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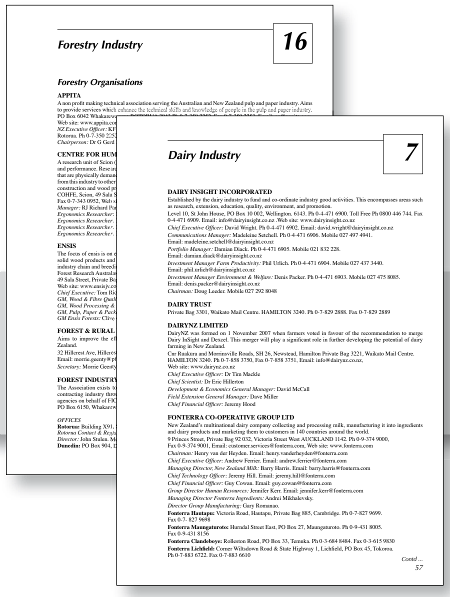

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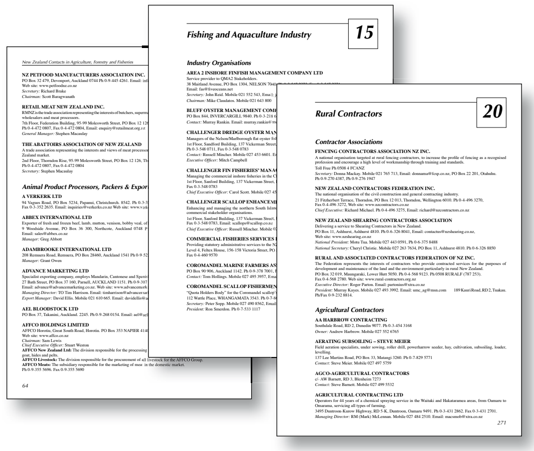

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Primary Industry Management is dedicated to the publication of articles on all aspects of agricultural science and the management of primary industry resources. The opinions of the contributors are their own and not necessarily those of the publishers or editor.

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Julian Bateson – Editor

Canterbury, irrigation and the Emissions Trading Scheme

This *Primary Industry Management* journal has two main features. The first is a feature on Canterbury, looking in particular at the increase in irrigation and the resultant dairy boom. The second main feature concerns climate change and the Emissions Trading Scheme.

Canterbury and irrigation

A lot has been said about water and its availability for agriculture in New Zealand. The changes and developments, in particular on the Canterbury Plains over the past few years, have been mainly as a result of more and better irrigation. Dairy farms have increased in number and size at the expense of sheep as the income from dairying is currently significantly more than from sheep.

We have significant amounts of water available in New Zealand, with the average annual rainfall around two-and-a-half times the global average. Water to New Zealand could be seen as the equivalent resource that minerals are to Australia. The main difference is that water will keep flowing, or so we expect, but minerals are only able to be mined once.

The area of Canterbury suitable for irrigation has been estimated at over a million hectares, according to the article by Marvin Pangborn and Keith Woodford. Currently the area in dairying is 200,000 hectares – so there is room for a significant increase in dairying in Canterbury.

However, even though we consider water to be a renewing resource, we should be managing water very carefully and with consideration for the environment.

As Andrew Curtis, CEO of Irrigation New Zealand asks in his article – is irrigation a threat or an opportunity? Wanting a dam on a river just because there is an opportunity to make more money, ignoring consequences for water quality, wildlife and tourism, is not the route to take. There needs to be a balance – sustainability for agriculture, wildlife and tourism as well as for the people who need to live and work with primary industry.

Climate change

The subject of climate change has been on the agenda for a long time and will be around for a much longer time to come. The Emissions Trading Scheme is now beginning to affect everyone, even though understanding it fully is too much for most of us. What the ETS offers is the chance to put right some of the past mistakes as well as a chance to add value to the farm income.

I must admit to being surprised at the reaction that some representatives of Federated Farmers have shown in the media recently with their opinion of the ETS. The comments I have heard have all been to disparage virtually everything that involves the ETS and generating carbon credits.

From 2015 agriculture will have to pay for carbon credits and this is not the time for denial and recriminations. Forestry generates carbon credits and the article by John Paul-Praat and Bob Thomson uses the examples of two Northland farms to show ways of balancing out the liabilities and credits. The solution is to think long term, get the right advice now and start getting those trees planted. The carbon liabilities will be reduced, there should be a profit at tree harvesting to offset these liabilities, marginal land will erode less and soil will be retained.

The NZ Farm Forestry Association has been encouraging more tree planting on farms for over 50 years. This is the opportunity to join in and to get it right. Everyone involved in primary industry should be aware that they will be affected, in one way or another, by the ETS. The year 2015 is not that far away.

Marvin Pangborn and Keith Woodford

The rise and rise of Canterbury dairying

Between 1980 and 2009 the land used for dairying in Canterbury increased from about 20,000 hectares to around 200,000 hectares. Per cow and per hectare production have also increased, to the extent that total production has increased about 15 fold. In this article we explore the driving forces that have led to this remarkable change. We also speculate as to whether the trend to increasing dairy production on the plains of Canterbury is likely to continue. The dairy statistics that we use are derived from NZ Dairy statistics and other product prices are from data supplied by Beef and Lamb New Zealand .

The Sixties and Seventies

Back in the 1960s and 1970s, dairying in Canterbury was a minor industry. There was a town supply industry, along with some small butter and cheese factories that coalesced around the Tai Tapu butter factory and the Temuka cheese factory. The dairy cows were farmed predominantly on heavy soils, such as Temuka clay and silt loams, where the main soil-related challenge was drainage.

Conventional wisdom said that drainage investment returned 20 per cent on capital. Having done this, but only then, it was possible to obtain a 10 per cent return on capital by irrigation. In those days, most of the light lands of the Canterbury Plains, such as the Lismore and Eyre soils, were used for sheep production, based on what were then called fat lambs and wool. On the medium soils, such as the Templetons and Paparoas, the predominant land-use was a mix of sheep, wheat, barley, white clover seed and grass seed.

Drought insurance

Substantial irrigation first came to Canterbury through the RDR scheme which became operational in 1944. It draws water from the Rangitata and provides about 64,000 hectares with border-dyke irrigation between the Rangitata and Rakaia rivers. Farmers initially tended to use this water as drought insurance for their sheep farming systems.

