return on asset for a HOSM (2013/15) is 12% (**Table 2**).

Table 2: Comparison of the operating profit/ha and return on dairy assets over a 3-year period for an owner operator, an owner with a VOSM, an owner with a HOSM, and the HOSM business *

	Operating profit $/ha 3-year average (2013/2015)	Return on dairy asset 3-year average (2013/2015)
Owner	$2,422	5.0%
Owner with VOSM	$2,394	4.6%
Owner with HOSM	$1,340	3.2%
HOSM	$968	12.3%

** Data from the industry benchmarking tool Dairybase*

Over the past 10 years, there has been a gradual increase in the level of term debt held by dairy farmers from $12/kgMS in 2004/05 to $20/kgMS in 2013/14.

While the individual businessperson will ultimately decide what an acceptable return on investment is, as a comparison a cashflow-based business in an urban environment would typically target a 20% return on investment in return for the risks involved.

Over the past 10 years, there has been a gradual increase in the level of term debt held by dairy farmers from $12/kgMS in 2004/05 to $20/kgMS in 2013/14. This is estimated to have increased by a further $1.50 to $2 by the end of the 2015/16 season.

For sharemilker equity levels, the industry is seeing situations where VOSMs or HOSMs can end up with negative equity simply due to the rapid change in milk price. With HOSM debt over time, the volatility in cow prices has a significant effect on the equity percentage held within the dairy business. **Figure 5** hows the changes in average HOSM debt over the past decade.

In 2009, the milk price and corresponding cow price dropped, creating a situation where the average sharemilker had debt levels of 123% of the value of their assets. The above trend lines do not include the 2015/16 season, which saw a significant reduction in cow value. Sharemilking agreements and structures have struggled to keep pace with this increase in volatility and swings in equity growth.

The survey respondents were asked how long they believed they could maintain their current structure of the business if the milk price remains below $4.50/kgMS. The pie graphs in **Figures 6** and **7** show there are a number of businesses feeling they are under some significant financial pressure. Sixty-five percent of farm owners with a contract milker can only maintain their current structure for this season (2015/16) and next, while 23% feel they are stable.

When comparing the sharemilker/contract milker perspective, the VOSMs feel under the most pressure, with 65% of these feeling they are only able to maintain their structure for this season (2015/16) and next. Compare this to 33% of contract milkers and 42% of HOSM who feel they can only maintain their business structure for this season and next, and 52% of contract milkers and 42% of HOSM who feel they are in a stable position in terms of their business viability.

Aspirations

There is a noticeable trend away from sharemilkers aspiring to farm ownership. In 1996, 70% of responders were intending to go on to purchase a dairy farm compared with only 55% in 2011 and 47% in 2016. While in some cases this is almost certainly due to sharemilkers seeing farm ownership as a goal beyond their reach, there are increasing instances where they are content to remain in their position until retirement or in a career change. However talks with rural professionals had posed the following question for industry discussion:

Is the drop in people wanting to purchase a farm at the end of sharemilking an issue for the industry, or is it that only the top 20% of people ever really achieved farm ownership, so now people are more realistic about the likelihood of purchasing a farm?

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Figure 4: Trends in cow values and milk price over the past 20 years

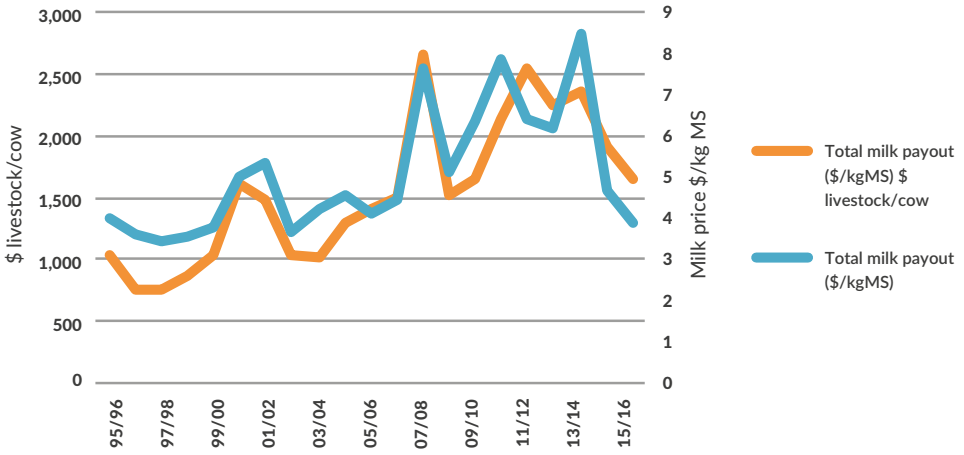

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Figure 5: HOSM debt $/cow and asset value $/cow

Source: DairyNZ Economics Group

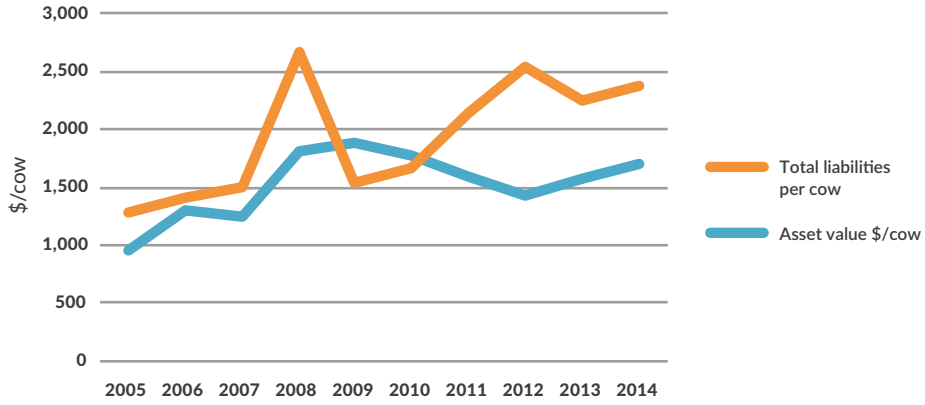

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Figure 6: Survey responses – farm owner – how long can you maintain your business structure if the milk price remains below $4.50/kgMS?

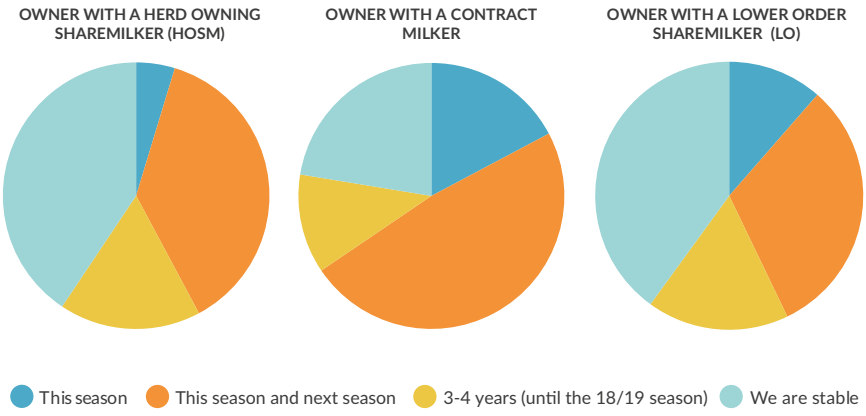

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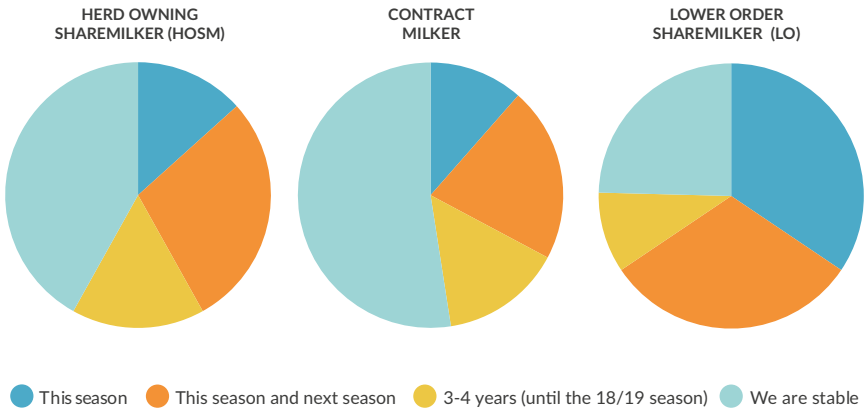
Figure 7: Survey responses – sharemilker/contract milker – how long can you maintain your business structure if the milk price remains below $4.50/kgMS?



The relativity of cow price to land price is an important ratio impacting on this. The trend of the number of cows required to purchase 1 ha of land over the last 22 years shows that during 2012/2014 when cow prices were high, farmland was on average just as affordable as in the mid-1990s and early 2000s. However with the drop in cow values and relatively stable land prices in the 2014/15 and 2015/16 seasons, there has been a significant increase in the number of cows required to purchase 1 ha of land (**Figure 8**). Again, this emphasises the importance of timing. If the milk price remains low in the short term, cow values are likely to remain low but may result in a softening of land prices. This could mean a slight decrease in the number of cows to purchase 1 ha of land, but this is not likely to change significantly until the cow values increase.

Alternative options

The workshops and surveys indicated two key points:

- There is an increase in the level of modification of the standard herd owning contract milking and VOSM agreements, e.g. maximum and minimum thresholds.
- There is a lack of understanding of alternative options, and a fair degree of caution amongst all parties about undertaking these options until further information is provided. Fifty-seven percent of farm owners surveyed indicated the business relationship between farm owner and sharemilker should be designed to maximise profitability of both businesses, whereas 83% of sharemilkers believed this should be the case. This highlights some disparity in thinking between farm owners and sharemilkers. The survey also illustrated that only approximately 40% of farm owners and sharemilkers shared their financial budgets with the other party to ensure alignment of plans and targets. Overall, while many sharemilking arrangements work well, there is still room for improvement.

Impact of volatility on progression

Although volatility is not new, the milk price troughs currently seem to be deeper and last longer than in the past. This volatility has significant impacts on the business including cash returns, equity growth, and difficulty in setting fair contracts at the start of the season.

