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AgScience

Inside

The New Zealand Institute of Agricultural & Horticultural Science Inc

A drop in the bucket...

I SEE NO REASON to complain about the Budget. It is necessarily conservative at a time when austerity is needed, so the Government's plan for $385 million of new spending on research, science, and innovation is both brave and certainly very welcome. It is a drop in the bucket of what is needed, though, and there are disturbing weaknesses in what I regard as other critical areas of expenditure, especially biosecurity.

The 2% increase in funding support for science degrees signalled in the Budget will be welcomed by the tertiary sector, but let's not fool ourselves that this is enough to address the low output of students in agricultural and horticultural science and – ultimately – our economic woes. A much bigger change is required and it doesn't necessarily mean spending more money. I am talking about changing the model we use to fund tertiary study.

To understand the problem, we need to look back to the free-market ideology of the 1980s. In short, we started to fund the tertiary sector based primarily on the number of "bums on seats". Simply put, more students equate to more money for a university or polytechnic. There are few constraints and provided students enrol in a programme, the taxpayer's money flows into the tertiary system. Perhaps unsurprisingly, the total cost of the tertiary sector has sky-rocketed.

Do we produce the type of graduates we need to grow our economy? The prevailing ideology of the time held that the "market place" would lead to competition and, through this, the tertiary programmes of greatest value to the economy would get more students and hence better funding. What the ideologues failed to realise was that the market place is global and if you are an English-speaking graduate born here, the world is your oyster, not just New Zealand. Little wonder then that so many of our best and brightest collect their degrees and get on the next plane out. We have, in effect, engineered the brain-drain!

I don't think you can force graduates to stay in New Zealand, or force them to study towards particular qualifications, but I do believe we can better incentivise graduates to stay. We could achieve this by better subsidising degrees that we deem are of greater value to our small and reasonably unique bio-economy and by ensuring there are meaningful and well-paid jobs available for them in New Zealand. We need to pick winners both in the qualifications we support and the industries we promote.

Governments don't seem to like picking winners, because it is inherently a political exercise, but we need to be realistic. Many of our qualifications at all levels including PhD, are in subjects or on topics that seem to be a luxury we can ill-afford as a small country. In contrast, and from my most certainly biased perspective, I think we need to spend a bit more on topics of more immediate economic relevance, including agricultural and horticultural science.

There is no magic bullet, but making a PhD in agricultural or horticultural science cost-neutral would be a start. It currently costs a student up to $20,000 a year to study when living costs and fees are factored in, and this doesn't include lost earnings. To gain a PhD takes at least seven years ($140,000 of expense) and there is no prospect of a highly paid research job at the end. If you are fortunate enough to get a job, you might be paid $60,000 a year, $70,000 if you are outstanding. Is that an incentive to apply your brains to solving problems in – say – the dairy industry, or should you just drive the milk tanker?

So start picking winners, Government. Facilitate free access to degrees in agricultural and horticultural science that underpin the creation of valuable and sustainable production systems. This could be cost-neutral if you reduce the "subsidies" paid to universities and polytechnics producing graduates in areas that are of limited benefit to anyone other than the holder of the degree, and whoever it is that ultimately employs them overseas. Funding of the tertiary sector needs to be an investment for our future as a country and not to supply graduates to make someone else's economy prosper.

Jon Hickford
President

Please Note : In this issue of AgScience from pages 6-16 we publish an abridged version of the papers given at our Forum "The Role of Agricultural & Horticultural Science and Innovation in the Future of New Zealand" held in Wellington late last year.

NZIAHS CANTERBURY SECTION FORUM

Date: Wednesday 22nd August 2012
9.00am to 4.30pm
NZ Emissions Trading Scheme and how our agriculture/horticulture/forestry will cope with what is required.
Venue: Baylis Lounge, Lincoln Events Centre, Meijer Drive, Lincoln

NOTICE TO MEMBERS

Please be advised that the
NZIAHS Annual General Meeting
will be held at 4.30pm on Wednesday 22nd August 2012
following the Canterbury Section Forum.
Venue: Baylis Lounge, Lincoln Events Centre, Meijer Drive, Lincoln.

WHAT'S IN A NAME
– and what's not?

Here we go again – more restructuring in the science domain, to take effect on 1 July. But we had only just got used to the idea of having a Ministry of Science and Innovation, launched last year after the Government combined the Foundation for Research, Science and Technology (which existed to drive innovation) and the Ministry of Research, Science and Technology (which supported those innovations financially).

Back in 2009 the Government started "the biggest overhaul of the science system in 20 years" (according to a statement from Wayne Mapp on 1st June last year, when he was Minister of Research, Science and Technology). The new ministry he was announcing that day was the next step in those reforms and eight Crown-owned research institutes would report to it. It had been charged with managing science funding, advising the Government on New Zealand's science system, and driving knowledge transfer from the science sector to business and other research users.

In his statement, Dr Mapp said the new ministry was set to play a key role in boosting New Zealand's economic growth. It would lead a robust science and innovation system that would improve our economic performance, he said. "It signals the Government's commitment to unlocking the huge potential science has to lift our economy and our whole society."

A few weeks later Fairfax newspapers reported him saying he had championed the ministry's name, because he was a believer in "business names describing to people what you are actually doing". BusinessNZ chief executive Phil O'Reilly agreed the name was "quite important". He said he had been pleased when he saw its title because it "doesn't suggest an exclusive focus but a clear recognition both [science and innovation] are important."

Other countries have similar attitudes to the importance of a name. Denmark has a Ministry of Science, Technology and Innovation. China, Japan, India, Pakistan, South Korea, Sri Lanka and Brazil each has a Ministry of Science and Technology. Russia has a Ministry of Education and Science.

Mr O'Reilly – by the way – said there was a lot of goodwill and enthusiasm in the business community for the new ministry's job, to build a bridge between the science and business communities as part of the Government's push for higher productivity and economic growth.

But its creation as a science and innovation ministry had been a close call. "There was always the opportunity to make it part of a wider agency," he explained. "The most obvious candidate was the Ministry of Economic Development". But he was pleased with the decision taken in the upshot. "They made the right call because science and innovation is a massively important cross-central thing we need to get our heads around in New Zealand."

Mr O'Reilly chaired the Capitalising on Research and Development Action Group, which at that time was working with the architects of the new ministry. But the design apparently became obsolete remarkably quickly, because new architects were called in when the post-election Key Government decided on another restructuring, to build a bigger (and better?) super-ministry.

Most obviously, the decision was taken to take "science" out of the super-ministry's name and to set it up as the Ministry of Business, Innovation and Employment. It will open for business under that name on 1 July, bringing together the existing functions of the Ministry of Science and Innovation, Ministry of Economic Development, Department of Labour and Department of Building and Housing.

There was a familiar ring to the rhetoric. Economic Development Minister Steven Joyce (who is Minister of Science and Innovation, too) said the new ministry would help the Government drive forward its business growth agenda and make it easier for businesses to engage with the Government. "Our business growth agenda will make it easier for businesses and companies to access innovative ideas, markets, capital, skilled workers, resources and the supporting public infrastructure."

Background notes from the Government said the Ministry of Science and Innovation played an important role in providing leadership for the science and innovation system to deliver prosperity and wellbeing for New Zealanders "and, as part of the new ministry, this important work will continue". Science and technological innovation were essential in helping companies understand and respond to domestic and global demands. There also was "an increasing desire to see value created from the commercialisation of smart ideas, and an increase in discovery-led research".

The new ministry will continue to fund social, environmental and health-related research. To ensure there continues to be "an appropriate emphasis" on these areas, it will be transparent about its priority setting (for example through the cross-Government Statement of Science Priorities). All current science and innovation funding decisions will continue to be made by appropriate boards.

– Bob Edlin

by John Lancashire
Immediate Past President

LOOPHOLES IN OUR BIOSECURITY SYSTEM

Failures threaten our economic recovery

The future growth of our economy and our major primary biological exports is threatened by ongoing leaks in our borders to incursions of dangerous pests and diseases. The Queensland fruit fly, which threatens our $3 billion horticultural export industry; the Psa bacterium which could cost the kiwifruit industry up to $1 billion (and dozens of jobs); the destructive varroa bee mite which requires a short-term fix by miticide applications costing $50/hive/year for control; the tomato/potato psyllid which is destroying tamarillo orchards and has cost the industry $100 million and the clover root weevil are recent examples of what biosecurity failures can cost the country. In addition, as pointed out by the Minister of Primary Industries, David Carter, the massive response to the recent detection of the fruit fly will cost millions of dollars. Although the Horticulture New Zealand chief executive Peter Silcock has said it is not the time to cast blame, it is still critical that we find the reasons for these costly failures.