Investigations during the 1960s, led by Lincoln's Professor of Farm Management Jim (later Sir James) Stewart, showed that many farmers, by using the cheap water in this way within traditional sheep systems, were not achieving an overall increase in profitability. More recent community schemes included the Amuri, the first water supplied in 1980 with considerable government subsidies, and the Opuha Dam in South Canterbury commissioned in 1998, with major funding from farmers. Extensive development of underground water sources began in the 1990s as a consequence of submersible pump technology.

Current estimates are that about 400,000 hectares of Canterbury land are irrigated. A little over half of this comes from community-based schemes using river water and the remainder from underground sources, both shallow and deep wells.

Dairying takes off

Early attempts to milk cows on irrigated light lands began in the late 1970s and early 1980s. There were a number of early entrepreneurs, but the one who received the most publicity from a series of articles in the *Dairy Exporter* was Don McDonald, who came to Canterbury from South Auckland. Others soon followed.

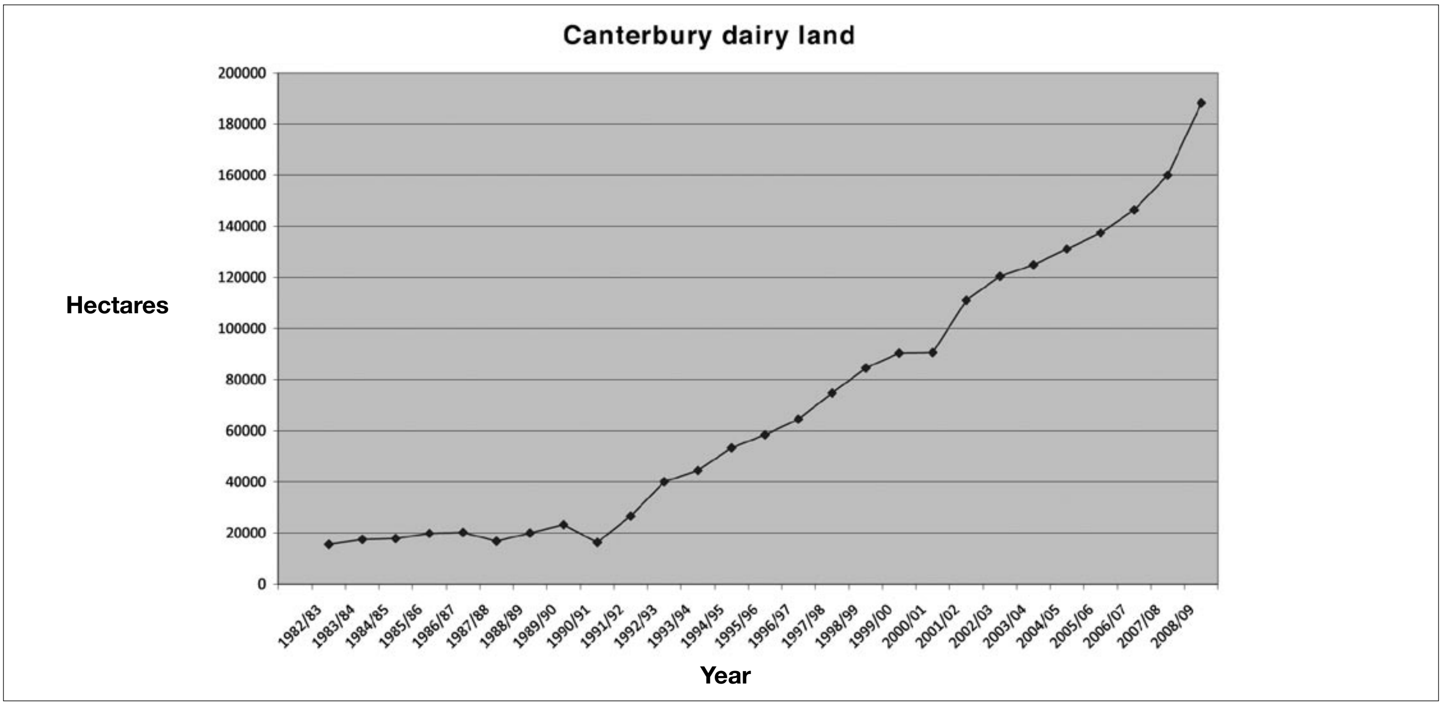
However, in terms of substantial land change, it was not until about 1992 that take-off occurred. Before that, the statistics indicate that the development of new dairy farms on the light land was approximately counterbalanced by farmers moving away from dairying on the heavy soils. Since that time, the land use conversion has fluctuated around a trend of about 10,000 hectares a year, reaching 188,235 hectares in 2008/09, the latest year for which data is available.