With the inter-seasonal volatility in milk price, it can be very difficult to set a fair income split between the farm owner and sharemilker, particularly for a VOSM agreement. The VOSMs bring only a very small investment into the business and therefore generally have very low equity levels. To illustrate this point, if at the start of the 2014/15 season a variable order agreement is set up at 21% when the milk price was estimated to be $7/kg MS the VOSM would be looking to receive $1.47/kgMS. From this the typical costs of labour, electricity, fuel, provision of motorbikes need to be met. These costs are largely fixed, with little room for the sharemilker to reduce them. Therefore when the milk price dropped to $4.39/kg MS, their income dropped to $0.92/kgMS, and many VOSMs were in a position of financial loss for the year with limited or even negative levels of equity.

Figure 8: Number of cows required to purchase 1 ha of land (2016* estimated)

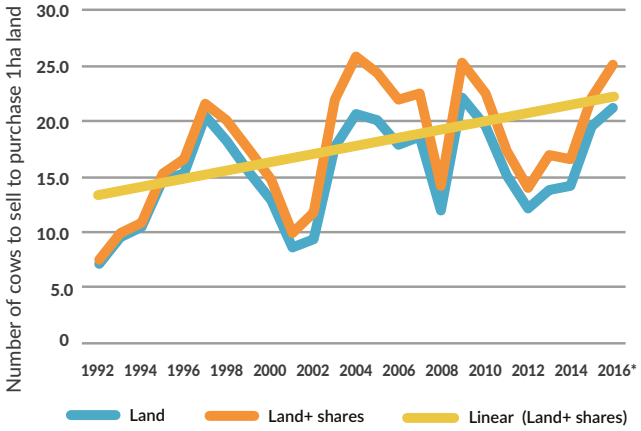
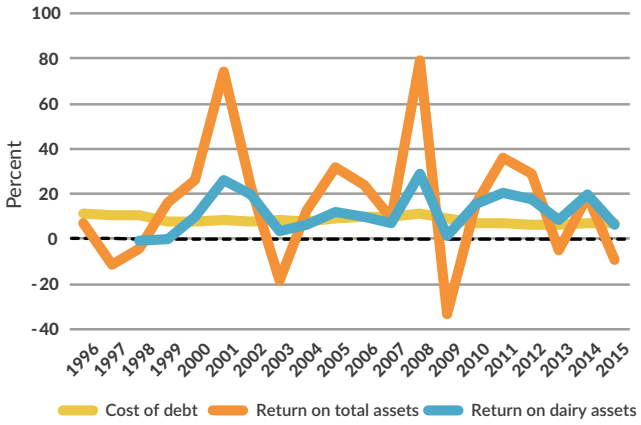


Figure 9: HOSM return on assets (total assets includes cow values) and cost of debt



This volatility can result in significant shifts in equity growth (or loss) from one season to the next. As cow prices are strongly correlated to milk price, and most of their assets are in the form of cows, it has significant implications for the equity of HOSMs.

As a result of the significant fluctuations in milk price and herd values, the timing of entering a HOSM position can have a significant influence on the success of the business. The steady decline in the number of HOSM positions available in any one year has resulted in it becoming increasingly difficult to control the timing of entry into a HOSM position. Often this is dictated by when an opportunity arises, meaning those looking to enter are frequently at the mercy of the market.

Some HOSMs that have taken on their first position when cow prices have been high have then experienced a significant drop in milk price and therefore cow values in their first season. The 2008/09 season was an example of this where the cow values dropped on average $1,100 per cow over the 12-month period. This is a significant drop in equity in addition to the drop in cash return as a result of the drop in milk price. However this drop in equity is only realised when the cows are sold.

This significant shift in equity over a 12-month period may result in the loss of some of our best young people who simply entered into a HOSM at the wrong time. This volatility is also likely to discourage some people from taking that step beyond contract milking due to the increased risk associated with VOSMs and HOSMs.

Figure 9 shows the significant changes to the return on assets, with the blue line including the value of the cows and the red line indicating the cash return on investment. The drop in milk price and cow values over the past 18 months will have had a significant negative impact on the return on total assets.

However farmers who are able to enter a HOSM position at the right time when cow values are low can experience significant increases in equity over a short period of time.

Increased volatility in the industry therefore accentuates the importance of timing in terms of an individual's first HOSM position and the timing of selling cows to purchase a farm or do something else with their career. With the decline in HOSM positions over time this timing is increasingly difficult to control.

There are positive aspects that are a result of volatility and a period of low milk price. It provides a great opportunity for those looking to take the next step, particularly if they are looking at purchasing their first herd of cows. The approach taken by the individual sharemilker will depend on their appetite for risk and perceptions of future milk prices.

Recommendations

Risk versus return

The issues of risk versus return do not appear to be well understood. For example, there is a definite trade-off between a contract milking agreement that eliminates the financial risk of milk price variability compared to a VOSM arrangement which includes it. Increased education is required. Detailed examples could be provided to increase understanding of the level and type of risk, the investment required and likely financial returns.

Alternative structures

It is suggested that although current sharemilking agreements are not necessarily broken, there is opportunity for further refinement. For example, in the 2015/16 season if the VOSM agreement included standard clauses around altering the percentage based on milk price (maximum/minimum thresholds), would there have been such a significant transition from VOSM agreements to contract milking or management agreements mid-season?

The industry needs to debate and raise awareness about sensible modifications to sharemilking arrangements, for example:

- VOSM agreements with a minimum income level (based on dollars/kgMS)
- Contract milking agreements with variable rates (depending on milk price)
- HOSM agreements with maximum/minimum returns for the sharemilker.

As individual farm businesses experiment with options, the industry needs to learn from these initiatives and use some of these specific examples to increase awareness and discussion.

Industry statistics

As contract milking becomes a more important and defined segment of the sharemilking sector, it is recommended that industry statistics be re-categorised to enable collection of data for this group specifically.

Due diligence

The research highlighted that in general there is a lack of due diligence when entering new business arrangements using sharemilking agreements. In general, there is a positional power imbalance between the farm owner and sharemilker due to issues around supply and demand (of sharemilking positions), but also around age, experience and wealth (useful for undertaking due diligence).

There were many anecdotal instances where sharemilkers entered into new arrangements without fully understanding the farming style, philosophies and personal dynamics of the other party, the physical aspects of the farm and farm system, or the financial position of the other party. Without fully researching these points, there is a definite risk of creating a mismatch between the farm owner and sharemilker, which ultimately can lead to failure through lack of financial performance or simply a deterioration of the business relationship.

There are a range of resources available to sharemilkers, but these should be packaged together into a due diligence checklist that could assist them and help redress the positional power imbalance described above. Such a checklist could include:

- Interview questions for the prospective sharemilker to ask the farm owner, e.g. farming philosophy, financial backing
- Reference checking of the farm owner
- Key points or skills for negotiating with the farm owner and purchasing stock, which is a major capital transaction for a young person
- Advice on preparing financial plans and bank guidelines on financial viability
- Due diligence checklist for physical aspects of the farming operation
- Where to seek professional help.

Ultimately the industry will dictate its own direction. Any initiatives undertaken will help smooth out some of the volatility, with the ultimate aim of keeping good people in the industry.

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ON-FARM STRATEGIES UNDER A LOW DAIRY PAYOUT

Dairy famers are now gearing up for their third low payout season. This article studies the focus of farmers, and how changes affect the viability and sustainability of the dairy farm.

WAIKATO RESPONSE

Dave Miller

When you reflect on how farmers have developed businesses over the last decade, and the recent responses we have seen heading into the third year of a challenging milk price, I suspect it presents a perfect study into rational economic behaviour.

Capital gain and budgeting

An environment that has presented tax-free capital gain opportunities means these will be chased. The shift to interest-only loans in the mid-1990s saw the previous principal payments capitalised into land value. The integration of supplementary feeding has allowed significant improvements in output per hectare and per cow and these too have been capitalised into land values.

In a similar cause and effect scenario, reasonable payouts and little accuracy in opening milk price forecasts meant that until two years ago the level of detailed on-farm financial budgeting was modest at best. Many of those budgets that were being done were often prepared by bankers with little ownership by farmers.

We have seen improvements in both the number of farmers actively budgeting and also in the accuracy of those budgets. However **Figures 1** and **2** highlight how variable the milk price is over the budgeting period. The first formal indication on expected milk price for the coming season is typically published in late May when draft budgets are being completed in March-April. **Figure 2** records the percentage change in the final milk price from the opening forecast.

These imprecise forecasts have tended to result in budgets that have been coarse in nature. Until very recently, many budgets were largely a roll-over exercise from the previous year. We are starting to see evidence of more 'blank sheet' budgeting, with increased scrutiny of every line item, although it is still not as common as might be expected.