Certainly the government decision to randomly x-ray baggage rather than checking all items at international airports, driven apparently by the Tourism sector and the perceived need to hasten passenger throughput, must have increased the risk of pest incursions. Moreover, as Andrew Fenton, President of Horticulture New Zealand, has pointed out, the reduction in front-line staff of 12% in the past four years when passenger numbers have increased by 14% cannot be helpful. Further, two former biosecurity officers have said that border screening short cuts have increased the chances of pests like the Queensland fruit fly getting into the country.

Andrew Coleman of Biosecurity New Zealand has responded by stating that there are 280 staff at international airports and 180 staff monitoring import health standards in cargo and parcel post. He also claimed that the system was working because the fruit fly had been found. With respect, that's a bit late and it is costing millions of dollars to search for other associated incursions. Of course no system can be absolutely fool-proof but some recent policies can only increase the risk.

Another example of government policies increasing the risk of disease is in the marathon battle between the Ministry of Primary Industries and the Pork Industry Board to allow imports of raw pig meat. The industry has already spent $1.4 million presenting its case and the High Court has recently ruled in favour of the Ministry of Primary Industry (MPI), although an appeal is still an option. The problem here is that the scientific advice to the industry is that the proposed imports pose an unacceptable risk in terms of bringing an extremely destructive disease – Porcine Reproductive Respiratory Syndrome (PRRS) – into the country. MPI Director General Wayne McNee has said "there is a very slight risk". Is that acceptable?

Unfortunately there are other pressures driving the New Zealand policy. They relate to the government push for more free-trade agreements. There is no doubt there is pressure from actual and potential free trade partners for the relaxation of imports of raw pig meat. And our pig industry is very small and presumably regarded as expendable by government. It is impossible to believe that if the threat was foot and mouth disease a statement "of a very slight risk" would be acceptable.

The situation with Psa bacterium on kiwifruit and the varroa mite on bees is different because the way these organisms got into the country is unclear. In the case of Psa, work at Otago University suggests the origin of the disease was probably China. There are several possibilities for the transfer of the disease via plant material, but importations of breeding material are strictly monitored through well developed quarantine systems.

The possibility of transfer by pollen has been considered, but an earlier ministry opinion was that "the risk was slight". As the disease has been causing severe damage to kiwifruit crops throughout the world for some time, it is unfortunate we have been unable to carry out the research that might have stopped this incursion. A relatively small investment on pre-border issues might have prevented the enormous costs and disruption now facing the industry and New Zealand. We know even less about the entry of varroa, although there is a fairly widespread view in the industry that an illegal importation of queens might have carried the mite.

It does appear that New Zealand has moved to a slightly "softer" position on biosecurity. Certainly the old "precautionary principle" – where restrictions remain in place if there is the slightest risk – has been dumped. Exports of our apples to Australia were banned for 90 years, because of the alleged risk of fireblight. This suggests our near neighbour takes a much harder and more effective line than New Zealand. Australia does not have Psa, varroa bee mite or the two devastating pig viruses PRRS and PMWS.

It appears that neo-liberal moves in recent years by both major parties to less regulation and freer trade have meant we are taking more risks at a time of growing biosecurity threats. The slight "loosening" of border controls has led to some very expensive search and control measures with the painted apple moth and now fruit fly. In other cases – Psa being a current example – search and control measures have failed. A simple business case suggests that a greater emphasis on off-shore prevention and tighter border controls would be more effective and give substantial cost savings over the expensive "clean up" required after an incursion has occurred.

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Mixed reviews on science spending

About a quarter of the way through the 2012 Budget speech, Finance Minister Bill English mentioned $385 million of new investment over four years in research, science, and innovation.

"We need to support businesses and farms to innovate and stay ahead of the competition," he said.

"And we need to ensure New Zealanders have the right skills to compete in an increasingly global labour market."

Over the next four years, Budget 2012 investments include:

- $166 million to redevelop an Advanced Technology Institute, which will help New Zealand's high-tech firms grow, increase exports, and ramp up productivity.
- $60 million to support a series of National Science Challenges, which will seek innovative solutions to specific questions of national significance.
- $100 million additional funding for the Performance-Based Research Fund to support world-class research in New Zealand's universities.
- $59 million to boost funding for science and engineering courses. Funding rates for engineering degrees will be increased by 8.8% and for science degrees by 2%.

In its first three years, the Primary Growth Partnership has stimulated more than $430 million in research and development investment from government and industry. A further $270 million of investment by the Government and industry is awaiting approval of business plans or negotiating contracts.

A statement from Science and Innovation Minister Steven Joyce added that the Budget provided $250 million of new operating funding and $76.1 million in capital funding over four years for science, innovation, and research.

The Government's total cross-portfolio funding for science, innovation, and research is being lifted from $1.16 billion in 2011/12 to $1.24 billion in 2012/13.

Total direct cross-portfolio science, innovation, and research funding has risen by 17% over the past four years.

The ATI and National Science Challenges would help boost the economy and improve New Zealand's health, society, and environment, Joyce said.

The creation of the ATI would better link business and science, and help create new high-tech products and services.

The National Science Challenges will focus multi-disciplinary teams of researchers on addressing challenges that are fundamental to New Zealand's future prosperity and wellbeing.

The scientific and farming community did not rejoice in unison at the announcement.

Dr William Rolleston, vice president of Federated Farmers, said it was particularly pleasing to see an increase in the PBRF funding and a $59 million boost for science and engineering courses.

Human capability, particular in agricultural sciences, had been run down over the years and needed rebuilding if New Zealand was to remain agricultural world leaders, extract more value from the agriculture sector and produce within environmental constraints.

Professor Shaun Hendy, President of the New Zealand Association of Scientists, said his organisation welcomed funding for the Advanced Technology Institute and the new National Science Challenges.

The contestable funding system had largely eliminated the type of research and development that gave us companies like Fisher & Paykel Healthcare, he said. "The Advanced Technology Institute should help rebuild this capability in New Zealand."

But the budget had ignored the issues facing New Zealand's emerging scientists. Last year more than 500 scientists called for the government to address the lack of opportunities for young scientists in this country. Figures obtained by the NZAS point to a 25% decline in positions for post-doctoral scientists since 2008.

"Young scientists today face much dimmer prospects than when this government took office", said Hendy. "After this budget, they will be booking tickets for countries that are willing to invest in the future."

The budget provided only a 3% real increase in science and innovation spending, falling far short of achieving the levels of investment in science and technology made by other small countries, like Singapore or Denmark. It also kept the focus only on the short-term while ignoring the long-term nature of science funding.

Hendy also noted that while the high-value manufacturing sector had benefited in the Budget, the other areas of science would face shrinking budgets.

Neville Jordan, immediate past president of the Royal Society of New Zealand and science and technology investor, was not so critical. He said it was "an excellent budget for science, engineering and technology", not just in terms of the new funding but the 'challenges' will have a marked effect on bringing together New Zealand science, engineering and technology to focus on solving issues of great importance to the country's economy. This previously had been difficult to achieve.

"Overall, a score of 8/10 from me and a well-finessed budget considering severe international constraints."

– Bob Edlin

NZIAHS President, Jon Hickford's reaction to the Budget's science provisions in AgHort Talking on page 2.

New Zealand's voyage of economic

I AM A THEORETICAL physicist, working at Industrial Research Ltd, Victoria University of Wellington and the MacDiarmid Institute. I have been looking at innovation, using tools from theoretical physics and mathematics to try to understand it. I am particularly interested in the role that scale and connectivity play in innovation.

By way of introduction, let me compare two New Zealand inventions. The first is use of fine merino wool to make clothing, which has led to Icebreaker, now an iconic New Zealand brand. Much of the manufacturing may be done offshore now but it is still based on New Zealand's merino wool. Kiwis have taken something invented in the Marlborough Sounds and turned it into a US$100m revenue company.

My second example led to a US$3b revenue company. The product it sells was invented in Auckland and is based on expanded polytetrafluoroethylene, which basically is stretched Teflon. The company is Gore-Tex. It is not a New Zealand company and despite the fact that a New Zealander invented the process to make stretched Teflon, New Zealand does not export this today.

Why is it that countries produce certain products and can take certain products to the market but maybe not others? Both Icebreaker and Gore-Tex target similar markets so why doesn't New Zealand sell both? Is it just luck or is something else going on?