Irrigation as an enabler

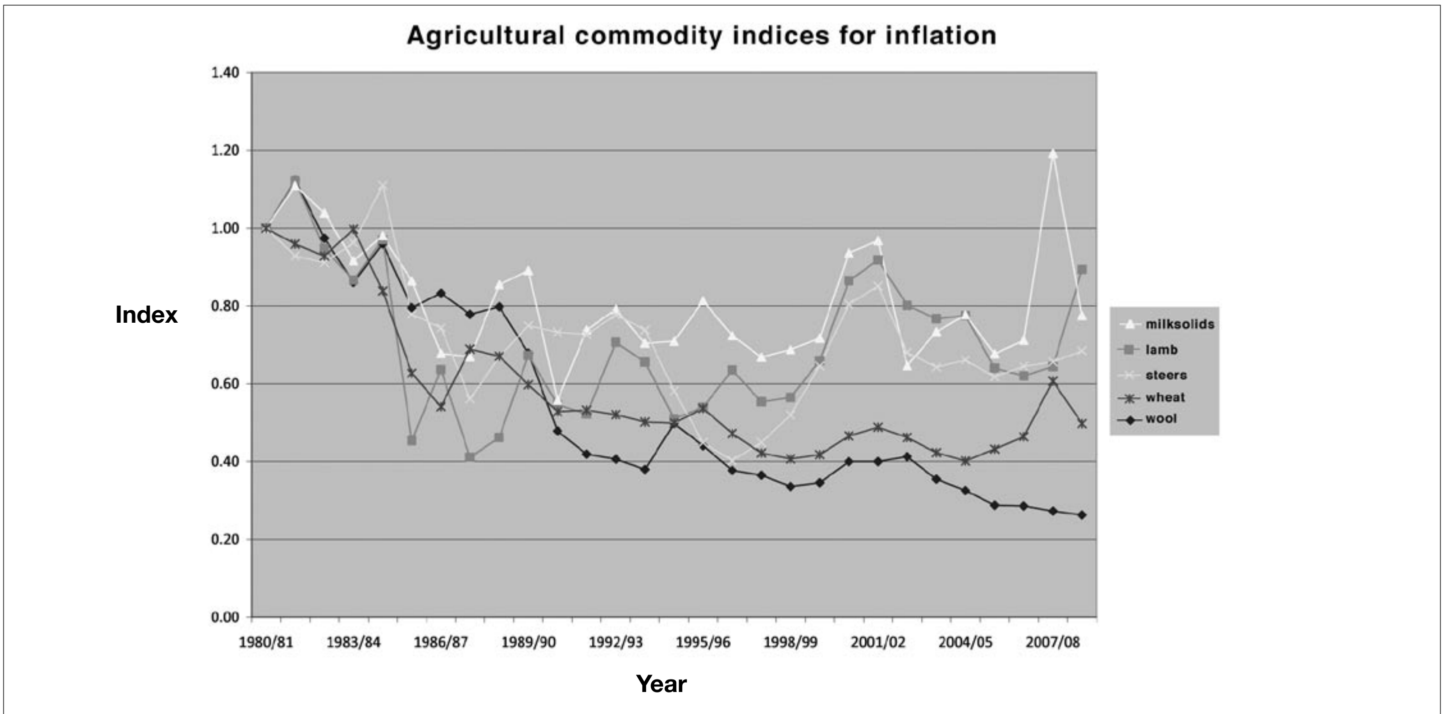
Apart from limited areas of heavy soils and other small areas in rain shadows close to the foothills, and excluding the special but limited historical case of town supply dairying operations, dairying without irrigation has never made much sense under Canterbury conditions. However, with irrigation, dairying has always provided a gross income several times that of traditional uses, except possibly intensive horticulture.

Nevertheless, during the 1970s and 1980s, the prevailing culture was that Canterbury was for sheep and cropping. In addition, there was limited rural finance apart from the government-owned Rural Bank. As a result, although irrigation was a necessary enabler, it was not a sufficient condition. Some entrepreneurs tested out the principles of

Canterbury dairy farming area in hectares 1982 to 2009



Inflation adjusted indices of agricultural commodity prices 1980 to 2008



dairying under border-dyke systems and Canterbury winters, but most farmers just watched.

The push and pull of prices

Most of the new dairying entrepreneurs of the late 1980s and throughout the 1990s came from outside of Canterbury. Many came from the North Island, but many also came from overseas, Holland in particular, but also from the United Kingdom. Farming syndicates and equity partnerships became increasingly popular in the late 1990s. Corporates, such as Tasman Agriculture and more recently, Dairy Holdings and Synlait, have also played a major role.

In all cases, these new entrants were attracted by the economics of dairying, based in particular on lower land prices and a larger scale of operation than in the North Island, combined with a more preferred climate than further south. None of this would have been possible if it were not for a steady stream of land coming on to the market from farmers who were exiting from sheep and cropping. In addition, a smaller number of sheep farmers themselves made the move to dairying, often linked to employment of a sharemilker or involvement with an equity partner.

Although it is widely assumed that returns from dairying have increasingly outstripped returns from lamb, our own data suggest that it is not that simple. Between 1980 and 1990 all product prices declined markedly in inflation-adjusted terms. Since then, both milksolids and lamb have more than kept pace with inflation. Apart from the dairy boom year of 2007/08, both the short term price fluctuations and the overall price trend of each have followed a similar pattern. The real problem has been the loss of income from wool, which has made sheep farming non-competitive. The relative decline in crop prices has also been important.

Encircled by pivots

The technology of pivot irrigation has been known for many years but it was slow to come to Canterbury dairying. It would seem that some Canterbury consultants and farmers, towards the end of the 1990s, saw the systems working in Tasmania and recognised the applicability of the same technology. Before that the challenge of irrigating the corners, which is possible either with pivot extenders or alternative spray systems, was seen as a constraint.

In addition, for river irrigators there had been little economic incentive to change from using established low cost flood systems. The problem of water being restricted to rostered days was another constraint for spray systems. This started to change in about 2000, first on farms using underground water, due to increased power costs. However, in 2010, even in the Amuri where river water is used but with water efficiency becoming more important, probably more than half the farms have pivots. There are also an increasing number in the RDR scheme, often in association with small on-farm storage dams.

For the early movers, it came as a pleasant surprise to find that not only were the pivots more water-efficient, they also led to increased production. Some of this production increase is due to less water stress on the plant, and some is due to increased irrigable area once borders and head races are removed. Many farms have been able to increase production by 15 to 20 per cent as a result of the shift.