Figure 1: Change in opening forecast and final milk price

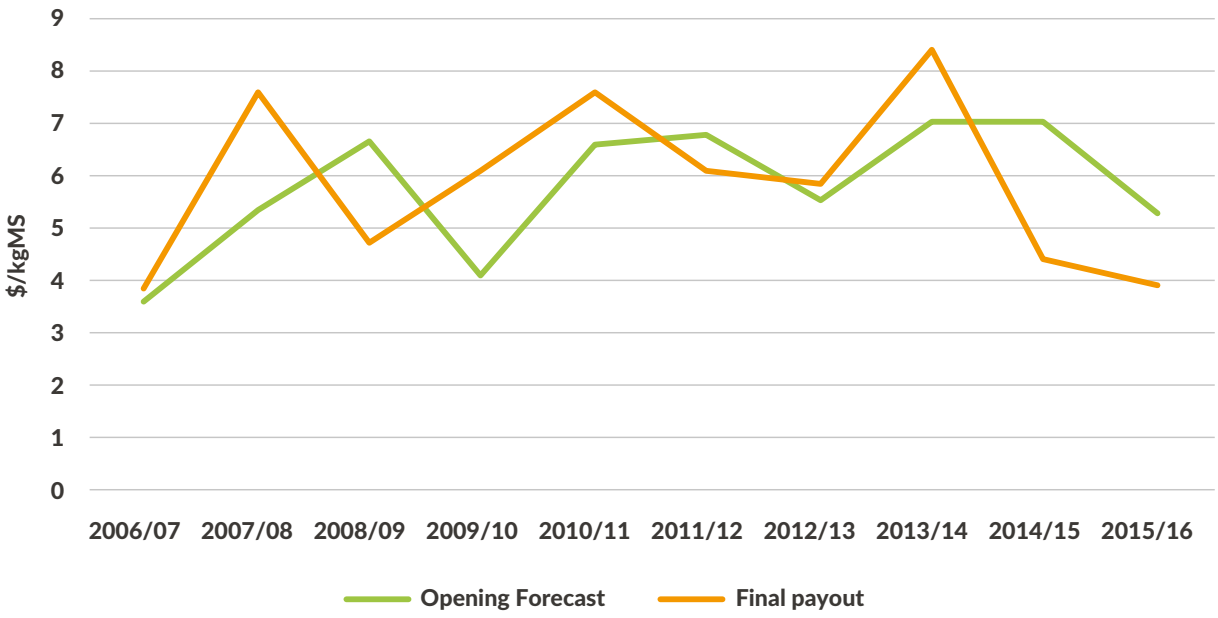


Figure 2: Percentage change in final milk price from opening forecast

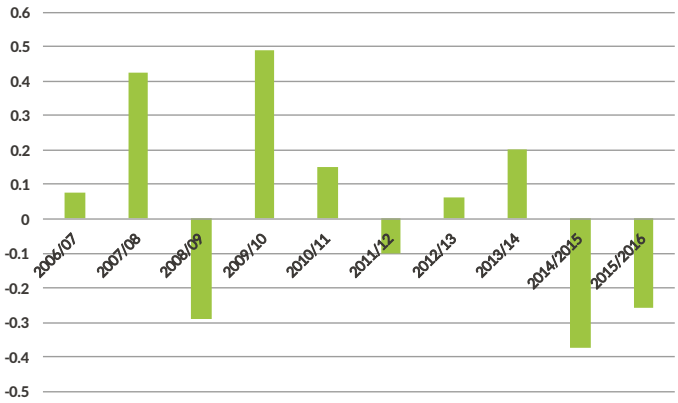


Table 1: Key variables from the AgFirst farm monitoring reports

	2013/14	2014/15	2015/16	2016/17 budget
Stocking rate	2.9	2.8	2.8	2.6
Kg MS/ha	1,023	1,060	1,020	1,010
Kg MS/cow	361	383	369	382
Net cash income $/kgMS	$7.90	$6.12	$4.09	$4.54
Expenses ($/kgMS)				
Animal health	$0.28	$0.25	$0.23	$0.22
Breeding	$0.16	$0.15	$0.13	$0.13
Feed including crops and grazing	$1.42	$1.27	$0.98	$0.98
Fertiliser	$0.43	$0.33	$0.38	$0.30
Repairs and maintenance	$0.33	$0.29	$0.24	$0.21
Overheads	$0.60	$0.41	$0.45	$0.43
Total farm working expenses	$4.54	$3.96	$3.63	$3.48
Interest	$1.04	$1.21	$1.24	$1.26
Net cash position ($/kgMS)	-0.18	-$0.10	-$1.22	-$0.56

On-farm decisions

This lack of clarity around the milk price prospects at the start of the season results in adjustments in input decisions as the season progresses, rather than a fully planned approach at the start of the season. This changing of the plans is impacting not just the dairy farmer, but a raft of suppliers to the dairy industry. Commercial growers of maize and fodder beet are increasingly gun-shy after bad experiences with cancelled orders.

The separation of farmers from direct market signals remains an issue for making finely-tuned on-farm decisions. At the time of writing, European stocks of skim milk powder (SMP) in storage were at 307,000 tonnes. The area planted in maize in the United States is the third largest planting since the 1940s and 7% up on last year. There appear to be few avenues for farmers to access interpretation of these macro influences on milk supply and demand trends as they try and make their own judgement calls on where payouts might end up.

Translation to on-farm changes

AgFirst has prepared a farm monitoring report for the Waikato/Bay of Plenty region for several years, with a Southland report prepared over the last two years as well. Participating farmers are not all AgFirst clients and the objective is to have a random sample that mirrors the Waikato average. **Table 1** details some of the key trends. Over this period term liabilities have increased from $16.20/kgMS to a forecast $21.45/kgMS in the 2016/17 season.

We did see increased spend on environmental mitigations, such as ugraded effluent systems and fencing of waterways, along with increased repairs and maintenance spending up until the 2014/15 season. This has significantly reduced over the last three years and is starting to show in the state of some farm infrastructure such as races. This maintenance can only be deferred so long before we see lifts in lameness etc.

The fertiliser spend has seen a reduced input of phosphate and an increase in nitrogen. While there was a soil fertility bank on many farms that could be exploited, it will have to be monitored carefully to ensure soil reserves are not depleted to the point where we see reduced pasture productivity.

The 2015/16 production season started with challenging spring conditions, with many farms falling below production expectations. Cash flow positions meant that despite a forecast El Nino drought, there did not appear to be any increase in on-farm cropping. As it turned out, we finished with a strong summer over much of the Waikato.

There is no doubt that stocking rates have eased back in response to reduced supplementary feed inputs. It is probable there will be a further easing as the impacts of the difficult facial eczema season become apparent post-calving.

I believe we are also seeing a firming of grazing residuals and rediscovery of what a 1,600kgDM/ha grazing residual really is. Supplements are being integrated with greater awareness of the linkage of response rate to the level of feeding.

Blank sheet budgeting is making a comeback, with a realisation that virtually all inputs have a marginal return. While there may have been a margin at $8 kgMS at current milk prices, no such assumption can be made now.

Longer term, the industry will have to accept and address the increased fixed cost in terms of interest through higher debt levels that the last three years have meant, as well as the deferred on-farm maintenance.

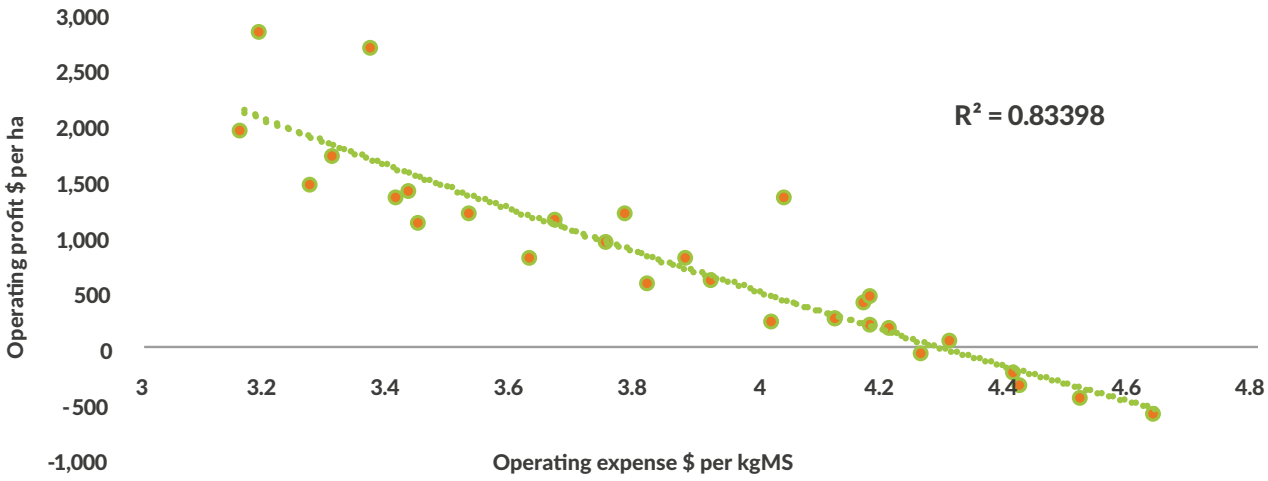
DRIVERS OF PROFITABILITY FOR CANTERBURY DAIRY FARMS

Jeremy Savage

As we are now entering our third season of low payouts, we have noted a real focus from dairy farming clients to run their farms at a low-cost structure on a sustainable basis. The initial focus was on the short-term savings. However with the current situation now turning into a medium-term downturn, consultants at Macfarlane Rural Business (MRB) have had a strong focus on farm systems and farm programs delivering resilience while also being in a position to deliver when the commodity prices recover.

We have analysed our client results for the 2015/16 season as part of our client benchmarking system (DSM). These results are for the Canterbury, Otago and Tasman regions (see **Figure 3**).

Figure 3: DSM profit watch – impact of operating expense ($/kgMS) on operating profit ($/kgMS) for MRB clients 2015/16



Farm operating expenditure

Farm operating expenditure continues to drive operating profit per hectare. As noted below, the physical performance indices show very poor relationships with profitability. It takes a very high ($8+/kgMS) payout before productivity per hectare begins to drive profitability (see **Table 2**). This is assuming that the cost structure remains the same, which is unlikely in a high payout environment as focus on cost control tends to wane.

Table 2: DSM profit watch – drivers of operating profit ($/ha) excluding depreciation for MRB clients 2015/16 season

Relationship			R-squared
Operating expenditure ($/kgMS)	vs	Operating profit ($/ha)	0.83
Feed harvested (kgDM/cow)	vs	Operating profit ($/ha)	0.07
Production per cow (kgMS/cow)	vs	Operating profit ($/ha)	0.06
Production per ha (kgMS/ha)	vs	Operating profit ($/ha) $6/kgMS	0.3
Production per ha (kgMS/ha)	vs	Operating profit ($/ha) $3.95/kgMS	0.09
Production per ha (kgMS/ha)	vs	Operating profit ($/ha) $8/kgMS	0.55

Operating costs per kgMS have a strong relationship with profitability. The ongoing low milk prices tend to amplify this relationship with profitability. The ability to derive a farm program and control costs is a key driver to high profitability.
The scale of the two samples is different and caused by just two very large-scale farms coming into the benchmarking group.
For the farm system, we have noted a deliberate drop in stocking rate and an increase in feed harvested per cow. Complemented with a solid standard of management we have noted an increase in per cow production. This is a parallel to the Lincoln University Dairy Farm (LUDF) and P21 research. To achieve this, we work closely with clients to achieve a high peak in the spring, maintain production and extend lactation well into the autumn, typically achieved with fodder beet (see **Table 3**).