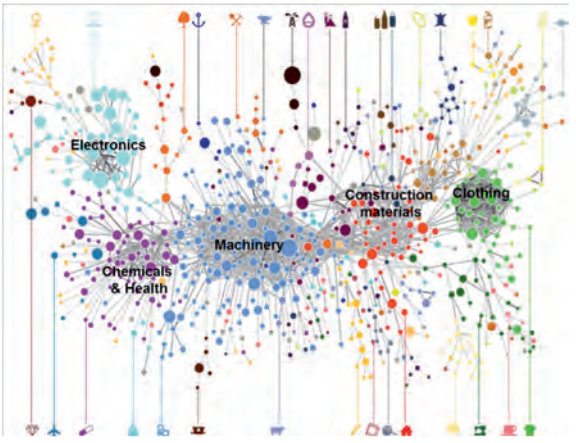

Figure 1: A map of product space based on relationships between the products that countries export (AJG Simoes, CA Hidalgo. Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence. (2011); R Hausmann, CA Hidalgo, S Bustos, M Coscia, S Chung, J Jimenez, A Simoes, M Yildirim. The Atlas of Economic Complexity. Puritan Press. Cambridge MA. (2011))

Economic development is path-dependent. The investment decisions we make now will lead to specialisations that determine the types of products we can invent and produce later. There are different paths we can take through the space of possible products, and to a certain extent countries can explore these byways. But it can be difficult for countries to venture too far from the basic pattern of specialisation that they develop.

A group of physicists at Harvard have produced a map of this space of products. They have looked at all the products manufactured in the world and built up relationships between those products based on which countries export what products. Poor countries are generally restricted to being on the periphery of product space. The periphery includes commodity products (such as milk powder). Rich countries have some products out in the periphery, too, but they also have moved into the interior of this product space. They are working in a much more complex space of products and this in turn gives them access to many more opportunities to develop new products. Rich countries therefore tend to have much more diverse economies.

The challenge for New Zealand is to find our way from the outskirts of product space into the centre where many more economic opportunities are available.

To find this path we will need to innovate. Most economists would agree that innovation is the key driver of prosperity in advanced economies. But comparative data showing the number of patents per million people puts New Zealand down near the bottom. Countries like Switzerland and Japan are at the top. Clearly, we are not innovating as strongly as other countries. Why is this?

Using a database of patents, we have looked at patenting in Australasia and broken it down by city. For example, we have looked at the number of patents per capita in Auckland and Adelaide, two cities with similar populations. The number of patents per capita turns out to be similar. But Melbourne and Sydney produce many more patents per capita than Auckland and Adelaide, and Australia is about 30% higher in patents per capita than New Zealand, almost entirely because of Melbourne and Sydney. So bigger cities produce more patents per capita and bigger population centres drive innovation. Cities like Shanghai and Bejing perhaps have the potential to become the innovation hubs for the world. This is consistent with our understanding of economic geography.

In another study, we have looked at scientific journal articles and the connections within different cities based on the way people can be linked by scientific journal articles. Again we find the bigger the city, the more connected the scientists are in that city. Auckland has a similar connectivity to Adelaide or Perth whereas Brisbane, Melbourne and Sydney have a much higher connectivity. Scientists in bigger cities are able to specialise more and get deeper into their areas of knowledge by working in a more connected way. This makes bigger cities more inventive.

New Zealand doesn't have a truly large city by international standards. This suggests we need to work harder at innovation to compensate for our economic geography, which hinders our ability to innovate. To overcome these disadvantages, New Zealanders need to learn to collaborate as if they were a city of four million people.

Let's look at our innovation ecosystem in another way. We have looked at the distribution of patents between companies in the US, New Zealand, Australia and Finland. A small number of companies have a large number of patents and a large number of companies have a very small number of patents. The Finnish data, for instance, show that the largest patent holder in Finland is Nokia, which built up a network of more than one thousand inventors over about a decade. These inventors obviously worked together in a dense collaborative network to turn Nokia into the dominant mobile phone company by the mid-2000s.

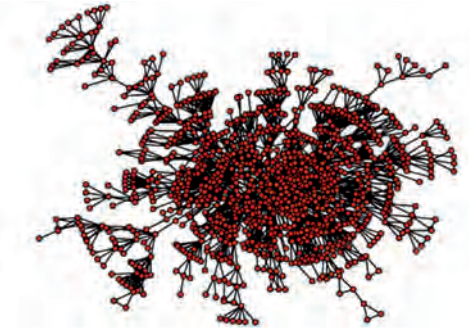

Figure 2: The Nokia inventor network constructed using EPO patents through to the end of 2006. The network, which began to grow in 1993, contained 1356 inventors by the end of 2006.

At the other end of the spectrum is an American example, Intuitive Surgical, which is one of the companies with just a handful of patents. Although it is a small company, it turns out to be embedded in

By Prof Shaun Hendy
President, NZ Association of Scientists

self-discovery

the biggest inventor network we have found in our studies. We have mapped 22,000 connected inventors in this network. They are not geographically located in San Francisco but stretch right down the western seaboard of California and no single large company dominates it. In fact they all seem to be smallish companies in the medical-device or healthcare sector.

We often look at and admire the big players in innovation, like Nokia. But it is also interesting to look at what is going on at the other end of the ecosystem and see that the companies there, too, are highly connected and working together.

Similarly, we can look at who is connected to whom in New Zealand's largest network of inventors and at our international connections, and then we can study local patterns of innovation. The largest group of people who have collaborated in this country is a network of about 450 inventors. It includes 14 different New Zealand companies, four CRIs, three universities and a private research institute. Fonterra is one of these companies and Massey is one of these universities. The Fonterra Research Centre is right across the road from Massey University so it seems natural that collaboration would occur.

We can go down to Otago and also find people collaborating with Fonterra. Then we find links to AgResearch. IRL is in there, too, and the MacDiarmid Institute. You can go all the way up to Fisher & Paykel Healthcare, and then there is Neuron Pharmaceuticals and the Mallaghan Institute back in Wellington, a medical research institute. Finally you can go offshore and find that companies like Pfizer are also linked in. So there is a lot of diversity in this largest inventor network and we would not necessarily expect, if we were to take a sectoral approach, that all these organisations would be working together and collaborating.

One of the messages from our studies concerns scale and connectivity. The scale at which you are undertaking an activity and the connectivity you have when you are undertaking that activity seem to be very important when it comes to innovation. But when you look at how scale and connectivity is being achieved, the connections are often very unpredictable.

When we looked at New Zealand's largest network of inventors we found links between Fisher & Paykel Healthcare and Fonterra. These links aren't always sector-based. A nice example of this is Weta Digital in Wellington. We are proud of having one of the top computer graphics companies in the world and Weta Digital's contribution to movies such as "The Rise of the Planet of the Apes". But what does Weta Digital want from the New Zealand science system? You might expect it wants ICT or parallel computing or something like that. Actually it is putting its dollars into the Auckland Bioengineering Institute, because to make convincing animation of an ape or person, they need to have an engineering model of how people and apes move.

But if we had sat down 20 years ago and said we want a film industry in New Zealand, we would not have said we must first put public money into Auckland's Bioengineering Institute. The Bioengineering Institute is not only working with Weta Digital, of course; it is also working with companies much more obviously in its sector, such as those making orthopedics or devices to monitor cardiac rates. But today, it is one of the players in New Zealand's innovation ecosystem that will help Weta Digital stay ahead of the game.

What I take from that is we need to think laterally, not literally. When we think about investing in particular sectors, we have to realise that we will need capabilities that aren't necessarily obvious to us. We need a rich and diverse innovation ecosystem that will enable us to fill in these gaps. We just won't know what types of knowledge we are going to need to build particular parts of our economy. And some of the bits of knowledge that we will need will be quite unexpected.

So I come back to that largest inventor network in New Zealand. If we draw a sectoral alignment between some of the public or private research institutes and some of the companies, we might pair IRL with Fisher & Paykel Healthcare or AgResearch with Fonterra and the Malaghan Institute with Neuren Pharmaceuticals. But the actual connections are quite different from those we would expect between those research providers and those end-users. It is hard to predict what connections will develop.

My final point brings me back to product space and to the example of Icebreaker versus Gore-Tex. Icebreaker's marketing draws heavily on the New Zealand environment. Icebreaker's images convey a great deal of creativity, and its marketing campaigns have deservedly won many awards, but contrast this with Gore-Tex. Their marketing simply says that Gore-Tex is a high-tech product that works and does its job well.

I think we need to take a look at how we project ourselves to the rest of the world – we have to start marketing our technical know-how. We need to see ourselves as exporters of knowledge not nature. If we can do this, then maybe we will have the confidence to seize the opportunities that our own inventions offer us in the future.

If we accept that we are going to have to move to diversify our exports to provide ourselves with more economic opportunities, then we are going to have to diversify the science we do in New Zealand. Denmark is a country often mentioned in relation to New Zealand because of its primary sector but it has developed a thriving high-technology sector as well. It is sitting at the rich-country end of the spectrum. It has done so by growing its spending on untargeted research.