The importance of technology packages

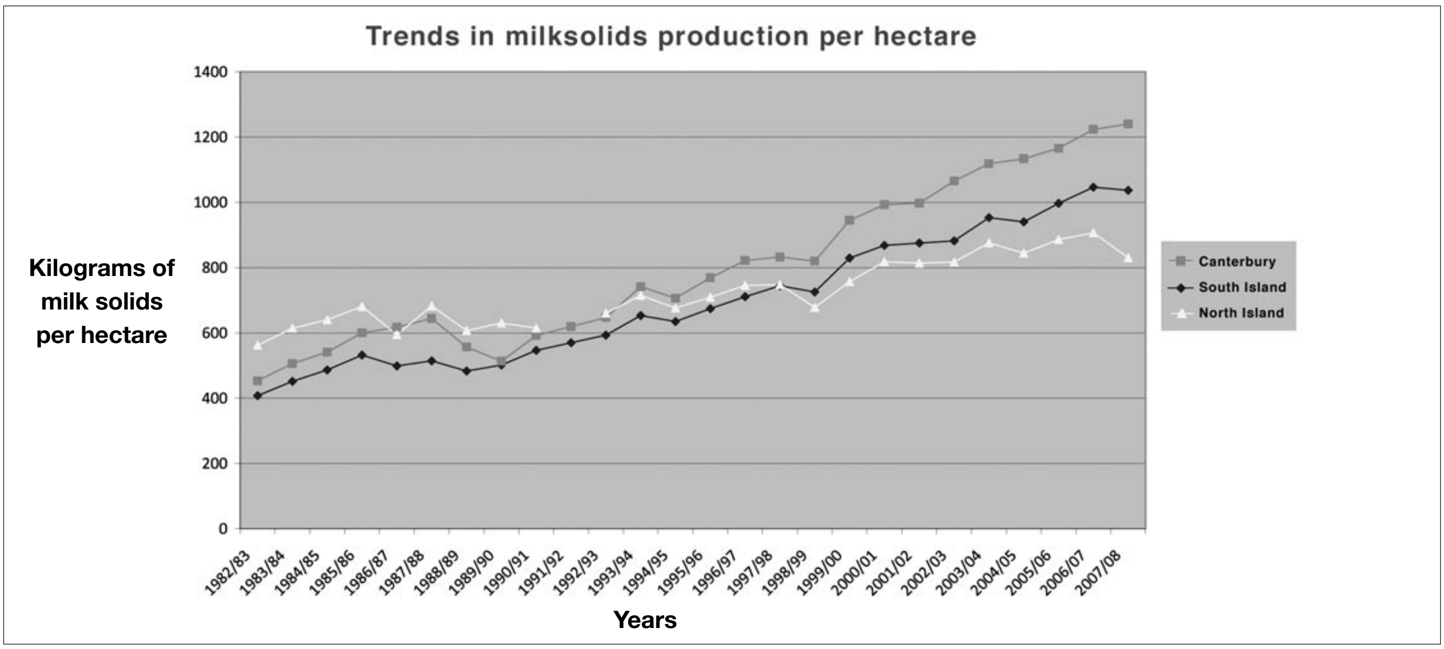
Since 1985, dairy production per hectare has increased faster in Canterbury than elsewhere in New Zealand. Part of this is undoubtedly due to irrigation technology.

First it was improved border irrigation systems, including laser levelling. More recently it has been influenced by pivots as already described. Other factors have been improved pasture management systems, improved methods for making and transporting silage, and the increased use of nitrogen. Teasing out the importance of further factors, such as the effect of the Lincoln University Dairy Farm, is more complex.

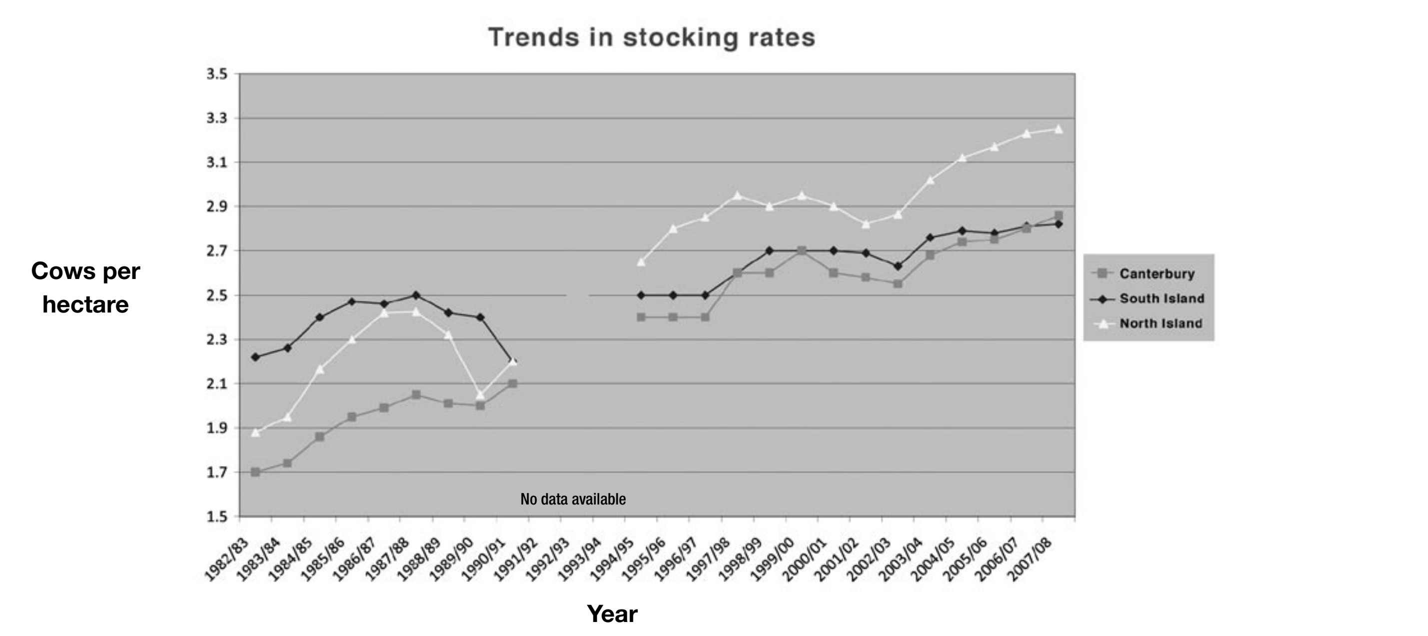
Although some new technologies have led to stocking rates that have increased faster than elsewhere in New Zealand, there have also been substantial improvements in per cow production relative to the North Island. This can be suggested as being mainly due to improvements in metabolisable energy, linked to grazing management and improved silage quality. Irrigation and the increased use of supplementary feed have also increased production by allowing more days in milk.

We consider it likely, but cannot prove, that the overall technological improvements in Canterbury dairying have been greater than for the competing sheep and cropping industries. We contend that in the competing industries there has been no technology package that matches the dairy package of nitrogen technology, endophyte technology, new grass species, management of pasture residuals, and labour