Farm operating expenditure has dropped significantly over the past 12 months. The reasons for this include:

- Grazing and supplements have dropped due to lower costs for grain and less supplement per cow being fed with drops in stocking rate. The introduction of fodder beet on-farm has dropped supplement use as well, which is offset with an increase in cropping costs

- Grazing prices will be lower for the 2016/17 season by $0.10 to $0.15/kgMS, with the lower winter feed price in winter 2016
- Animal health and breeding has dropped $34/cow. Farmers have greater focus on areas of spend and have cut out some of the more marginal inputs
- Repairs and maintenance is back $75/ha. The big saving is tracks and laneways, but this area of spend tends to be one of the biggest and lumpy. It will need to be fixed up when the payout improves
- Fertiliser is back $97/ha, which is due to a combination of lower prices, targeted fertiliser application and, in some cases, mining soil fertility on the very high soil-tested paddocks. Only one farm in 34 assessed have cut their fertiliser well below the ideal.

The Canterbury sweet spot

Three seasons of low payouts have cemented our view that the sweet spot for a farm needs to be a resilient low-cost farm system. From the 2015/16 data, it has become clear that the key components of the sweet spot for Canterbury farms (see **Figure 4**) are:

- Operating expenditure – $3.80 per kgMS or less for low-cost irrigation systems
- Per cow production – 470+ kgMS or more
- Feed harvested – 3,800 kgDM/cow or more
- Supplement use – 700 kgDM/cow or less – supplement use only when it is essential to maintain per cow production or extend lactation length
- Repeatable and sustainable – calving spread, cow condition and conditions of employment all need to be sustainable and this farm program needs to carried out year-on-year, not just in one year
- Where the risks are understood and minimised – high per cow production expectations come with significant risks. Are the staff and management capable, do you have high-quality supplements to deal with shortfalls? Reliability of irrigation etc.

We appreciate that not all farms are able, or wish to be, in this zone of farm program. Having farms out of this zone allows us to learn aspects of how different farm programs work.

We also note that not all farms can fit this criteria. Some irrigation schemes have a higher working cost due to an interest and principal component being incorporated in the charges. These farms have costs structures $0.20 to $0.30/kgMS higher. A number of clients are only capable of producing 420-450 kgMS/cow due to smaller cows or a drought-prone environment. However they have been able to drop stocking rates and lift per cow production over the past three seasons, and drop operating expenditure below $4/kgMS as a consequence.

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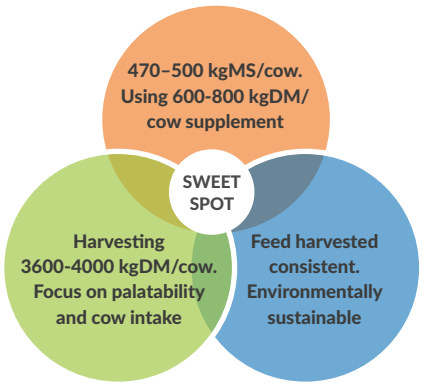
Table 3: DSM profit watch analysis over the seasons

Profit Watch Season Comparison			
Season		**2014/15**	**2015/16**
Farm numbers		**28**	**30**
Month – collated		**March**	**June**
Region			
Production	Effective area	242	227
	Stocking rate	3.56	3.5
	Kg milksolids/ha	1,609	1,709
	Kg milksolids/cow	452	484
	Cows	863	801
Feeding	Feed harvested – TDM/Ha	12.7	13.4
	Feed harvested – kgDM/cow	3,528	3,796
	Supplement per cow	761	857
	Total feed per cow	4,350	4,558
	Supplement as a % of intake	0	20%
Profitability	Milk price ($/kgMS)	$4.50	3.92
	Dividend ($/kgMS)	0	0.30
	Gross farm revenue/ha	7,891	7,107
	Operating expenses/ha	7,082	6,355
	Operating profit (EFS)/ha	809	754
	Gross farm revenue/KgMS	$4.91	4.32
	Operating expenses/KgMS	$4.35	3.87
	Operating profit (EFS)/KgMS	$0.49	0.45
	Farm working expenses/KgMs	$4.19	3.68
	Return on capital	0	0.01
	Assets employed	19,181,120	17,156,495
	Assets employed ($/Ha)	81,357	59,492
Financial KPI's		**2014/15**	**2015/16**
	Aninal health + breeding – $ / cow	$175	$140
	$ / kgMS	$0.39	$0.29
	Feed + grazing (incl lease) – $ / cow	$764	$665
	$ / kgMS	$1.69	$1.39
	Fertiliser + nitrogen – $ / Ha	$698	$644
	$ / kgMS	$0.44	$0.39
	Repairs & maintenance – $ / ha	$352	$291
	$ / kgMS	$0.28	$0.18
	Vehicles + fuel – $ / ha	$170	$172
	$ / kgMS	$0.11	$0.10
	Electricity (irrigation not incl) – $ / ha	$165	$178
	$ / cow	$46	$51.20
	$ / kgMS	$0.10	$0
	Overheads – $ / ha	$367	$342
	$ / kgMS	$0.23	$0.21
	FarmMax GM $ / cow		

Figure 4: The Canterbury sweet spot



KIOUMARS GHAMKHAR

Conserving and utilising plant germplasm and genetic resources

Biodiversity and genetic diversity

Biodiversity, which is variation among species, can only occur by means of variation within species. Genetic variation is a measure of the variation that exists in the genetic make-up of individuals within populations. It is the product of evolution. The theory of evolution is at times crudely known as the concept of the 'survival of the fittest'. Variation allows populations to adapt to a changed or changing environment. What happens if a plant is required to adapt with ecological changes? Variation is essential not only for the survival and reproduction of plant populations, but also for the very existence and the preservation of species diversity. Information about the genetic diversity of agricultural plants helps scientists and farmers to form strategies to preserve and protect the diversity of plants on and off-farm.

Why do we have gene banks?

In 1970, a disease epidemic struck the maize crop in the United States because of genetic uniformity, which resulted from the widespread reliance on cytoplasmic male sterility (CMS-T) for hybrid seed production. Later identified as 'race T' of the fungus *Helminthosporium maydis*, it shortly became known as the Southern corn leaf blight. In the early 2000s, an aggressive fungus spread from Africa and headed for the global centres of wheat-growing areas. This crisis is well documented and was known as the 2000s wheat rust (Ug99) crisis. It was brought partially under control only when a resistant accession (collected from North Africa) in Germany's IPK seed bank was found, hence the significance of the preservation of genetic diversity for generations to come. Potato cyst nematode (PCN) is the latest threat in 2016 that destroys more than 80% of the crop and remains active for a long time once established.

On a frozen arctic island, more than 850,000 samples of seeds are being stored at the Global Seed Vault to protect the world's food supply from epidemics, disasters or wars that might wipe out irreplaceable seed varieties. It is an international back-up centre for national and international plant gene banks around the globe. These gene banks are crucial resources for sustainable agriculture. Currently there are just about 2,000 gene banks worldwide holding 7.5 million accessions or individually collected packets of seeds. These genetic resources are strategic global assets. A sensible investor would be passionate about generating satisfactory yields with the lowest cost, lowest risk practices. Genetic resources held at the gene banks are a safety net against the loss of valuable germplasm. Guaranteed support for national gene banks is essential for the preservation of genetic diversity of food and feed crops and the protection of food resources. These assets conserve rich gene pools and help feed the host country as well as the world.

The relatives of today's crop and forage species, the ancestors and families of today's crop and forage plants, promise farmers an effective weapon to adapt to, rather than fight, climate variation. Priceless genes can be lost if these genetic resources are not collected, characterised, regenerated and maintained. Gene banks have the responsibility of routine processes and jobs, many interlinked, needing strong management.

Seeds of some cultivars developed from germplasm at AgResearch's Margot Forde Germplasm Centre

The seed collection at gene banks includes important traditional cultivars, their non-domesticated relatives, advanced as well as obsolete commercial varieties and breeding material. However to make this collection useable by breeders, scientists and the end users (farmers), a limited number of the accessions in a collection of each species (with a minimum amount of repetitiveness) must be provided by gene banks. This subset must represent the genetic spectrum of the whole collection. Any data obtained from the collection, including passport (collection site) and characterisation (molecular or non-molecular) data, can be used to select this 'core collection', which will then have as much genetic diversity as possible depending on its size. Genetic variability within the core collection of a species increases the chance of at least a few individuals being resistant to diseases or tolerant to abiotic stress such as drought, ensuring the survival of rare genes in that species.

On a frozen arctic island, more than 850,000 samples of seeds are being stored at the Global Seed Vault to protect the world's food supply from epidemics, disasters or wars that might wipe out irreplaceable seed varieties.

Climate change – threat or opportunity?

Climate is rapidly changing, putting our agricultural systems under more strain than ever before. Agriculture needs to acclimatise to tolerate more unusual weather patterns and varying conditions such as increased occurrence of low or high rainfall, heat waves and salinity.

The prospect of climate change in New Zealand based on patterns and forecasts by NIWA will inevitably force agricultural practice to change, adopt and adapt. The pace of this change must be planned in two tiers:

- *Incremental* – by doing better what we are doing now for the next 10 years
- *Transformational* – meaning something has to give/change and there are consequences. This needs to begin today and yield new products in the next 10 to 15 years.

Incremental change

Continuous testing and characterisation is recommended for the incremental change approach to develop new cultivars of current forage species used in New Zealand. The end products must match the system, environment, soils and management. Red clover is an example of a current species without exploitation of its potential genepool for this country. There are pros and cons in using red clover as a forage in New Zealand. The positive attributes are quality and intake, wide adaptation, seasonality of yield, ability to grow in mixed swards and, indeed, free nitrogen. The negative sides include low seed yield, poor persistence and under-grazing by animals. A focus for future research on red clover germplasm might be to explore germplasm with more bioactive components and the mechanism by which it can increase protein use efficiency in livestock rumen.