We need to do likewise. Because of the variety and unpredictable nature of the science we will need, we must subsidise the generation of new knowledge across the board and not pick winners. Any investments we make should bear in mind we are working in an innovation ecosystem, and that the diversity and connectivity between the players in that ecosystem are as important just as they are in a natural ecosystem. We must keep in mind the need to experiment and to explore different paths into the heart of product space. New Zealand's voyage of economic self-discovery must go on.

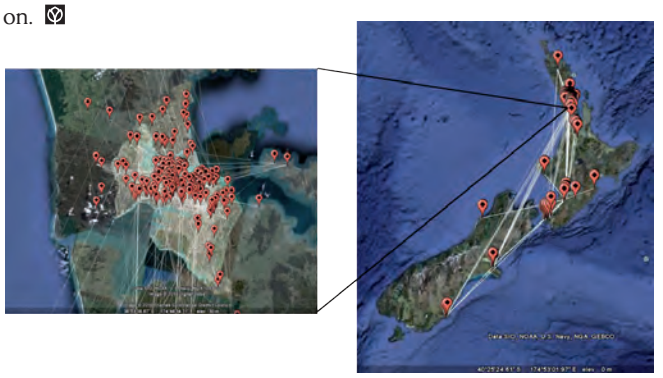

Figure 3: New Zealand's largest inventor network (the inset on the left is zoomed in on Auckland) on Google Earth. Inventors in New Zealand that have filed patents in the European Patent Office have been geolocated and are linked if they share a patent. This particular map shows the largest group of inventors (more than 450) that can be linked together in this way.

By Rod Oram
Business Journalist

Shaping a first-world economy with high-productivity food exports

This article considers the question of the primary sector's role in fast-forwarding New Zealand's development. If we get it right we will be reinventing paradise in various forms.

Let's start by looking at what the primary sector is up to, bearing in mind the goal the government's Economic Growth Agenda has set for it – a trebling of the value of its output by 2025.

The meat industry is making a useful step forward through its red-meat strategy, but this is a sector that still can't co-operate. Silver Fern Farms is trying to prove that co-operation isn't necessary at an industry level. As a company, it is doing some useful things but the jury is still out on whether it can truly add value for farmers. Meanwhile New Zealand is starting to lose critical mass in lamb with the conversion of farm land to dairying continuing apace.

Dairying is in a commodity trap at home and its science is still heavily production-focused, rather than trying to extract more value from the milk itself. And the global strategy is flawed. Fonterra is a terrific global trader and has made important breakthroughs, like establishing an internet auction model for the global dairy trade to bring some transparency into pricing and to encourage more rational behaviour between suppliers and buyers. But where we should be truly globalising the dairy industry – by taking our farming expertise overseas – we see disasters, such as New Zealand Farming Systems Uruguay, a venture now owed by Olam, a Singapore company. The New Zealand farmers who invested in NZFSU have lost a good part of their money. Synlait, in South Canterbury, couldn't go it alone. The valuable processing and downstream part of the business is now majority-owned by Bright Dairy, a company owned by the government of Shanghai. This has enabled Synlait to complete its second big phase of downstream processing: it has invested $200m downstream and will get some benefit from the relationship with Bright Dairy. But the lion's share of the value created may well accrue to the overseas owner, not to New Zealand.

Horticulture has a good but conventional export strategy. Viticulture has been very good in terms of product and brand but the latter is now under threat. When you get New Zealand Sauvignon Blanc in anonymous wine bags in British supermarkets, you know the brand and value from it are being undermined.

Seafood volumes and values have been constrained by the tight quotas needed to maintain viability of fish stocks and aquaculture has been stymied by poor legislation. Let's hope the recent aquaculture legislation will remove the blocks. The previous government killed off any expansion but it is hard to see where large volume increases will come from and it is hard to see seafood breaking away from being a traditional industry.

Forestry has seen a big scaling down of New Zealand ownership of forests and this is very much a commodity-driven market. Its economics hang on the commodity price of logs and the carbon price of the trees.

Kiwifruit has its act together in terms of research on-orchard and what Zespri is up to at home and abroad. It has established a powerful brand position in the market and is benefiting from innovation in the orchards and intellectual property. Of all our primary producers it has done by far the best job of developing production overseas. Its contract growers in countries such as South Korea and Italy are loyal to the system and tightly bound to it through intellectual property rights and terms. They know they can get much more money for the fruit they sell into Zespri because of the value creation: it commands a premium of 40% – 100% over fruit from other suppliers.

So Zespri is the one example from the primary sector where you are starting to see all the elements that could create real value in the primary sector because of the way Zespri has started to de-commoditise a commodity. Clearly, though, the arrival of Psa and the devastation it is causing is a threat to the kiwifruit industry. But I'll come back to that topic when I consider the role of science in the primary sector.

Fonterra's strategy is to remain a big global trader but the arithmetic is difficult. The entire New Zealand dairy production is less than the annual growth of worldwide dairy industry output. Even if we get volume growth here, Fonterra is dependent on building up overseas supply, which is good – it should become a global business. But I have a problem with it farming in China because I doubt that is where its skills lie. It is also feedlot farming, which seriously muddies the free-range brand. It is about to do the same in India too.

Fonterra has created some extra value in ingredients and in the supply chain and it has had good growth in the value of its consumer products but these remain relatively small parts of the business. The world-wide commodity part of the business, on the other hand, continues to grow faster than the relatively high-value branded consumer business. In other words, because of the large growth of milk supply world-wide, Fonterra is actually commoditising rather than de-commoditising.

Then there is the challenge to shareholder farmers in New Zealand. We ceased to be the lowest-cost producer of milk in the world about eight years ago. We rank fourth today, according to DairyNZ. The competition is not necessarily coming from poor parts of the world. You can buy good dairy land in south-west Missouri in the centre of the United States for one-third the price of New Zealand land, and you don't pay any capital into the processor and you get more for your milk. Terrific New Zealand farming families (including the chairman

of Fonterra) have invested in the United States. It is perfectly right they should because we should be taking our technology out to the world.

But high-priced land in New Zealand – which is constrained in environmental terms too – erodes the future for our dairy farmers. I am a huge fan of the dairy industry. But these are real issues about its long-term future. The dairy industry's response is to direct the vast majority of its research into on-farm efficiency, or into trying to keep up with low-cost producers elsewhere in the world.

Looking globally, we know the world needs a lot more food and the United Nations Food and Agricultural Organisation is among those emphasising the need to improve productivity, which is about science, farming and liberalising trade. That is fine but anybody who thinks New Zealand has a moral responsibility to feed the world needs to remember that our entire annual dairy production is less than the annual growth in world dairy production. That means we cannot possibly feed the world, or even a tiny part of it.

What we should be doing is contributing to the science to encourage better farming around the world. That would be our best commercial opportunity but, I would argue, it is a moral responsibility too.

The Wallace family began investing in a dairy farm in Brazil in 2001. Simon Wallace, who runs it, is very proud of the farm. They made some dreadful mistakes initially with wrong pasture grass and other issues but as Simon said at New Zealand's Dairy Business Conference in 2011, they are learning to farm a biological Ferrari. The grass growth is so good they are bringing cows back every 18 days to a particular slice of paddock and the productivity from those cows is huge. The Wallaces have also invested downstream in processing UHT milk and selling it as a branded product.

This is exactly what we should be doing around the world. But that near-commodity end of the value chain won't deliver a big, profitable future for dairy farmers in New Zealand.

Some simple maths should come into considering the goal the government has set the primary sector to treble the value of its output in 15 years. It can grow volume a bit but there are real physical constraints. We don't have vast acres of virgin land without cutting any trees. We can grow productivity a bit (historically it grows about 2%-3% a year) and we can benefit a bit from higher prices. But we don't go to the bank on that basis. When world wholemilk prices hit around US$3,500 a tonne plenty of new volume comes into the market to cap the price rise. We can earn a bit of a premium for New Zealand quality and brand (but to do that we must break free from the retailers' value chain, because they capture the lion's share of the value). And we can stave off overseas competition a bit (but the competition gets ever better on cost, volume and quality).

So the primary sector's commodity model fails on simple maths to deliver the trebling as does the government strategy. There is a great paradox in this, as we think of the hundreds of millions of new consumers in India and China and how they could enrich us, if only we could sell them a few more lamb chops, a bit more infant formula and a few holidays in this country. But the simple maths of that says that it would not generate sufficient volume or value for dairying in its current form to be a big driver of accelerating GDP growth.