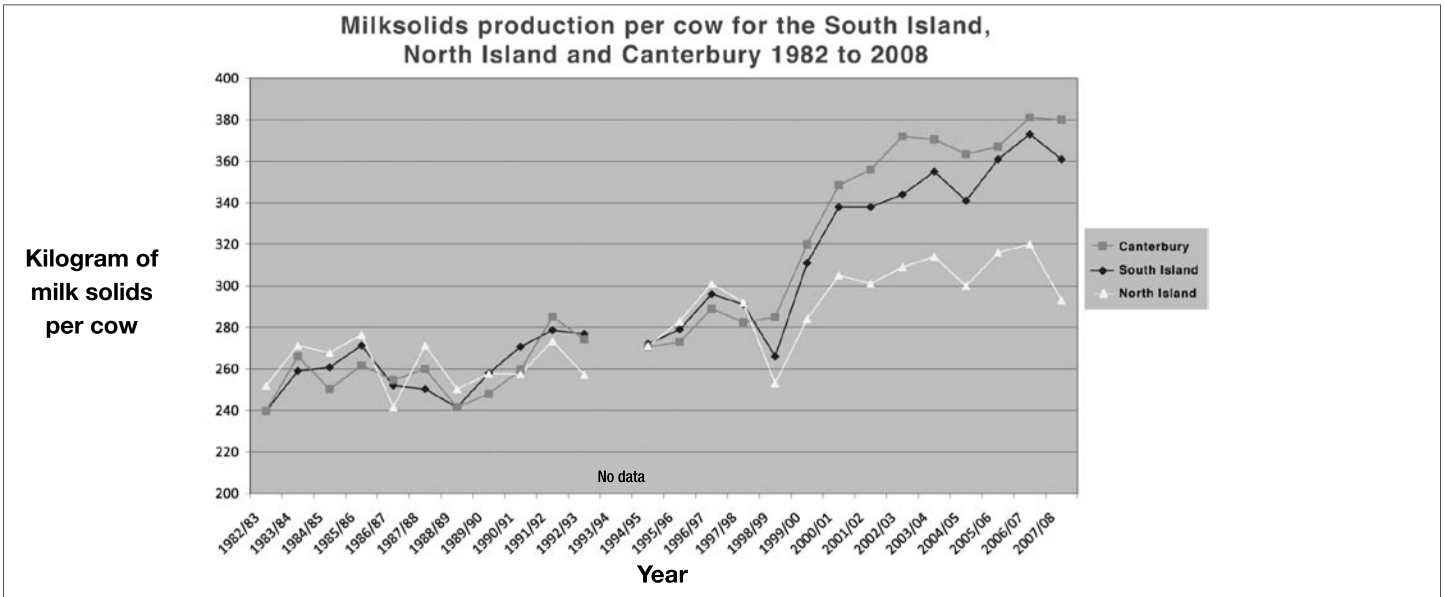
Milksolids production per hectare for the South Island, North Island and Canterbury 1982 to 2008



Stocking rates in cows per hectare for the South Island, North Island and Canterbury 1982 to 2008



Milksolids production per cow for the South Island, North Island and Canterbury 1982 to 2008



saving in the milking shed. Although ewe productivity has increased in sheep farming, and grain yields have increased significantly in cropping, these have been insufficient to maintain relativity.

The future

The future of dairying in Canterbury is controversial. There are concerns about its effect on water quality, and there remains a belief in parts of the urban community that there is something fundamentally wrong with dairying

However, there are known technologies to ensure that dairying has no more effect on water quality, and in many cases less effect, than do other farming types. Also, economic issues are likely to lead to changes away from sheep and mixed sheep with crops. We foresee closer integration between crop farming and dairying, with the increased used of annual crops for feed, including by cropping farmers who convert part of their farm to dairying.

The area of Canterbury suitable for irrigation has been estimated at about 1.2 million hectares, of which about 650,000 hectares are currently consented for irrigation, and perhaps a little over 400,000 hectares are currently under irrigation. The current area in dairying is only in the order of 200,000 hectares. We can therefore see a scenario in which Canterbury dairy production could easily double in the next 20 years.

Marvin Pangborn is a Canterbury dairy farmer and a lecturer in Farm Management at Lincoln University.

Keith Woodford is Professor of Farm Management and Agribusiness at Lincoln University.

Mark Geddes

Rural lifestyle development – potential threat to the primary sector

Rural lifestyle development generally happens as result of people wanting to live in a higher quality environment which is capable of providing for their desired lifestyle. Rural lifestyle properties normally offer more privacy than suburban houses, provide higher amenity values and are capable of accommodating the house and garden of your dreams, along with the pet horse and sheep to go with it.

With the combination of a buoyant property sector over the last 10 to 15 years and relatively relaxed planning controls, there has been a surge of rural lifestyle development across New Zealand. Typically, the highest concentrations occur close to towns and cities where urbanites can enjoy the best of both worlds by living in the country and working in town.

Rural lifestyle development, or one-off rural housing as it is referred to in the United Kingdom, has long since been the bugbear of town planners. The principal reasons for this are that it –

- Is dependent on unsustainable private vehicle movements
- Can have a negative effect on landscape and visual amenity values associated with rural areas
- Can negatively affect water quality
- Can undermine the urban structure of a district
- Creates expensive demands for an urban level of services, including road infrastructure.

It is not the intention of this article to address all these matters, but to specifically address the effect of rural lifestyle developments on the viability of the primary sector. This is often overlooked by planners and councils alike. Using the Timaru district as an example, this article examines the effects on land availability and the constraints that this type of development can impose on the primary sector.