Depositing NZ's forage seed collection at the Global Seed Vault. L to R: Dr Asmund Asdal-Nordgen, Ms Marie Haga (Executive Director, Global Trust), Dr Kioumars Ghamkhar (Director, Margot Forde Germplasm) Centre)

The expanded understanding of the needs of a future-ready agriculture by scientists, the industry and farmers has directed research toward increased acknowledgement of the benefits of new forage species.

Hybrids of current and new species may also be another end product of the incremental change approach. These hybrids are implausible to transpire in nature, except when there are exceptional circumstances, e.g. very remote populations without other populations from the same species. The aim of these types of hybridisation would be to increase root biomass (persistence), shoot biomass, phosphate use efficiency, drought tolerance, disease resistance, nitrogen use efficiency etc that have been diluted in the genepool of the current forage species in New Zealand. However to show these features the hybrid may be dependent on coordinately controlled activity of plant proteins and metabolites associated with environmental factors.

Strategies for cost reduction of fertiliser in pastures are aimed at the inefficiencies of white clover. Some hybrids of white clover (*Trifolium repens*) and its closely-related wild species (*Trifolium uniflorum*) have shown higher biomass than white clover at Olsen P 9-20, increasing phosphate use efficiency (PUE) for future white clover hybrids. Adding to other effects of change, the water availability will be down by ~5-7.5% between 2030 and 2045 as a result of less precipitation or rainfall. Other hybrids of this cross-combination have maintained 10% soil moisture at 20 cm after almost four months with no irrigation, promising some white clover alternatives for this scenario. If they were irrigated weekly they maintained 30% of soil moisture at 20 cm. This is impressive knowing that soil moisture content is critical in biomass accumulation, run-off, soil conservation and evapotranspiration.

Transformational change

Products or species/cultivars resulting from the transformational change approach will be harder to take in and accept. Not only will there be novel species, new practices will also be needed for the successful implementation of this approach. However the expanded understanding of the needs of a future-ready agriculture by scientists, the industry and farmers has directed research toward increased acknowledgement of the benefits of new forage species.

Resilience and adaptability to different soil types and environments is a very important factor in the selection of species and their cultivars in summer dry and dryland agriculture. Subterranean clover (*Trifolium subterraneum* L.) is the most widely-sown species in Australia with three subspecies. The promise of this species to offer nutritious forage for farm animals and increase soil quality was recognised by A.W. Howard of Australia. Subspecies *subterraneum* tolerates grazing if managed well. It grows favourably in well-drained soils, while subspecies *yanninicum* is a perfect option for poorly-drained soils, both adapted to soil pH_{Ca} 4.5–6.5. Subspecies *brachycalycinum*, however, is recommended for cracking clays and stony soils and grows in pH_{Ca} 6.0–9.0.

There are 45 registered cultivars of subterranean clover in the public registrar or with the Plant Breeders Rights (PBR) Office in Australia, eight introductions from the wild and 21 crossbreds. Also, the germplasm of this species has been recently rationalised to a representative 97 accessions (core collection) out of the original 3,000

wild populations. This unique resource provides an unprecedented opportunity for New Zealand to discover new traits in this species across its diverse hill country. In summer dry hill country, it seems, we continuously fight against the hostile atmospheric conditions. The core collection consists of subterranean clover populations with potential drought tolerance (range of annual rainfall at collection site: 275-1200 mm), which can lead into developing cultivars for this region. Cold tolerance screening of this core collection is in progress in Germany, the results of which can be used to select the appropriate approach for developing cold tolerant subterranean clover for New Zealand. The availability of high-throughput screening of this trait via simple and non-invasive methods will speed up this development process.

Estimating the depth of a plant's underground structure is also a criterion for agricultural practices, with the aim of both yield and preservation of the soil and environment, and leads to sensible research decisions. Biserrula (*Biserrula pelecinus* L.) is a hard-seeded annual forage legume persistent in Mediterranean farming systems. It has a deep root system (more than 2m in unrestricted soils) and a significant seed yield of 300-1500 kg/ha, with an average of 17 seeds per pod. If low contamination seed packages, with the highest vigour in combination with the right germplasm and with up to an average of 24 seeds per pod, are chosen then the maximum yield is certainly achievable. It is adapted to a wide range of acid and alkaline soil types, and under heavy grazing adopts a prostrate growth habit that protects it from over-grazing. Appropriate management strategies and another forage species are needed when feeding animals with *biserrula* due to potential photosensitivity effects. It is also well suited to intensive crop-pasture rotations, thus minimising impacts on soil (health, nutrient deficiency etc). *Biserrula* has provided herbage yield as high as 11 t/ha in Western Australia.

NZ's gene bank contributing to change

New Zealand's only standard and internationally registered gene bank, the Margot Forde Germplasm Centre (MFGC), is based in AgResearch's Grasslands Campus in Palmerston North. The Centre has a set of tools, data and expertise to collect germplasm from around the globe and accumulate the diverse seed collections. It is also capable of making this collection of use to the breeders and research community for plant improvement and cultivar development. The information used by staff is mainly categorised into three groups: origin data, phenotypic data and genotypic data.

Origin data

The first group or origin data comprises: ecological data such as information about the structure or dynamics of the collected population and its neighbouring species; geographical data such as latitude and longitude or the GPS coordinates of the collection site on a map; and passport data such as soil pH, soil texture, climate.

Phenotypic data

The second group or phenotypic data comprises: agronomic data such as flowering time, hardseededness, cold tolerance, drought tolerance; morphological data such as hairiness, leaf colour patterns; and biochemical or physiological data such as primary and secondary compounds, chlorophyll content. To produce secondary compounds, plants operate an extremely complex process where factors such as biosynthesis, accumulation and expression play important roles. The complexity of these phenotypic traits must therefore be taken into account at the time of the germplasm rationalisation process. Techniques ranging from traditional chromatography to mass spectrometry can be used to obtain and interpret these data. Techniques such as gas chromatography mass spectrometry combine both powerful methods to identify compounds that are extremely hard to detect and conduct quantitative measurements.

Staff member working inside the cold room at the Margot Forde Germplasm Centre

Genotypic data

The third group or genotypic data comprises: DNA marker data such as amplified fragment length plymorphisms (AFLPs); simple sequence repeats (SSRs); single nucleotide polymorphisms (SNPs); and DNA sequencing data such as genotyping by sequencing, whole genome sequencing, exome sequencing. The existence of many of the markers, as well as their differences, and methodologies for their use require cautious consideration before choosing such methods. Sequencing means the identification of the arrangement of chemical compounds – coded as A, T, C and G – that form a genome.

Multivariate data for faster breeding

All these three main sets of data are interrelated. A good example of this is the different morphological types from populations collected in islands that normally show the uppermost genetic variation and the broadest range in phenotypic variation as well. In this particular case, origin, phenotypic and genotypic data are highly correlated. Together, these three sets of data provide 'multivariate data' to increase the chance of selecting the right and promising germplasm or population for faster breeding by targeting traits of interest. This practice is called pre-breeding and the process is currently being streamlined at the Centre.

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BOB ENGELBRECHT

Changes and progress in irrigation planning, development and management 2010-2016

This article is an update by the same author on an overview of the implications and effects of land use changes and water issues in Canterbury published in this Journal in September 2010.

Significant changes

It was only following my review of this article that I realised the very significant changes and progress that have been made over this six-year period. The changes have been to irrigation planning, development, installation and management in Canterbury, mid-Canterbury in particular, as well as in many other parts of New Zealand.

It is now estimated that of the 250,000 effective hectares in the area of plains land between the Rangitata and the Rakaia rivers, close to 220,000 ha (or nearly 90%) is now irrigated. This fact needs some qualification, as there are a few farms remaining still where the consented area for irrigation is greater than the area that is actually irrigated, while in other sites, whereas the farm may be fully covered for irrigation, there is less than adequate water to irrigate the property effectively or efficiently.

With increased water use efficiency and other technology changes many, if not most, of the original Ashburton district schemes are now commanding and irrigating a greater area of land than originally contemplated. The efficiency of application, particularly with new centre pivots in all their forms, frequently leads to a 20-30% saving in water compared with more traditional irrigators such as rotorainers and the like, and a saving of perhaps 70-80% of water use compared with the original borderdykes. With greater performance outcomes, this is simply because an application of say 8-10 mm a pass and a return cycle of perhaps 48 hours means that the soil moisture is managed within a very narrow range. There is no need to completely fill the soil profile and equally no need to allow the soil moisture level to fall to wilting point.

With these improvements in irrigation technology there is now perhaps more than enough water to irrigate the whole area of the Ashburton district plains. Water storage capability, varying from on-farm storage ponds, to larger scheme pond storage, to the availability of Lake Coleridge water to buffer the irrigation needs of the district, has led to a vast improvement in irrigation management capability and consequently improved farm production performance.

There was once a view that if farmers were allocated less water than they needed they would use it more efficiently. The understanding now is that if water availability is high then farmers can use it more effectively, always knowing that the final application necessary for a crop in its final growth days will be there when required. Many of our irrigation schemes now have a reliability factor of over 95%.

Improved irrigation technology and soils

Irrigation technology is constantly evolving and improving from variable rate application systems, to controlling irrigators by mobile phone management, to the increasing use of electronics for managing and monitoring what is happening in the field. Sophisticated developments include the ability of many modern spray irrigation systems to be monitored for maintenance requirements from their manufacturing base on the other side of the world.

A significant factor relating to soils that is frequently overlooked is the development of these soils, some of which have been irrigated for over 40 years. These now have the ability to 'hold' significantly more water and nutrients, which are available to the growing plants compared with 40 years earlier. Putting a spade into these soils that have had irrigation and adequate fertiliser and lime for the past 20-40 years will reveal soils that bear no resemblance to their original status. Compared with small dryland areas remaining in paddock corners, I would defy anyone to identify these soils as being the same. Those that have been irrigated for 30-40 years, and even more so if part of that time was dairying, will be full of worms and organic matter and will also be full of 'energy'.