The paradox is that we have to think hard what the opportunity is. We milk 4.4 million cows but even if we doubled the number of cows, which would be a huge challenge of land use and environmental performance, the maths still doesn't deliver a trebling of dairy exports.

So the problem is not a shortage of cows. It is a shortage of scientists to create more value from the milk. Similarly, we don't have a shortage of tourists, but all our tourism measures – length of stay, average spend and so on – are going backwards. Australians make up more than 50% of our inbound tourists which is where they were 25 years ago… and they are short-stay, low-spending compared with the likes of German, Japanese and American visitors.

Thus the paradox is about scarcity. Other people have a lot more land and a lot more cows than we do. So what is the scarcity we should be exploiting to make more of our dairy industry? It would be something like lacto-pharmaceuticals, rather than milk powder; and rare earths, rather than coal; and travellers who spend a long time here and really engage with us rather than just flitting in and out for a sports tournament or two. And it would be about strong sustainability too.

The most distressing economic news I have heard for a long time was that Nestlé has been investing over the years is bioactives and nutraceuticals. Therefore it already has a nice line of yoghurts – for example – with bioactives in them. It announced last year an incremental investment in that science of US$500m.

We hardly do this science in New Zealand. We are heavily focused on getting more milk off the land rather than more value from the milk. Even if we did more of that downstream science, I would not expect or want Fonterra to be the organisation that tried to commercialise it because that is not its mindset and not what it is good at. It should keep on being the global trader and processor of largely commodity products.

No amount of renaming science ministries or re-jigging the CRIs or turning IRL into the Advanced Technology Institute is going to make much of a difference. To drive true value into our food and beverages products calls for much more.

Essentially the strategic failure to do this has been a failure of corporate New Zealand. The red meat strategy is more about brand and if you look at the Primary Growth Partnership project with Silver Fern Farms and others around it, you will find the retailers have been left out of the project. Some quite good projects are being put up to PGP with some good rhetoric around them, but the review panels are old-style and very limited in their long-term strategic vision so they sign off on projects that are only an incremental improvement on past ones.

Trying to re-orient that science is a big challenge. But the signals have got to come from the corporate sector and from farmers »

who understand the commodity game is over, especially when the price of dairy land is three times higher here than in Missouri. That is where the signals have got to come from, not from civil servants, with all due respect to their skills.

Here's one primary sector example of science playing a vital role. The kiwifruit industry is fighting back against Psa. While it doesn't expect science to eradicate Psa in the foreseeable future, it believes it can control the disease through new cultivars and orchard management practices.

Zespri believes the sector can get its ambitious growth strategy back on track by 2014. The goal is to treble gold production by 2020. If it achieves this, it will have pulled off a remarkable recovery compared with other kiwifruit growing countries. Japan, South Korea, Italy, Chile and China got Psa first but are still struggling to deal with it.

Innovation will have to accelerate in plant breeding too. Of the 100,000 plants in the breeding programme, perhaps up to half will prove too sensitive to Psa. Many potentially profitable new varieties have been lost. But Zespri believes there is sufficient genetic diversity in the rest to deliver new diseases-resistant cultivars.

New Zealand scientist are also playing a leading role in the worldwide research into Psa involving more than 100 projects among 20 institutions. In every sense Psa is a massive hit for the kiwifruit industry. But all being well, its response will build a stronger, more profitable sector.

We do have interesting options in science and I firmly believe the basis of the economy is biology-based. There are a few bright spots. For example, John Key went off to the Climate Change negotiations in Copenhagen in 2009 and New Zealand proposed an agricultural greenhouse gas research alliance to other countries. The chemical constituents of those greenhouse gases essentially are nutrients. It's a very inefficient farming system that produces such a loss of nutrients. If we can change the way cows and sheep are fed, how they digest that feed so they can turn more of it into energy (milk or meat) and less into greenhouse gases, that will be one of the biggest breakthroughs in agricultural science in a long time. It would make a hugely important contribution to global food production and would encourage more countries into global framework.

There are three main research groups. We co-lead with the Dutch on animals, the US leads on arable farming and Japan is leading projects on paddy rice farming (a prodigious producer of greenhouse gases). We are the secretariat.

The alliance now has 36 countries representing 70% of agricultural greenhouse gases. Coal for electricity generation and oil for transport might be bigger challenges, but the issue of greenhouse gases from agriculture is an example of where we should be focusing.

It is a glimpse of our future as a leading, prosperous and sustainable agricultural nation.

SIMON ALAN MENZIES

Simon Menzies made an important contribution in disease control for the agricultural and horticultural sectors in New Zealand, especially in pea, asparagus, and clover disease research, and had an excellent rapport with growers. He was a highly practical plant pathologist working for the Plant Diseases Division of the DSIR at Mt Albert for many years until his premature retirement due to ill-health in 1991.

Simon graduated M.Ag.Sc. from Lincoln before taking up a position at Mt Albert. In 1972 he was awarded a Ph.D. from Manchester University where he worked with Professor John Colhoun on the clover pathogen, *Codinaea fertilis*, one of the factors involved in the clover decline syndrome in New Zealand pastures.

On his return to New Zealand he became involved in research on *Fusarium* and *Aphanomyces* root rots of peas, particularly assisting the plant breeders at the Crop Research Division of DSIR at Lincoln. In the latter part of his career he became an expert on fungal diseases of asparagus. His colleagues are unlikely to forget the innovative "asparagus cutter" he developed to assist sampling of the asparagus crowns without having to bend over!

He was a keen supporter of the New Zealand Institute of Agricultural Science, the fore-runner of the present NZIAHS, and retained his interest in the affairs of the Institute after his retirement.

A man of good humour, he was a qualified pilot, a yachtsman, and had a huge passion for fishing and scuba diving. He was a devoted husband to Rosalie. Friends and colleagues say he would give anything a go.

Through adversity in life, nothing was ever too difficult for him. He could always be relied on for comment and/or constructive criticism on just about any topic. He will be fondly remembered by friends and colleagues as the "devil's advocate".

– Chris Hale and Mike Manning

By Dr Garth Carnaby
President of The Royal Society of New Zealand

The Outlook for New Zealand

New Zealand has been riding a commodity boom over the past five years. Throughout the 1980s and 90s it was a given that the value of commodities would fall year on year. We were urged to get out of them and into differentiated or manufactured products. Commodities were even seen as a dumb thing to do, although the prosperity of New Zealand since colonisation has been linked to them.

We should change our model, said Michael Porter and the Foresight project. McKinsey gave lectures on how we should make a living through the growth in the share values of start-ups which never need make a profit.

But several new factors have combined to fuel global shortages of agricultural commodities – the growth of new consumption from vast populations in China, South East Asia and India, the removal of agricultural subsidies in Europe, and land competition from biofuel production. We were not very successful at creating new-economy businesses based on supplying the world with mobile phones or flat-screen TVs, biotech or clean tech. Thank goodness the renewed value in commodities came when it did for New Zealand. They suddenly don't look so dumb anymore. We can do all right so long as we have the lowest cost of production.

So our economy is not spectacular but it is solid and our ability to pay our way in the world will probably continue to be sound. It's a good starting position and the explosion of new middle-class consumers in the emerging mass markets of Asia augurs well for our traditional commodity-type exports. If they are no longer falling in real value, or even increasing in real value, we can actually get wealthier without having to produce more of them. Protecting and growing this critical part of our economy is becoming even more important, not less.

New Zealand grew rich by feeding the Europeans more cheaply than they could feed themselves. The free trade agreement with China and the one mooted with India promise to recreate those circumstances.

Due to our location and geography, moreover, we have stumbled on the fact that New Zealand is 96% under water and that we have at our disposal as a nation the fifth-largest area of Continental Shelf. It's bigger than Europe, there are only 4.4 million of us, and we know very little about it or how to use it sustainably.

What an opportunity! We will almost certainly end up having an internal argument about who owns it, but from the national perspective we are the beneficiaries of the evolution of the international laws of the sea. Forget mining the National Parks – focus on what's out on the shelf.

Our good fortune doesn't end there. Like all other modern economies, the New Zealand economy is now dominated by the provision of services. More than 1 million of the 1.5 million New Zealanders in work provide services. Most of the rest work in secondary industry and only a tiny fraction work in the big primary export industries, on the farms producing dairy, meat and timber. The fastest-growing export sector in New Zealand is services. We haven't put enough effort into understanding the potential impact on our export receipts of the services sector in New Zealand, even big sectors like education, health and consultancy services.