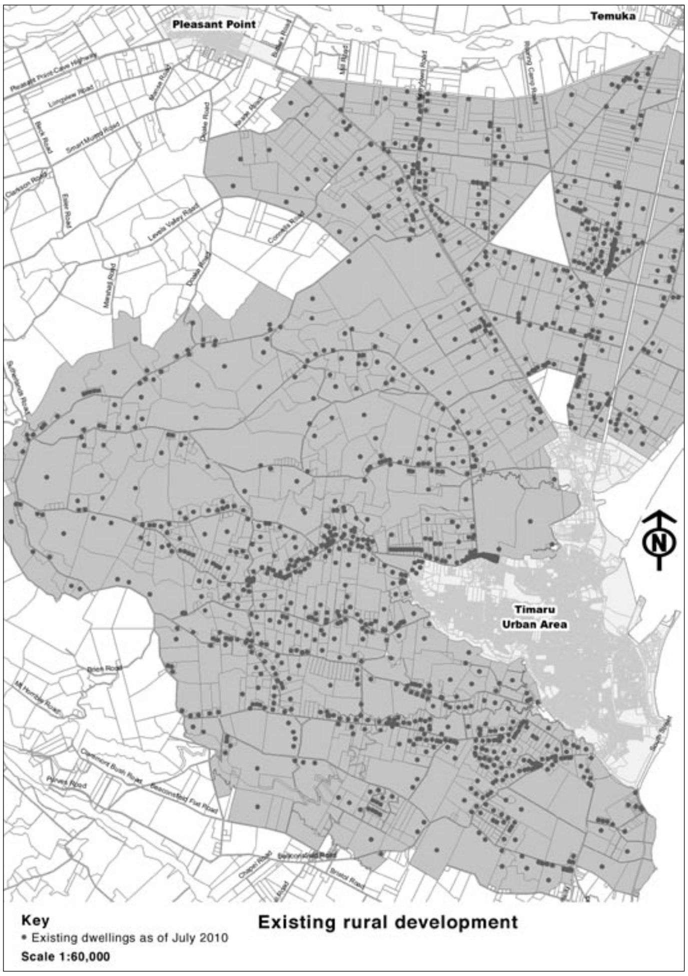
Effect on the viability of agriculture

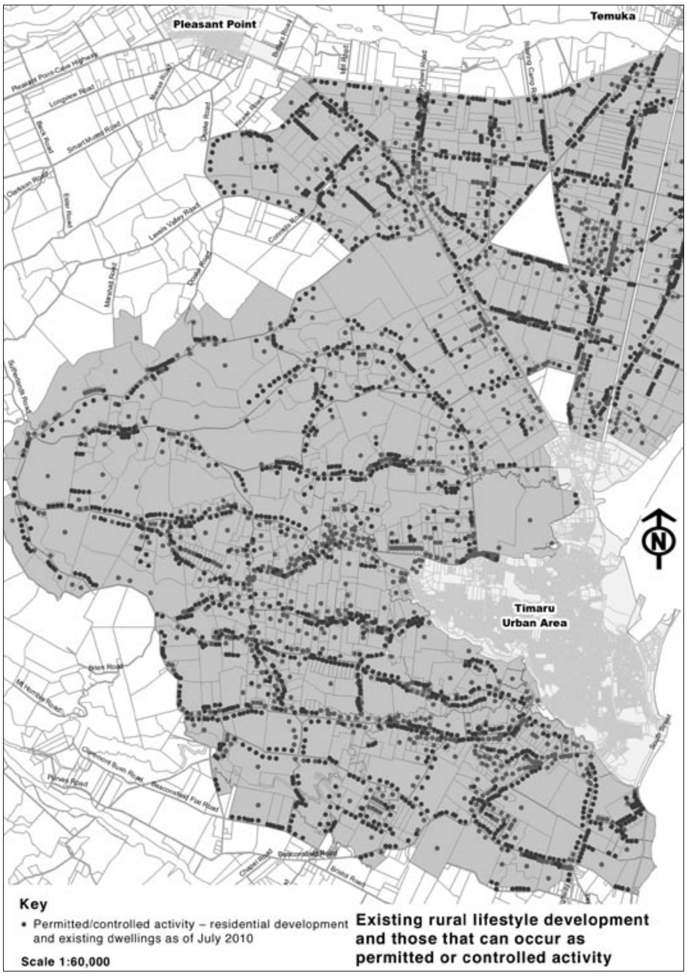
Although rural lifestyle development has almost eliminated commercial production in some rural areas of the Timaru district, its effect overall on the primary sector is not yet at alarming levels. As stated above, rural lifestyle development is mainly around urban centres, with development concentrations generally being highest close to towns. Larger urban areas normally have more and high concentrations of development than in smaller urban areas. These trends have meant that the concentrations of dwellings further away from towns are still at manageable levels. If the current rate development continues, it is considered that it may become a significant issue in the near future.

In an effort to sustain the potential of natural and physical resources to meet the reasonable foreseeable needs of future generations, the Resource Management Act requires territorial authorities to take an inter-generational perspective in their decision making. It is when viewing the current level of rural lifestyle development over an inter-generational period that the true severity of the problem becomes apparent.

Losing land for agriculture

The first map on the next page illustrates the existing rural lifestyle development around Timaru while the second map shows both existing developments and what could occur as a permitted or controlled activity under the Timaru District Plan. If current trends continue, the rural lifestyle developments will probably occur within the next 15 to 30 years.





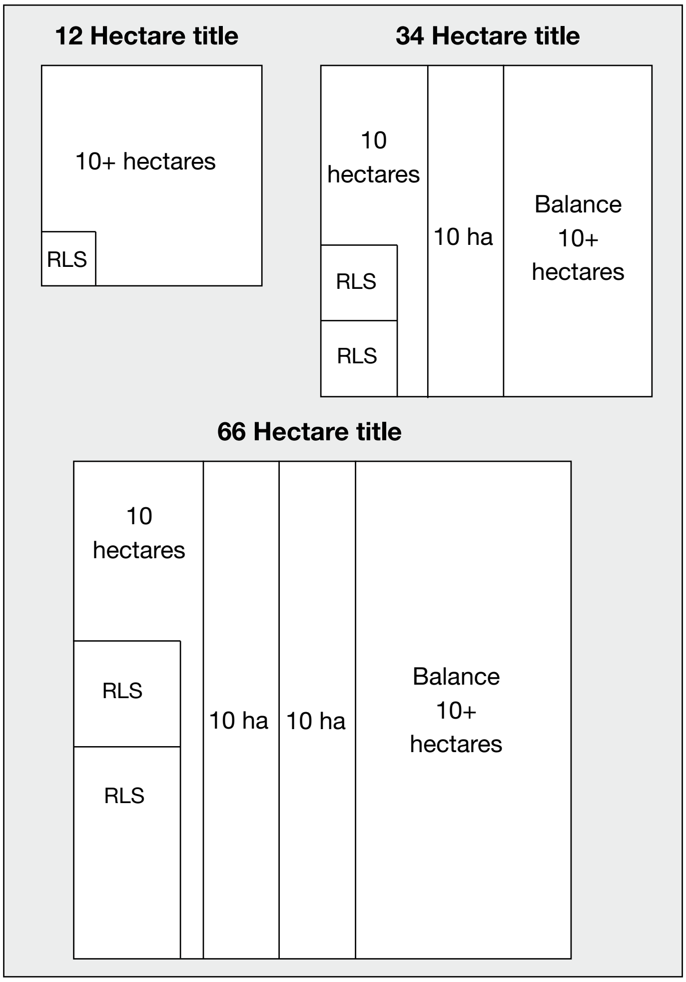
The map on the left illustrates the remaining 100 hectare allotments around Timaru, 100 hectares being approximately the area required for a viable farming unit. The maps make it clear that if current trends continue, large areas of productive land will be taken out of commercial agricultural production.