With irrigation available, the range of land uses appropriate for any particular farm becomes increasingly greater, enabling a wide range of crops (both cash crops and forages), pastures, specialist seeds and horticulture crops to be grown. A wide range of reliable alternatives may be grown with potentially very high yield and quality and consequently much improved profitability.

Effect on rural communities

One of the major advantages that Ashburton district and the town has had over the past 30 or so years is that the reliable production from irrigation, along with further irrigation development (both on and off-farm) has encouraged an increasing urban population. With this has come the increasing demand for farm services and stability for the rest of the community.

Some 30 years ago my assessment then, confirmed by Ministry of Agriculture staff at the time, was that without irrigation in the district the population would likely be between 7,000 to 10,000. Farming would be predominantly dryland sheep production. The current population is around 33,000, of which 19,000 live in Ashburton town. The district's population is progressively growing, with unemployment being amongst the lowest in New Zealand.

Ashburton town is now generally recognised as the most dynamic rural town in New Zealand. This is undoubtedly a consequence of irrigation development over the years, exciting new initiatives from individual farmers, and irrigation equipment designers and technicians working in a collaborative manner. Amongst other processes this has been possible through increased measuring and monitoring and reporting between all the parties involved. The beneficiaries are the whole Ashburton community and the wider economy.

For the individual farmer developing irrigation, the investment almost always outperforms the original forecast.

If global warming has been correctly assessed then irrigation for our district, along with other parts of New Zealand, will become even more important for both the reliability and versatility of farm production no matter what form that might take. While tourism is often now touted as New Zealand's largest export earner, if all of the components of farming are combined, then tourism is still only a percentage of that of land-based industries. In fact, our intensive farming activities do provide significant opportunities for tourism within the district.

What must be recognised by our urban population and our country's leaders is that irrigation is a relatively long-term investment, so it needs appropriate funding to recognise this. The inter-generational development on many farms in Ashburton district has allowed the latest irrigation technology to be undertaken without placing too much financial stress on one generation of the farming family.

Farmer confidence

For the individual farmer developing irrigation, the investment almost always outperforms the original forecast, subject always to the need for a high standard of management practices and skills. Over the years, we have seen the changes in the level of confidence that grows in a farmer and their family after changing from dryland to irrigation farming.

Ashburton-Lyndhurst Irrigation Scheme new storage pond outlet

A high standard of environmental management is now accepted as being an important component of the current and future irrigation necessary to manage the nutrient losses from fertiliser and livestock waste for the benefit of the environment in the short, medium and long term.

Ashburton-Lyndhurst Irrigation Scheme trench preparation for main pipe (1.28 m) installation

In many conservative farming families, it has often been the change in generation that has initiated the irrigation development on properties. In an erratic and unreliable climate, such as is the case for much of the plains land of the Canterbury/North Otago region, without irrigation there is little chance for intensive farming operations to be carried out profitably.

Without irrigation on-farm incomes would fluctuate wildly between seasons, affecting the local farm servicing businesses, as well as the urban area itself. Undoubtedly, the cooperation between the various original schemes in the Ashburton district, the involvement of Electricity Ashburton as investment partners for much of the recent irrigation developments, along with improved and more cooperative relationships with Environment Canterbury and other local authorities, has aided the progress of irrigation development and the quality of projects in recent years.

More effective irrigation

The change from elected councillors for Environment Canterbury to Commissioners under the chairmanship of Dame Margaret Bazley has undoubtedly contributed to more effective progress for irrigation in Canterbury, in all respects.

By early 2010 the early stages of the Ashburton Lyndhurst Scheme were being converted to piped water delivered under pressure to farm boundaries, thus eliminating the need for pumps, with the associated operational and maintenance costs. Farmers could then simply 'turn on the tap' to operate their modern pivot irrigators. The lower pressure operating advantages of more modern irrigators contributed to the lower operational costs, effectively replacing them with the capital and debt servicing involved in the piped delivery systems.

With the increases in scheme storage, many of these irrigation schemes are now progressively being upgraded to those same high standards. The gentle and relatively consistent slope of the Ashburton district plains land undoubtedly contributes to the effectiveness of these irrigation systems. When further developed these schemes, incorporating the on and off-farm components, will become amongst some of the most sophisticated irrigation developments in the world.

Environmental issues

The need to manage the environmental challenges associated with irrigation has created new demands on farmers, both those operating from groundwater as individuals, as well as farmers within the various group schemes. However a high standard of environmental management is now accepted as being an important component of the current and future irrigation necessary to manage the nutrient losses from fertiliser and livestock waste for the benefit of the environment in the short, medium and long term. Greater cooperation between local authorities and irrigation farmers, both within the schemes and by individual irrigators, has developed well in recent years, contributed to by the involvement of the many technical advisors now operating within the irrigation industry.

While there is still some significant debate over the degree of environmental impact by irrigation farmers on the wide range of soil types within Canterbury, resolution is being achieved by greater cooperation between everyone involved in the process. Without doubt, the approach of 'self-regulation', particularly by those farmers within the irrigation scheme areas, is enabling progress to be made more effectively with a greater understanding of good management practice (GMP) in the preparation and auditing of farm environment plans (FEPs).

Ashburton-Lyndhurst Irrigation Scheme laying the main pipe for delivering irrigation water under pressure

The choice of 'Overseer' to determine nutrient loss to groundwater and/or open streams has had its sceptics and challenges along the way. However with increasing cooperation, discussion and debate there is more agreement developing over time between the parties in an effort to try and understand the various points of view, and there is a willingness to work together to achieve a satisfactory outcome for everyone.

Irrigation equipment

The Canterbury wind storm of September 2013 created havoc with most types of irrigation equipment. Subsequently, as a result of cooperation between irrigation farmers and their insurance companies there has been developed a number of means of securing mobile irrigators of all types to minimise damage to both machines and other equipment and structures.

The development of fixed-grid irrigation systems for irrigating steeper hill faces and other more difficult areas to access has demonstrated that many of these soils are very productive when water is applied, as the production is increased by a greater degree than most farmers could have imagined. With computer controls, while the capital cost of installation of such schemes is quite high, when under good management the cost-benefit of these in many locations is very acceptable.

Summary

Irrigation technology is constantly evolving and improving, reflecting the improved cooperation and communication between farmers and the irrigation equipment designers and installers, to the advantage of the farmers, the environment and the wider community.

Irrigation development is progressing in many districts throughout the country, extending to regions previously considered not likely to benefit from supplementing existing rainfall.

There are times when many involved in the irrigation industry, in all its aspects, have become quite concerned about the negative and adverse publicity that the irrigation farmer is subject to by the media. However most people recognise and understand that negative news is more popular than good news, whether it is by newspaper, radio, TV or social media.

Irrigation development is progressing in many districts throughout the country, extending to regions previously considered not likely to benefit from supplementing existing rainfall. However with improved technology, a greater understanding of the benefits of 'managed' water for the growth of both pasture and crops, and an increased cooperation between the many sectors of the industry, the continuing development and expansion of irrigation in rural New Zealand will continue for the benefit of the country as a whole.

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JOCK ALLISON

What does the future look like for agricultural science?

This article looks at the the challenges in rebuilding scientific capability within institutions servicing the primary industry in order to make the necessary changes to the present science system.

There have been many treatises on what are the requirements for science in New Zealand, and there isn't much point in repeating much of that material here – see the *National Statement of Science Investment* (NSSI) (2015-2025), *A Science Manifesto*, Royal Society (2008) and the latest *AgScience* (2016).

What is of interest to NZIPIM members I suggest is the effectiveness of the science effort in the primary industries in providing technologies for their clients. A significant decline in scientific effectiveness in providing opportunities and solutions for industry over time has been inescapable since the establishment of the Crown Research Institutes (CRIs) in 1992.

Government's vision for science

The NSSI sets out the Government's long-term vision for the science system and a strategic direction to guide future investment. Under the Minister of Science and Innovation's foreword, the Hon Steven Joyce states, 'The Government believes excellent high impact science is fundamental to our ability to achieve excellent economic, environmental, social and cultural outcomes for New Zealand.' I note that for applied agricultural research, that if the first criterion of high impact science is met then the following four virtually look after themselves.

Is the proposed change to a quadruple bottom line criteria going to deliver leading edge agriculture research in our primary industries, or is this simply being used as defensive response to a lack of agricultural research so desperately needed at the moment? The genesis of the CRIs was a political belief that the way that science was organised in New Zealand meant that MPs were unable to have any influence on what science was being undertaken or on the main organisations undertaking that science. The MPs must have assumed that their influence would be positive? We will see later.

Science funding in the past

The primary industries were well served in the 1960s, 1970s and 1980s. The highly successful and productive Ministry of Agriculture and Fisheries (MAF) Agricultural Research Division and the Department of Scientific & Industrial Research (DSIR) were both funded 100% directly by government. Annual allocations were made, there was no competitive bidding for funds, and there was thus a well-defined and relatively safe career in science. Alas, all of this has changed. More importantly, scientific staff were able to communicate directly with farmers and these organisations had a strong profile and reputation within industry through technology produced and transferred.

The senior directors of MAF and DSIR had strong track records in science and application, and much time was spent on assessing opportunities and priorities for research. Despite this, there was a strong political will to change. In 1986, MAF decided it was time for the industry to pay for advisory services and MAF Tech was formed, which included the Advisory Services Division and Agricultural Research. User pays was the requirement for Advisory Services, for a service which previously had been free, and this worked in concert with the private advisory services and farm improvement clubs.

The main part of the reforms was the establishment of the CRIs and there was bi-partisan political agreement between Labour and National that a new research configuration was required. The CRI model was hatched by National's Simon Upton. Competitive funding required CRIs to bid for funds and more industry funding was also sought. Further, it was thought that even a little debt (up to $20 million at a time) on the balance sheet would help the new CRIs to think commercially. The new Foundation of Research Science & Technology (FoRST) managed the process of assessing bids for R&D funds and a new Ministry of Research Science & Technology (MoRST) developing science policy.