Why, when given that this services sector represents 60% of our economic activity, do we not have a CRI (apart from the narrowly focussed ESR) dedicated to growing the sector and its exports? What are the science, maths, social science and technology issues needing to be addressed by research to advance the exports of the services sector or just to make it more efficient? Are the skills needed limited to science? I think not. There is a fascinating intersection of relevant disciplines stretching from IT to the humanities.

So here we are with a sound starting position and conditions for growth which are in my view strongly positive. Add to this our advantage that, unlike Australia, we have a plentiful and dependable supply of water and a diverse range of microclimates which will give us flexibility in a warming climate. We are well educated, innovative and energetic. We are favoured with excellent factor advantages which will lead to increasing comparative advantage for our economy.

In a series of talks, the late Sir Paul Callaghan identified one possible solution to closing the $40 billion gap with Australia. His solution was to create in New Zealand around 100 companies which match the average performance of the top ten high technology companies. These top ten, companies like Rakon and F&P Healthcare, produce $4 billion a year. So 100 of them would create $40 billion. No pressure on the environment (unlike dairy), no need to exploit natural resources (with attendant Treaty issues), just brains and IP tied up in niche-engineered products servicing high-value specialised industries.

It's a good idea but it's not the only option.

Take the food industry in New Zealand. Here we have $21 billion of gross output created by 68,000 people, around $300,000 per job – not bad. Some jobs in the sector are producing well below this figure. So it follows that some parts of the sector (probably dairy) must be very attractive indeed.

One thing Professor Michael Porter of Harvard Business School did convince me of is the importance of clusters.

We may be making less than $120,000 per job in producing bales of greasy wool for example, but scourers, wool testers and carpet yarn spinners do rather better. We can easily achieve world-leading technology positions in the know-how associated with our farm commodities. Did you know, for example, that we test the Chilean wool clip in New Zealand Wool Testing Authority labs in Napier or that 90% of the world's scouring machines are made by ANDAR in Timaru?

We can do these things because a cluster of critical mass has been built up around this core commodity activity and the companies in this cluster have highly specialised technical capability and critical mass on a global scale. There are many opportunities to add value to our agricultural commodities through R&D which is not likely to be replicated anywhere else.

In the food sector we have companies in the Waikato exporting stainless products based on dairy processing expertise – for example, Stafford Engineering, which exports ice-cream-making plants. In fact the whole Waikato Innovation Park is building its business model on the collaborative export of agri-services by its resident companies.

There are other high-level public interventions available to New Zealand Inc which will accelerate innovation in New Zealand in a generic sort of way. The first is the roll-out of faster broadband. This will help all of us, but is particularly relevant to the group of business services companies I alluded to earlier. No other single intervention is more likely to get more of them exporting services and software more quickly. And the McKinsey team was right about angel and venture capital. You can make a good living by burning some-one else's capital in a start-up. But in New Zealand it is particularly difficult to access early stage capital to fund ➤➤

risky start-ups.

It used to be said that the small number of block-busters would cover the cost of all the failures and that if an investor spread his or her risk across a significant number of start-ups, their average return would justify the high and variable risk. I am no longer sure I believe this. Investment in high-technology start-ups probably has a return on equity of less than 1:1, which means it is a loss-making activity. How then are we ever going to get Sir Paul Callaghan's 100 new technology companies off the ground?

The answer again is public intervention. If you get a Ministry of Science and Innovation R&D grant to study something for a year, do you capitalise the grant into your balance sheet? No, you write it off 100% in the year the expenses are incurred and everyone is happy. Why is this OK? Well basically it is too hard to capture all the value from R&D and appropriate it to a company balance sheet. And there is a public benefit in the creation of the new industry knowledge which can be shared across the sector.

But suddenly just because we have now put an idea into a company and raised money to explore the idea we suddenly capitalise all this cash onto the balance sheet and painfully write it off as losses through the P&L. Are there not public benefits here too? A start-up company is often quickly copied and the "me too" companies can be like the second mouse – the one that gets the cheese.

So a bit of public intervention here in the so-called valley-of-death stage of new-company creation is good. If it has to be written off, it differs only in degree from R&D funding which is always written off. Investing in start-ups may justify public funding leverage. We need the 100 new companies.

I was reminded of this at a small dinner party in Christchurch hosted by the British High Commissioner. On the guest list was a couple who have developed a business in Rangiora composting nappies. They have grown this business rapidly and said they had just achieved a trade sale of it to a British-based multinational which is going to roll the business model out as a global franchise. This business was built up on the Hot Rot technology which I was involved in spinning out of WRONZ about ten years ago now. The Hot Rot technology was originally designed to process scouring industry wastes which are exceeded in their disgustingness only by fellmongery wastes and the primary screenings at Bromley. Nappies are a benign starting material by comparison.

The initial investors had to endure many years before the business became a success. We must never forget the patience and fortitude of entrepreneurs who do decide to navigate the valley of death – we should help them if we can.

New Zealand is surrounded by favourable factors for strong comparative advantage in our main agricultural commodity-producing industries. We can add to that by using our brains.

We should be able to create additional competitive positions in high-technology engineering, in the clusters which have grown up around our traditional agricultural commodity businesses, by accelerating the export capacity of our large services sector, and by making available angel and venture capital to companies trying to cross the valley of death. If we further leverage them with Technology New Zealand funding once they are cash-flow positive, we can expect them to keep innovating and even to grow their global points of difference.

Acknowledgement: *This article was influenced by talks given by the late Sir Paul Callaghan and draws on a number of points first made by him. It also draws on a talk by accountant Pita Alexander, and discussions with Professor Michael Kelly. The views contained in it are however those of the author alone.*

the ROYAL SOCIETY of NEW ZEALAND
TE APĀRANGI

THE ROLE OF THE ROYAL SOCIETY OF NEW ZEALAND

The Royal Society has been a constant advocate for greater public and private investment in research and we have been generally positive about the National-led Government's moves to more strongly engage science with business. To that end we co-opted Phil O'Reilly of BusinessNZ on to our governing council.

The decision on exactly where to invest more public money in research is essentially a political one. The society represents interests from basic research in science and the social sciences and humanities to the most applied areas of technology development. There is a wide range of views in the academy and among obviously conflicted recipient organisations as to where public investment is most effective. As president of the society I refrained from commenting on this issue other than to try to explain the different value propositions for public intervention in the various alternative areas to the politicians who hold the public purse strings.

I have also promoted the view that different excellence criteria should be used to assess the excellence of research in the pure and applied areas. I have put the case within the society circles and publicly that applied research such as occurs frequently in the agricultural sector needs to be assessed according to the objectives of the research and that the society's systems of recognition of achievement in research in New Zealand need to be fully inclusive of this world view.

In agriculture, state-imposed levies play a significant role. This is another form of public intervention. I will refrain from expanding on the inadequacies of the Commodities Levy Act as a means of doing this. But can someone explain to me, for example, why New Zealand has no adequate research effort to support the value and our earnings from sheep products such as wool, leather and meat, when there is no other economic use for much of New Zealand's steeper hill country?

Much of our most successful technological innovation in New Zealand has come from institutions utilising combined levy and direct government funding. Organisations such as Fonterra Ingredients Research in Palmerston North, Cawthron in Nelson, or the CRI's generally are critical for wealth creation in our large commodity industries such as dairy and aquaculture. The Royal Society has gone out of its way to be inclusive of their value systems, to promote their innovation, and to recognise the researchers involved while taking nothing away from those researchers involved in more traditional academic research and scholarship.

– Dr Garth Carnaby

CHRIS VAN KRAAYENOORD

Dutch-born Chris van Kraayenoord, who became known as Mr Poplar, in 1970 persuaded the Ministry of Works to buy 12 ha of good quality horticultural land at Aokautere, where the National Plant Materials Centre was established. Now known as Aokautere Park, it contains a large poplar and willow collection.

With Chris as scientist in charge, the centre became the national poplar and willow breeding centre, using superior material obtained from throughout New Zealand, but increasingly from overseas when it became evident local material could not cope with new diseases such as poplar rust. He had observed this rust in Europe and Australia and foresaw its reaching New Zealand. It did so on 20 March 1973, the day the National Plant Materials Centre was officially opened. By then his team of young dedicated scientists had developed resistant strains that could be released immediately to the country's catchment boards (whose work nowadays is done by regional councils). This was facilitated by the centre's tissue culture laboratory, the first in New Zealand to pioneer this technique on a commercial scale in 1976.

To obtain plant material from overseas, Chris relied heavily on the services and expertise of the International Poplar Commission. He ensured New Zealand (through the National Water and Soil Conservation Authority) became a member of the IPC in 1969. He established a National Poplar Commission and retained a vast network among IPC members.