The trend generally starts with small parts of farms being subdivided off. If continued, this decreases their viability and often leads to more subdivision until the farm is so small that it is no longer a viable farm unit and can only be used for rural lifestyle development. As the concentrations of rural lifestyle development increase, it causes the landscape quality, amenity and privacy of these areas to be diminished. This then tends to push style developments even further from urban areas as people try to find a better quality environment. This ripple effect is commonly seen along rural roads as over the years, rural lifestyle development moves further away from town.

The availability of productive land is a natural and physical resource that the primary sector inherently depends on. Rural lifestyle development reduces the availability of productive land and also constrains the expansion of existing farms. Once this land has been taken it is unlikely that it will ever be used again for commercial production. The use of land for rural lifestyle development therefore does not sustain the potential of that land for the reasonable foreseeable needs of future generations and is contrary to the fundamental tenets of the RMA.

Although rural lifestyle development does not prevent the acquisition of the land for farming purposes, it

The Timaru district plan has been operative since 2005 and has continued the previous regime of relatively permissive subdivision and development controls in the rural area. As long as the development complies with a number of performance standards, land can generally be subdivided for rural lifestyle development as a controlled activity under the district plan. The RMA provides that the consent authority has to grant consent to a controlled activity and can only impose conditions on the matters which the plan limits control over. In the case of the Timaru District Plan these are mainly limited to matters of servicing.



Minimum lots size rules

The performance standards for subdivision in the Rural 1 zone, which covers the majority of the rural parts of the district, aids subdivision of allotments depending on their size and whether they have been subdivided before. Potentially sites over 40.3 hectares in area that have not been subdivided since 1988 can be subdivided into seven allotments, being made up of three rural lifestyle sites of 1,000 square metres to two hectares, three 10 hectare allotments and a balance lot. Once the property has been subdivided, the district plan helps in the erection of a dwelling on each site as a permitted activity without the need for resource consent.

Examples of how sites can be subdivided under the district plan are shown above. As is mentioned, if anything like the rural lifestyle development that is permitted by the district plan occurs, large parts of the district will be effectively taken out of primary production.

Options for control

There are many ways of controlling the rural lifestyle developments. Commonly used mechanisms both here and overseas include minimum allotment size standards, environmental effects based controls and provision of rural houses for rural people controls.

Minimum lot size rules can be effective, but they depend on how large the minimum lot size is. Large rural allotments. They obviously more expensive than small allotments and therefore discourage many buyers who are reluctant to accept the higher price and the burden of taking care of a large property. Minimum lot size rules also have the benefit of not discriminating against urban people and give anyone who wants to, the opportunity to live in the countryside, albeit at a price.

Effects based controls are common in New Zealand, but have often proved to be ineffective and are difficult and expensive for councils to administer. The effects of rural lifestyle development are cumulative in nature and are consequently difficult to evaluate and control until saturation point is reached and then it is too late to reverse the effect.

Rural houses for rural people type polices are used in parts of Ireland and the UK and can also be difficult and expensive to administer. Despite the type of control used, what is important is that there is a clear, district wide strategy employed as to where rural lifestyle development can occur and where it should not.

As discussed above, it is also important that the issue of rural lifestyle development is viewed over an inter-generational period so that its true effects can be put into context. Generally it should be located in parts of the district that –

- Avoid areas of productive land and quality soils
- Are capable of being serviced
- Have good existing road access
- Are located close to an urban area
- Do not significantly detract from the landscape and visual amenity values of the area.

Political will plays a part in implementing any policy As the effects associated with rural lifestyle development are cumulative in nature, and often only apparent over inter-generational periods, politicians can find it difficult to support restrictive policies. This is understandable, and after all, what is one more house going to do?

Conclusion

Productive land, and in particular quality soils, should be seen as a finite economic and environmental resource which should be protected from the encroachment of non-productive uses such as rural lifestyle development. For the primary sector to operate efficiently it needs to be able to operate without significant constraints and be able to acquire land relatively easily and at a reasonable price. If we are going to avoid the problems associated with rural lifestyle development, we will need to view this issue over a broader time period and put in place effective district wide strategies to deal with the issues raised.

Lyndon Matthews

Changing land use in Canterbury
The effect and implications for rural valuations

It is possible to observe general trends in the rural land market. For example since 1954 the average growth in all farms has been 9.2 per cent each year, and indexing is used by some as a means of giving a value to rural property.

However, indexing general trends gives no indication as to what is driving the change in land values. Simplistically we could say that any change was due to the economic circumstances prevailing at the time. However in Canterbury in particular, changing land use has had a significant effect on land values over a long period. This change was brought about due to the variation in economic returns between sheep, cropping and seasonal supply dairy farming, and the availability of water for irrigation.

Seasonal supply dairying has continued to increase. This is due to the success of the dairy model with its co-operative structure, single product, regular cash flow, international marketing and distribution, along with the ability to convert pasture dry matter into product more efficiently than other forms of pastoral production. Balanced against this other forms of agricultural production have not performed as consistently well over the same period.