This outcome achieved the research funder/research provider split that was deemed to be so important at the time. Immediately, the financial impost of FoRST and MoRST, plus the time required for the preparation of bids for funds (many scientists estimate this at more than 10% of their time), resulted in less being spent on research. The new CRIs required much higher salaries for senior management, and new business managers were important to the requirement for revenue generation from industry as service provision was now a signficant part of revenue derivation. In the new corporate structure, chief executive officers and senior management were responsible to boards of directors and the salary norms related to 'best practice' for companies of the particular size, well in excess of previous science norms, leading to the commercialisation of science.

Real value of science funding for agriculture research diminished

At the outset in 1992 AgResearch had a budget of about $95 million, approximately 1,200 staff and about 90% government funding. Now the revenue is about $155 million, with slightly more than half the number of staff, and with only 39% government funding (about 230 active scientists). Given the demise of scientific capability within the CRI structure, how can it be rated as a success for agricultural research?

Of particular interest is that in 1993 the value of New Zealand's agricultural exports was $10.16 billion, and there has been an increase of about 175% to $28 billion in 2015/2016. The CPI index has increased by 62% since 1993, so we have a real industry value of exports about 75% greater in 2015/2016, yet government only provides funding of 39% to AgResearch, or $60 million. This illustrates a very big drop-off of funding to the agricultural industry, when its share of total New Zealand exports has in fact been growing over the period, having increased from 55.6% of total exports to 60% in 2015/2016.

The situation is illustrated in **Table 1**.

It is clear that agricultural exports are still a major component of New Zealand's export income and are likely to remain so. There might be some debate about the figures in the table, but New Zealand does not compare favourably with the OECD, which has increased average R&D investment from 2.2% of GDP to 2.4%, while this country has decreased from 1.19% to 1.17%. What is of no debate is the decline in capability and impact since transitioning from MAF and the DSIR in 1992 to the present day.

What has happened and what might be done about it?

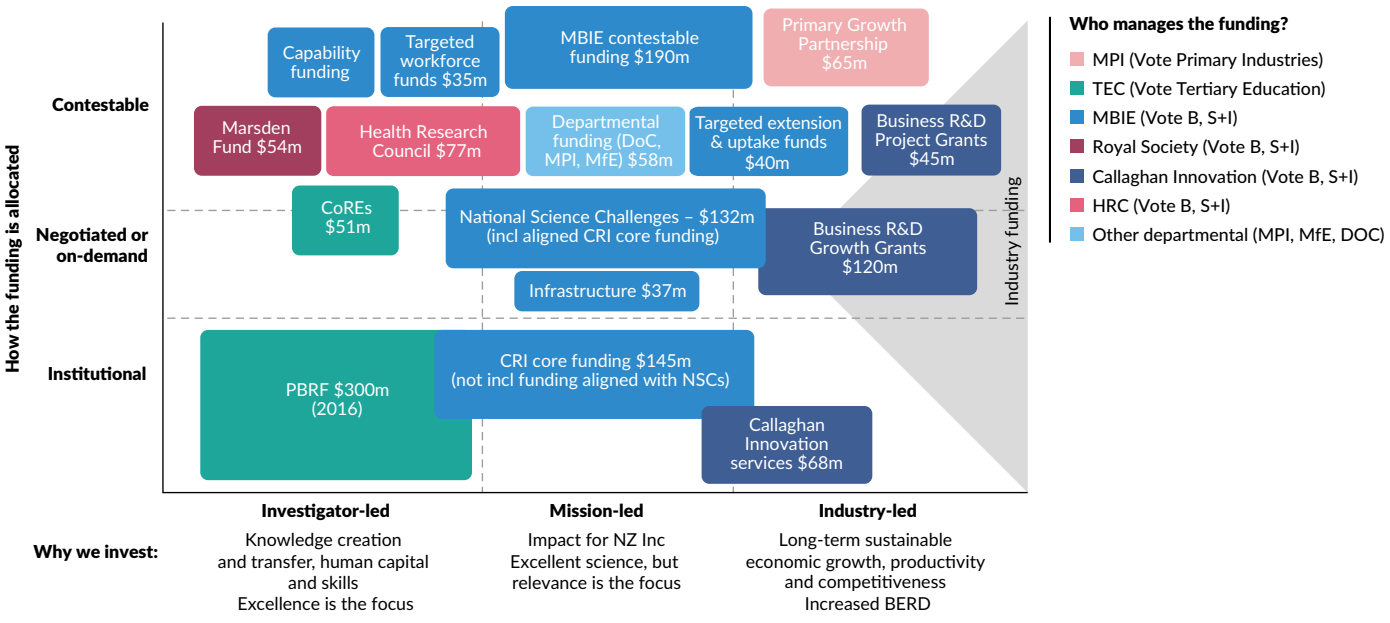
At the start of the CRIs in 1992, the main research funders were FoRST and the Health Research Council. Since that time, universities have come into competitive funding and government funding is dispersed through many channels with a number of parties managing it. This can be seen in **Figure 1** (from the 2015 NSSI). Even with a total of 16 different funds, administered by seven different ministries or institutions into which

Table 1: Estimate of the value of primary production exports and government funding for AgResearch

Year	1992/1993	2015/2016
Agricultural production exports ($ billion)	10.1	28.0
CPI adjusted ($ billion)	10.1	17.3 (+71%)
AgResearch funding ($ million)	95	155
Science + MAF funding ($ million)	85	70
CPI adjusted ($ million)	85	43.2
Government funding for AgResearch % *	89.5	39

** Some revenue from farm produce, but it is not possible to estimate from Annual Reports how much actually comes from government*

Figure 1: Governments's main expenditures on science and innovation



Source: National State of Science Investment 2015-2025 *(MBIE), p. 26.*

intending scientists/research providers might bid, there are further divisions within those funds. For example, there are 11 National Science Challenges and the number is being added to 'as more money becomes available' as various science projects are completed. The business grants and the Primary Growth Partnership (PGP) funding require co-funding, with government providing 20-40% for business grants, and 50% for PGP up to December 2015, and 40% thereafter. The reason for the reduction of government funding within the PGP is unclear, but represents a further decline in agricultural research funding.

AgResearch are now recruited overseas. Within the CRI models, commercial income has not grown as expected and declining funding has required cuts in budgets (staff), thus reducing science capability.

The success rates in derivation of funding from many of these funds is low, said to be less than 10% for the Marsden Fund and the Health Research Council. The requirement for demonstrated cooperation with other groups within organisations, and between organisations, further increases the complexity of applying for funding and following that the conduct of research. The staff time expended in bidding for funds has variously been estimated between 10% and 15% of total science time.

When government funding is low, the competitive funding environment is even more destructive. If funding applications are not successful, then staff redundancies follow and science staff are mostly affected. A demonstrable 'track record' is a critical prerequisite for a successful funding application, and as senior scientists are progressively made redundant due to a lack of funding then derivation of further funding becomes even more difficult.

Through successive restructuring in AgResearch we have progressively lost a vast amount of institutional memory. So how do we promote science as a positive and rewarding career choice to smart young New Zealanders when potential candidates observe well-reported redundancies occurring within our leading agricultural research institution (or perhaps they have simply decided to pursue other career options)? I understand that 60-70% of scientists at AgResearch are now recruited overseas. Within the CRI models, commercial income has not grown as expected and declining funding has required cuts in budgets (staff), thus reducing science capability. Further the 'corporate model' has often required that all communication with the industry and the press be routed through head office, thus clogging up the previous public service model (pre-1990) of complete openness with industry. Most journalists have simply given up, leading to a very low-profile and much diminished coverage in the farming press.

Industry funding has also become more difficult. Initially for AgResearch the Ovita developments invested close to $100 million of the Wool Board reserves in biotechnology R&D towards the sheep industry. Additional investment by the Meat Board in beef cattle and plant genomic research, plus contributions from Deer NZ, added significantly to the research effort and there was a strong industry/AgResearch cooperative effort co-funded by FoRST for several years. AgResearch was the main research provider, but was particularly reticent about sharing their intellectual property with the consortium intellectual property.

The relationship between research providers and their industry funders has also changed the relationship between scientists and funders. CRIs have restricted publication to protect putative intellectual property, as have commercial funders. An example of this is having scientists promote new products developed under commercial arrangements, where scientists have till now been regarded by industry as not being independent and driven by other interests. It is particularly concerning to see scientists and management of research institutions fronting advertising campaigns where efficacy claims are made for a product or, even worse, diminishing 'other company' products. Independence in scientists is a criterion which must be cherished.

The upshot of all this is that the significant injections of industry funding, much of it from reserves, has now largely dried up from within the sheep and beef sector. Now Beef+Lamb NZ outside of Beef+Lamb Genetics fund only about $5 million per annum for research, which doesn't go far. An additional $7 million per annum is spent on technology transfer/extension. Fonterra has historically invested more in R&D, but with the dairy industry in a slump significant additional funds from that quarter may be less likely in the short term.

What could a new science funding system look like?

The NSSI clearly identifies the important features for a world class science system, the vision being a highly dynamic, better performing and with a growth in business expenditure on R&D (or BERD) The features specified are:

- As simple as possible with clear expectations and incentives
- High-performing and transparent
- Should be stable over time
- Would have an appropriate role for government.

The two main pillars of the system should be research excellence and impact.

In agricultural research over the past decade there has been a huge loss in capability, a consequent loss in funding, and a concentration in many areas not of particular relevance and/or of application to the primary sector.

Research excellence

Research excellence implies that the most important criterion in the system is capability. In agricultural research over the past decade there has been a huge loss in capability, a consequent loss in funding, and a concentration in many areas not of particular relevance and/or of application to the primary sector. This is further complicated by the need for research institutions to recover overhead costs. Universities also look to recover overhead costs for developing programmes and undertaking research.

The first two bullet points above do require high capability to attract funds, to lead high-quality innovative research programmes and to attract scientists to high-performing groups. Research excellence (read capability) also provides much needed new technology to the agricultural sector and attracts international cooperation. Thus the highest capability is the most important ingredient for a successful research organisation. Of course stable funding is required to nurture that capability, with the opportunity to expand as new skills are attracted to the already successful individuals and/or groups.