Chris had arrived in New Zealand with his wife, Lous, in 1952 after a chance meeting with Doug Campbell, then Chief Soil Conservator at the Department of Agriculture, at an International Soil Conference in Amsterdam. He had a master's degree in forestry from the University of Wageningen (having studied soil erosion in Mediterranean countries) and obtained a Certificate in Soil Conservation in 1954 at what then was Lincoln College under the tuition of Lance McCaskill, who mentions Chris several times in his book, "Hold this Land".

He was employed as a soil conservator to study soil erosion and run-off under pasture in the Soil Conservation Reserve at Tangoio from 1952-1955, but became keenly interested in native vegetation too. In his spare time he helped to preserve what is now known as White Pine Bush Reserve at Tangoio by labelling its more prominent trees.

In 1955, he was transferred to Palmerston North where he worked on sand dune stabilisation and established a nursery for soil conservation trees, focussing on poplars and willows because they are fast-growing, easily established, and could be planted in the presence of stock. Between 1956 and 1958, he carried out a nation-wide survey of poplars and willows.

As well as building a vast network of IPC and IUFRO contacts, Chris kept up a wide range of contacts among catchment boards staff, foresters and farm foresters, farmers, nurserymen, fruit growers and willow basket makers.

The National Plant Materials Centre in 1975 was incorporated into the Aokautere Science Centre, a multi-disciplinary environmental research centre, surveying the sustainable use of land and the techniques to understand and maintain that sustainable use. It was disestablished in 1992 with the creation of Crown Research Institutes.

Chris retired on 3 November 1987 after a career which included lecturing at Massey University and his enthusiastic promotion of poplars and willows, bamboos and other soil conservation plants. He was the author of some 50 reports and articles in academic journals, and popular magazines.

He was awarded a Fellowship of the New Zealand Institute of Agricultural Science in 1981 and an Officer of the New Zealand Order of Merit in 2002 for "services to agriculture and forestry".

After his retirement, he became more involved in the Manawatu Tree Trust which he had helped to found in 1984 and was a Research Associate at HortResearch, now Plant & Food Research.

– Dr Nick Lambrechtsen QSM

DR ALEXANDER RAINBOW

Dr Alexander Rainbow – or Alec – became renowned for his down-to-earth, logical, energetic approach to solving problems in quarantine science. His philosophy of facilitating trade while minimising the risk of introducing pests and disease, now recognised as managed risk, remains a doctrine of quarantine scientists.

Born into a farming family in England, he completed a B.Sc. degree in 1952 at Nottingham University and gained practical experience in pesticides and plant health working as a technical representative for the Shell Chemical Company. He then joined the Research Department of the Cameroons Development Corporation in West Africa conducting field trials on diseases affecting plantation crops such as bananas, rubber, and cocoa.

Alec and his wife Kate returned to England in 1961 and he went back to Nottingham University where he obtained his PhD in plant pathology in 1964.

In 1965 the Rainbow family came to New Zealand where Alec worked as a scientist in the Department of Agriculture and Fisheries. He became Officer-in-Charge of the Levin Plant Health and Diagnostic Laboratory in 1972, responsible for a team of plant pathologists and entomologists in the development of measures facilitating the importation of fresh produce, new propagating material and plant health information supporting market access for our produce. His work took him abroad several times to represent New Zealand's interests in those matters.

In 1984 he was made Officer-in-Charge of the Ministry of Agriculture and Fishery Lynfield Plant Protection Centre in Auckland. He retired in1989 but continued to work as a consultant at the centre until 1991.

He was secretary of the Auckland Section of New Zealand Institute of Agricultural Science in 1986 and 1987 and chairman from 1988-90, showing outstanding qualities of leadership and vision. In 1990 he was the senior author of a paper entitled "Whither the Institute" which made an important contribution to the debate that resulted in the decision to merge The Institute and New Zealand Society for Horticultural Science to form the New Zealand Institute of Agricultural and Horticultural Science Inc.

Dr Rainbow became a Fellow of the Institute in 1992.

– Murray Dye

Basking in the rising sun:

The late Sir Paul Callaghan, New Zealander of the Year in 2011, has said: "We are brilliantly successful at dairying, but sadly we cannot scale up this industry because of the risk of further environmental damage." What's more, "our dairy industry exports milk powder, rather than developing new products. Our forestry industries send raw logs offshore and despite the past capacity to invest in processing, have shown no inclination to do so."

So there you have it. We can send dismissal notices to our staff and report to Ministers, the scientific community and the public, that biologically, we are as good as we can ever possibly be.

On TVNZ's Back Benches, I was asked if we could have a vibrant agricultural sector and other exporters. It was a simple question demanding an equally simple answer. Of course we can. This is not a question of 'either/or', yet that thinking tends to bedevil our approach to research and to economic development.

Sir Paul had a low regard for the biotech sector. He wrote in the NZ Herald: "I saw the waste of the last ten years when we biased our science 'system' to chase the Biotech fashion. We should not make the same mistake again". But wasn't he making the same mistake in his dismissal of the biological economy and his promotion of the physical sciences economy (what I call "tricks and gadgets")?

Sir Paul was as passionate about physics as I am about agriculture, biotechnology and science in general. I celebrate that our top 100 technology companies collectively export around $5 billion a year, a quarter of Fonterra's revenue. I would celebrate even more if another 500 technology companies existed to match what we export each year from the primary sector.

As a species we face our largest challenge ever. Our rate of population growth means 1.2 million more people are born each week. By the end of 2012, there will be some 64 million more people on earth than at the beginning of the year. At the Cairns Group meeting in Canada last year, food security was the dominant issue because it influences global security. Future wars could flare over access to land, water, food or energy or over the freedom to gain from their use.

The second greatest global issue is that, as families reduce in size, children become more precious to their parents who become more risk-averse. They want safe food for their children and life-prolonging products for themselves.

Third, there is a concern, in the first world at least, for the environment.

Fourth, while the population expands we are not making more land. The number of hectares available for food production per person has steadily dropped from 0.44 hectares in 1960 to 0.26 hectares in 1999. By the time the world's population is expected to peak at 9-10 billion in 2050, the number of hectares available per person is predicted to be 0.15.

The green revolution of the 1960s, with the use of pesticides, fertiliser and new hybrid seeds, gave us a quantum lift in production. These were not New Zealand inventions but our farmers and scientists adopted and adapted them to maintain our agricultural leadership. The world needs new technologies now to make similar quantum leaps.

Another consideration for New Zealand is competition. The developing sophistication of agriculture, in places like South America, is a competitive threat. The rapid deployment of genetic modification around the world is eroding our competitiveness through increased productivity and reduced environmental impact.

In a globalised world, technology is fast-moving and highly mobile. Out of the top ten technology Kiwi high-fliers, Fisher and Paykel Appliances, Fisher and Paykel Healthcare and Rakon have moved significant manufacturing offshore. Of "New Zealand's technology top 20", Fisher & Paykel Appliances is partially overseas owned, Navman is partially Kiwi owned while NextWindow is no longer New Zealand owned and Allied Telesis is a Japanese company.

By contrast, the global population growth curve demands solutions from economies with the vital resources of water, land and people. In that respect, New Zealand's geopolitical position and economic profile make it attractive in a resource-hungry world and there is major scope to develop highly profitable companion industries off our primary base.

To ensure our research efforts make a difference we need to have an appropriate research spend and an effective science system with the right incentives. New Zealand has one of the lowest investments in science, research and development at around 1.2% of GDP (the OECD average is 2.3%). Federated Farmers believes we need to aim for 3% of GDP and fast. Funding of this magnitude would enable more expansive research, not just retaining our top scientists, but attracting the world's best here. But just spending more on R&D would be wasted if we don't get the implementation right.

The Federation welcomed the recent change in direction last year towards a more collaborative approach to science. The merging of MoRST and FfRST into the Ministry of Science and Innovation, the Centres of Research Excellence, Research Platforms, the Crown Research Institute reforms and the Primary Growth Partnership were all positive moves to create a science and innovation ecosystem. This enables more strategic deployment and coordination of our scant research resources.

But there is still a space for competitive science funding to stimulate new ideas. The Science and Innovation boards, on which I sit, help to provide that role. Business is at least beginning to embrace the concept of R&D with bids becoming more competitive.

For agriculture, the PGP is helping to engage business and science with a focus on commercial outcomes.

Creating the right science ecosystem is about balancing the science portfolio between discovery and applied science, between industry sectors and between economic, social, cultural and environmental outcomes. It is also about rewarding excellence and about deciding priorities which provide strategic direction.

Our primary industries earn about $31 billion or roughly 31% of New Zealand's $43 billion annual merchandise exports. Our number one priority is to protect and increase those earnings and we need science to do both.