As the science bureaucrats note, international cooperation is desirable/essential for effectiveness. Scientists cooperate with others on the basis of their science capability and mutual interest, not because they are forced together in the same location. The appropriate role for government is to provide the financial support. After a minimal amount of planning for the successful science system, there is a minimal requirement then for government continuing to impose new funding directions and diffusion, which is the case at present.

It is concerning that there has been no political traction regarding the diminution of the science effort at Invermay, and big science capability losses within AgResearch suggests limited political understanding or effectiveness in maintaining and building R&D for the primary sector. There is much posturing about doubling the value of primary exports by 2025, but seemingly no concern about the present and future losses in science capability within AgResearch.

The present fixation on new research hubs at Lincoln and Palmerston North has already ensured a considerable loss in scientific capability, particularly within AgResearch. In my view, there has been no compelling justification for the shifting of the deer research programme and the Sheep Genetics and Genomics Group to Lincoln where there is little land available, few other researchers with whom to cooperate and, more importantly, most staff will simply not shift. Further both the deer industry and the stud sheep breeders industry strongly indicated that they did not want these two groups to shift to Lincoln. I would expect to see a similar loss of staff from Ruakura when (and if) they are required to shift. Stable funding over time is required to allow the redevelopment of a career structure for science, which hopefully will follow through for more students to have the confidence to embark on postgraduate study in agricultural topics.

Impact

In the NSSI there is considerable emphasis on 'impact' specified as the number of papers in top-ranked journals and/or based on citation indices. Certainly these criteria have relevance as to the quality of the research, but they have less relevance as to 'impact', particularly as this relates to the agricultural sector. From an agricultural production point of view, the value of impacts on farm production will make any perceived CRI financial profits, or the importance of citations or scientific papers, pale into insignificance. Thus the requirement for a profit from operations in the CRIs is really a nonsense and the model for R&D in New Zealand is inappropriate.

There has been much promotion of the view that there is a huge 'gulf' between technology and application and that 'farm systems' research (or application) is worthy of much more research emphasis. I disagree strongly with this thesis, and note that farmers have always been very good at the uptake of relevant technology when it is developed and when it is promoted/extended. Good recent examples are the parasitoid wasp which has been widely released to control clover root weevil, and the Invermay Sheep Genetics and Genomics Group at Invermay.

It is my view that there is not the widely espoused gulf, and that the real problem is the low ebb in agricultural research, with few new technologies available for uptake by the industry. In their 2015 Annual Report AgResearch outlined five areas for increased emphasis in the future:

- Assisting New Zealand firms in their desire to move up the value chain by growing our R&D activities in food safety and security and innovative, high-value food products
- Working much more closely with Māori agribusiness across the agriculture value chain
- Increasing our R&D to develop future dynamic farm systems that achieve economic, social, cultural and environmental outcomes

Continued from page 43

- More strongly integrating R&D in animal and forage sciences into a farm systems framework
- Growing our, and assisting others', understanding and planning for adoption and practice change behaviour to ensure technology and knowledge generated from R&D is taken up and deployed on New Zealand farms.

The first area is part of Food HQ, a major initiative to catalyse increased value in food products, and the next three are really within the realm of primary industry farm advisory professionals, not the science effort. The last is an area of social science which will in my opinion not add significant value. There is no particular science excellence and/or relevance in the last four of the five areas. We do not want detailed sociological study as to why farmers don't take up technology, when in fact they are very good at this when the technology offers financial and/or other benefits.

Clearly technology that will add significant value to primary sector businesses will be attractive for uptake as has proved to be the case many times in the past. Perhaps we are in a relevant technology drought for the primary industries due to a run down of total science effort and a concentration in areas which have little relevance to the farmer.

Challenges ahead

For the reasons outlined above we have a number of challenges ahead of us in rebuilding scientific capability within institutions servicing the primary industry. If we are to be successful in this regard, I believe a new science system should:

- Have a greatly simplified largely bulk funding system, which means that the plurality of science funds and controllers should be reconfigured (see **Figure 1**)
- Not be a commercial model where profit is a driver. This funding should come under the control of science leaders (directors) who have a demonstrable track record in science in the industry and strong industry links
- Allow cooperative research with the commercial sector, but maintain scientific independence
- Encourage scientists to engage with the industry and the general public about their research, as appropriate.

However implementing changes to the present science system will be difficult. It will require admission from politicians and senior science policy-makers that for agriculture, the enduring backbone of New Zealand's export industry, our scientific capability and effective output is at a very low ebb with no indication that this is likely to change any time soon.

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NZIPIM PROFILE

Hilton Collier
Ngati Porou

Ruatoria beginnings

The journey from growing up in the East Coast township of Ruatoria to giving a mihi whakatau (welcome) to influential interior design consultants in an upmarket Seattle soft furnishings store marks another career milestone for immediate past-President Hilton Collier. His life mission to continue to push the development of tribally-owned lands is now being connected to the users and consumers of the products from the farms he works with.

From an early age he was exposed to the work of renowned Ngati Porou leader, Te Apirana Ngata. He had a legacy of land development programmes, and the mercantile co-ops he set up to support those developments when he realised the mainstream merchants were unwilling to provide the support they readily extended to pakeha.

Lincoln

In Hilton's view the use of contemporary economic activities as a conduit to ensure the retention of heritage assets for the benefit of future generations is a powerful motivating force for many. In his case, it was a driving force that saw him depart from the sanctuary of the family farm on the East Coast to complete his secondary schooling in Gisborne. From there he attended Lincoln where he experienced life as one of the very few Māori who were attending the college in the early 1980s – a world far removed from the predominantly Māori, East Coast of his childhood.

At Lincoln he built many friendships and experienced the passion of high country farmers for their land. He also first came into contact with fellow student John Brakenridge. In 1985, Hilton graduated with a Bachelor of Agricultural Science degree and was offered employment as a farm advisory officer by the Department of Agriculture. This was a career path that developed many farm advisors over the years.

Rogernomics

During that time farming was confronted with the radical restructuring of New Zealand's economy during what was called Rogernomics. No longer was the government supporting farmers, but worse, they were exposed to market forces and interest rates of 20% or more were the norm. The industry was in survival mode – raise productivity, diversify revenue streams or get out. Many farmers failed and left and this was a tough time for an early career advisory officer.

Large client management

A posting to Wairoa saw Hilton start to really develop his own farming client base – a mix of owner-operators, managed farms and some government work. He also began working with Māori incorporations keen to support 'one of their own' and these relationships endure today.

In 1995, he became one of the founding shareholders in Agfirst. The signs were good – his client book was full with solid repeatable business to provide the cash flow to support a family, including four children. It was also a pivotal time as he realised providing advice was unfulfilling. The decision to cease working with owner-operators and concentrate on 'managing' large clients was risky, but being an area of keen interest it became a deliberate strategy.

Māori-owned farming

In the meantime another Ngati Porou leader and Hilton's uncle, Apirana Mahuika, convinced him to help his iwi with their farming ventures. He agreed to help with some project work for Pakihiroa Station. Over the next decade this small project resulted in Hilton restructuring that farming business and set it on a growth pathway. Entry into the Ahuwhenua competition also extended the network of large Māori-owned farming.

By now Hilton was busier than directing the management of a large number of Māori trusts and incorporations who wanted his style of leadership. He had also accepted some governance positions, including NZIPIM, as a way of giving back to his community. Unlike the production at all costs thinking of his early career, he had now had leaned back towards the values of his childhood. Water and land were both taonga and people were the kaitiaki. Production remained important to him, but so was the operation of farming systems that enhanced these taonga for future generations.

Firstlight Foods

To enable this a higher farm gate price was needed for produce, but the challenge was to see how this might be achieved. He understood value came from delivering on consumer needs. These needs are not usually known by the consumer so they cannot be articulated by them. Understanding this requires market definition, research and interpretation. What Hilton had done in the 1990s when he consciously decided to work with a defined client type was his first insight into the power of this approach.

A search for a niche meat marketing company renewed his acquaintance with Gerard Hickey of Firstlight Foods, a company with a mature venison business model and a farmer production group aligned to a defined consumer segment. They also had the other participants in that supply chain aligned to deliver on their promise to customers.

Following this meeting, Hilton introduced Wagyu genetics across part of their Angus breeding herd and the aim was to provide a consistently exceptional dining experience. The execution required a premium steak product that was marbled to provide consistent tenderness and taste. The cattle had to be grass-fed and come from an environmentally-friendly farm.

A simple plan required farming skill to be applied to breed and grow these cattle using methods that enhanced the environment. Other brand partners would contribute processing, logistical and cooking skills to deliver on the promise to customers. This approach was not far removed from his core training as a farm advisor, but required a different way of thinking and great relationship building skills. It also meant the farmers' interests in the result went beyond the delivery to the processor.

Merino NZ

A chance meeting with John Brakenridge in 2013 followed a similar path. Hilton no longer had any interest in managing for wool and that meeting proved a fertile thinking ground. The following year Merino NZ were taking wool from Hilton's farming clients and prototyping a new channel to market with them, as well as looking to develop new product offerings. Merino rams were trucked to the East Coast to be used as terminal sires across part of their ewe hogget flock. The aim was to find a way to support the Siliere branded lamb programme, with shoulder of season supply, and to produce finer cross-bred wool that might be suitable for use in the active sportswear apparel market.

Te Hono Bootcamp

In 2014, Collier attended the third Primary Sector Executives Bootcamp (Te Hono) at Stanford University in the heart of Silicon Valley. He felt the value of this experience was the time spent in an ecosystem of innovation. For Hilton, disruption is the norm and failure is a badge of honour and he saw Te Hono also happened to have a population of the consumer profile LOHAs (lifestyles of health and sustainability).

Te Hono is a movement of primary sector leaders working together to help transition New Zealand from the industrial age mindset of produce at all costs to turning the nation into an artisan supplier of food and fibre products to clothe and feed just 40 million LOHAs. For Hilton believes that higher-value goods produced by people who care very much about how we treat our land, water and people must be the way forward for Aotearoa New Zealand. He believes that because Māori do not sell land they have a vested interest in ensuring the land is a better place as a result. The challenge now is for all the primary sector to participate in this journey.

Building the capability and capacity of Rural Professionals

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