To take advantage of our opportunities, while mitigating our threats, farmers would like to see three areas of focus for research spending: increasing our productivity; increasing the value of our




By Dr William Rolleston,
Vice-President of Federated Farmers

unlocking our primary potential

products; and reducing our environmental footprint.

Farming is a complex – and at times unforgiving – business and one of the many 'arts' of being a top farmer is to manage multiple farm inputs and livestock. We must also take account of the unpredictability of weather and commodity markets.

The role of science is to convert farming's art into rational decisions, allowing us to intelligently use resources. We are only scratching the surface on-farm when it comes to the adoption and use of technology to aid decision making.

Agriculture's year-on-year multi-factor productivity has increased by 1.8% over the past two decades. Since 1990, we have managed to produce 7% more lamb but from 55% fewer sheep. With beef, our meat volumes are up 23% but from 11% fewer cattle. Dairy production growth per cow has averaged 26% since 1990.

We've also managed to reduce carbon per unit of product by about 1.3% a year, all without the need for an ETS but driven by efficiency and productivity.

For all farm businesses, though, there comes a point when the law of diminishing returns is invoked and where increasing investment to increase production becomes uneconomic. This represents one of the greatest opportunities for science – shifting an individual farm's point on the production curve or, better still, changing the shape of the curve to generate more from the same or more from fewer inputs.

The economic damage brought by the 2007/08 drought, "for instance, has been costed by MAF at $2.8 billion. Developing crops and pastures requiring less water and fewer nutrients would revolutionise the economics of farming. Similar traits bred into horticultural varieties would allow expansion of production land for niche, high-value crops. This reduces market risk through diversification and provides greater security in the face of climate variation. The bonus is that we reduce nutrient loss and get to keep more water in our rivers. Like so much that science has to offer; an economic win and a win for the environment.

Improved farming productivity also comes from better utilising what's under our feet. A dairy farm's effluent system may cost $100,000 – $300,000, but, according to DairyNZ research, it can save the average dairy farm $10,000 – $20,000 in synthetic fertiliser costs each year. Adding biogas production to this system could further reduce the carbon footprint of a farm by reducing both fossil fuel use and biological emissions at the same time. Currently biogas production is too expensive to be deployed on-farm but the New Zealand Energy Strategy includes biogas as a research priority.

We must develop these technologies where we find a niche or have excellence and world leadership. Otherwise, we should adapt technology from abroad

Productivity gains also lie in the nutritive value of feeds because this materially influences the quality of stock and the stocking rate. With it comes the ability to influence effluent and emissions too.

In other words, we need science to help us to do a whole lot more from a whole lot less while ensuring that the minerals, insects, bacteria and nutrients in soil are kept in optimal balance. We may have something to learn from organic agriculture here but we must be sure that the ideas we deploy have a scientific basis while satisfying our productivity and environmental outcomes.

Science, not dogma, lies at the heart of turning our challenges into opportunities. In that respect, water represents an opportunity, although some see it as our Achilles' heel.

Despite being our most precious asset, water is only now being realised for the potential it offers. We have increased the scale and efficiency of water use through central pivot irrigation. But to put irrigation in perspective, the combined water take from rivers of all irrigation in New Zealand is only marginally more than the take from rivers for the Manapouri power scheme which diverts water destined for the Maroroa River.

While farmers see water storage and irrigation as an enabler, the environmental lobby often views it as a means to 'intensify' yet further.

We need science to deliver the commercial means to optimise the efficient use of this precious resource while helping us to deal positively with the outcome of its use. For example, we need a better understanding of water and nutrient flows in specific catchments to inform decision-making by farmer and regulator alike.

To optimise our returns and to give farmers confidence about their future, we need to develop new products tailored to specific market preferences and needs. The Japanese grain-fed beef market specifies black cattle only. It is but one example of market preference.

Let us remember that commercialising a new apple variety can take up to 30 years from selecting the initial cultivar to market launch. It involves something we are only just beginning to value – intellectual property. This is where we need a close collaboration between farmers, scientists, processors and marketers to communicate market requirements into the science pipeline.

Farmers can sometimes feel disconnected from the end market, which determines not just how we farm but how we stock our farms and orchards. One example from aquaculture is a seven-year PGP programme with Sanford, Sealord Group and Wakatu Incorporation to domesticate and selectively breed green shell mussels of high value to the market.

Aquaculture, we must remember, is around 10,000 years behind terrestrial farming in terms of domestication and the genetic improvement of livestock. We have the knowledge and tools to make rapid gains here.

The value of our products can be improved in two ways: we can improve current products and create new products to stimulate demand and maximise returns. Farmers need to be open-minded. The bagging of Keratec was short-sighted. The product, while small in its demand for wool, had the potential to significantly lift the value of the wool which went into it.

Velvet Antler Research New Zealand, which I chair, has a product from deer velvet which is ready for human trials. If the trials are successful, the product could demand half of the country's velvet. What's more, accredited farmer suppliers, those capable of putting in place the demanding supply systems, will see a significant jump in their revenue and profitability with no increase in environmental impact. »




It's positive, too, because New Zealand doesn't have chronic wasting disease for deer. That means it would be hard to move production offshore.

We need scientists to be thinking outside the square as well. Research can take some direction from its users and that is important but as Henry Ford famously said, "If I listened to my customers, I would have built a faster horse."

Federated Farmers asks that farmers and scientists work together to understand one another's point of view and each other's situation in environmental issues, too. It is in the environmental space that our greatest challenge lies.

The key challenge is the perception that we are at our limits and only harm can come from intensification. This is a recipe for economic and technical stagnation. Nevertheless, we need a better understanding of how to trap and utilise nutrients such as phosphorus and nitrogen within our farming systems. Nitrogen needs greater focus because there's a growing policy sense that phosphorus is coming under control.

The policy response to nitrogen is akin to blunt force – nutrient caps or farming by consent – as councils invoke caution in the face of insufficient knowledge on management options.

Helping farmers develop better nutrient cycling will satisfy the public and policymakers that we have the environmental means to grow as an industry. The Ballance-led PGP on improving fertiliser utilisation and reducing nitrate loss is a start.

Retaining these nutrients on-farm is vital for us to farm to our potential. The world needs its most efficient producers farming to potential while using resources optimally.

We need our agricultural and horticultural scientists to be supporting the farm system with solutions to meet several challenges. This requires the whole agricultural sector to be united to address pasture, crops, soils, farming systems, feed and genetics.

Federated Farmers' president Bruce Wills has talked about a collaborative approach. Collaboration needs engagement from both sides; we need to understand one another's points of view.

So, if there is a plea to the scientific community it is for more and better communication. But collaboration does not mean complicity. We aren't looking for sycophancy, only balance to what is a one-sided debate. This needs your engagement.

Finally, I wish to address "genetics". It will excite the green movement who overlook the fact we've been breeding beneficial traits in and less beneficial ones out for thousands of years.

There comes a point in time where we need to use all of the tools at our disposal and that demands you, as scientists, to stand up to a Luddism that relishes a climate of fear.

'Genetic Modification' seems to be the science that dare not speak its name. We need to wake up to the reality that 3,600 or so people have joined the human race while you were reading this. They need food, shelter and – if we want the world population to stabilise – economic development.

Perhaps this September's Agricultural Biotechnology International Conference in Rotorua is a means for us to showcase what we do to the rest of the world. It has the potential to lead to direct investment into the research we do because we are good at biology. There is no reason why we ought not to be the epicentre of global agricultural research.

New members We welcome

Dexter McGhie (Hawkes Bay)
Indra Ratnayake (Waikato)
Tom Woutersen (Waikato)
Brent Barrett (Manawatu)
Abdul Jabbar (Manawatu)
Gayani Gamage Manawatu)
Majid Hashmi (Manawatu)
Sarina Manandha (Manawatu)
Thamarath Pranamornkith (Manawatu)
Munazza Saeed (Manawatu)
Nick Craddock-Henry (Canterbury)
Catherine Snelling (Canterbury)

Corporate members

- AGMARDT
- AgResearch
- Ballance Agri-Nutrients
- Catalyst R&D
- Plant & Food Research
- DairyNZ
- Federated Farmers of New Zealand
- Horticulture New Zealand
- Lincoln University
- Massey University
- PGG Wrightson Seeds
- Ravensdown Fertiliser Co-op

The New Zealand Institute of Agricultural & Horticultural Science Inc

National Secretariat
P O Box 121 063 Henderson, Waitakere City
Phone 09 812 8506 Fax 09 812 8503
secretariat@agscience.org.nz

Contributions to the Editor
Phone and fax 04-237-8074
bob.edlin@xtra.co.nz

www.agscience.org.nz

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