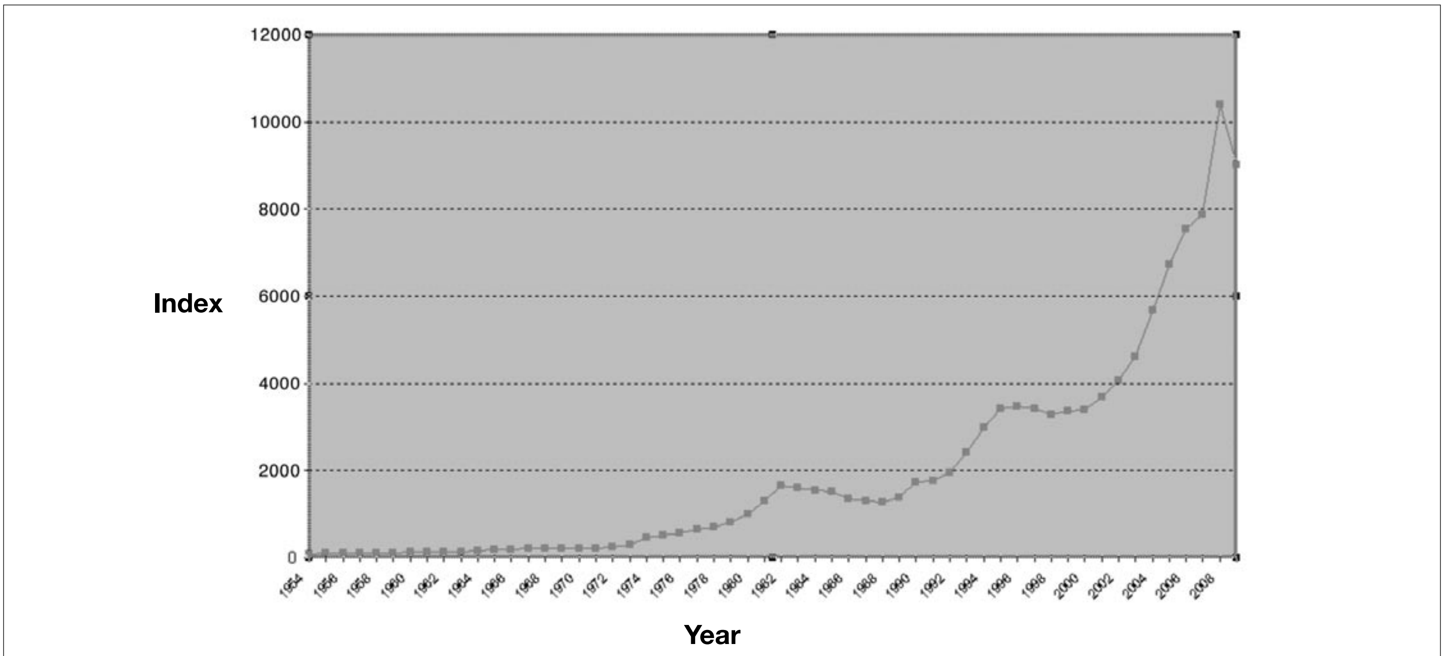
But before considering the effect of changing land use in Canterbury we need to revisit some basic tenets of valuation. Contrary to the belief of some, valuers do not set values. The market sets values. It is the valuer's role to interpret what the market is doing.

Highest and best use

One of the first principles of valuation is the concept of highest and best use. This being – the most probable use of an asset which is physically possible, appropriately justified, legally permissible, financially feasible, which results in the highest value of the property being valued.

A number of factors influence value. These include –

- Economic returns within an industry and between industries competing for the same resources
- The availability of capital, both debt and equity
- Required rate of return
- Availability of resources
- The regulatory environment.



Land price indices 1954 to 2009

Arbitrage opportunities

Changing land use occurs when an arbitrage situation exists – where an astute purchaser can buy land under one use and convert it to another for less than the cost of purchasing an existing unit. This creates a development margin or profit from doing so. This profit is captured at the time of purchase and effectively increases the purchaser's equity.

Against this framework we need to consider changing land use in Canterbury and the implications for valuers. For example, for the Canterbury Plains in the mid 1980s in general, the greatest economic return from the better soils with or without irrigation was arable farming growing traditional cereal crops and small seeds with a small component of sheep and beef trading or finishing. Sheep farming was found on the lighter dry land and border-dyke irrigated Lismore stony silt loam soils which had limited water holding capacity. Traditional dairying tended to be smaller farms confined to heavy land often close to the towns.

The first wave

During the 1980s, as sheep farming fortunes waned, some early innovators within the dairy industry began to purchase the border-dyke land, apply capital fertiliser applications and erect cowsheds. The advantages of dairying on the lighter land of the Canterbury Plains quickly became apparent. These farmers discovered the free draining soils and reliable cheap irrigation water provided a more consistent production profile, the availability of inexpensive supplementary feed and the ability to winter-off.

The ability to achieve greater economic returns off this land than the incumbent sheep farmer meant the dairy farmer invariably became the purchaser of this land. The valuer then had to recognise that the highest and best use of this land was changing to seasonal supply dairying. Production levels on border-dyke land were in the order of 1,000 to 1,200 kg of milk solids per hectare after development consolidation. Often it was only the production increases as the land consolidated that kept these conversion farms viable during the difficult financial times of the mid-late 1980s.

Over the next 15 years until 2000, these conversions continued steadily. Other lighter dry land was developed by putting down bores to obtain ground water for development into spray irrigation, again for dairying as it offered the greatest economic return. The cost of obtaining the ground water resource was only the development cost as the resource was not considered, at that point, to be limited.

The second wave

The second phase of changing land use has taken place in the last 10 years. The ability to convert a volumetric flow from border-dyke water allocations to a continuous flow regime, by the construction of an on-farm storage dam, enabled entrepreneurs to convert border-dyke farms to spray irrigation and grow substantially more pasture and have surplus water to irrigate other land. Under pivot irrigation it was possible to achieve up to 1,500 kg of milk solids per hectare – a 25 per cent to 50 per cent increase in production off the same land area.

This created an arbitrage opportunity as a completed conversion had a higher production capability than under a border-dyke regime. This gave a greater economic return and effectively increased the equity of the owner as it had a greater market value, based on production capability. The attractions of low cost surface water and low energy requirements were also starting to become a significant factor when contrasted with the more expensive deep well irrigation systems.

No more shelter

This second phase of conversion, or redevelopment, involved the large scale removal of the shelterbelts that have long been a feature of the Canterbury Plains, land contouring, capital fertiliser and pasture renewal. The effective areas on most farms increased as shelter belts and head races were removed.

This, in conjunction with the pasture renewal, technical changes and management, accounted for part of the increased production from these conversions. The number of properties bought for conversion continued to increase with border-dyke land of the Ashburton-Lyndhurst, Mayfield-Hinds, Valetta and Amuri irrigation schemes all being sought-after.

It was no longer sufficient for a valuer to value a property for its dairy production capability under a border-dyke watering regime. In valuing a property with conversion potential, a valuer needed to ensure the property had sufficient water resource to apply approximately 5 mm per hectare per day to the milking platform area – the platform area generally being determined by the amount of water available. In addition, the valuer needed to carefully consider the post-development market value on completion by comparison with established dairy unit sales. Then the valuer needed to deduct the costs of development and a profit or contingency margin to arrive at a market value for the land in its current state. The valuer also needed to consider the value of surplus water associated with the property.

Lower payouts

The low payouts of $4.59 per kg in 2004/05, $4.10 a kg in 2005/06 and $4.46 in 2006/07, and increasing costs including share capital, saw profit margins diminish and the number of conversions slowed significantly. There were only seven dairy farm sales in Canterbury in 2006/07 and the cost of completing a conversion or redevelopment became more than an existing dairy farm was selling for.

However, irrigated land continued to be sought-after for dairy support purposes such as grazing of replacements, growing feed for the milking platform and wintering cows. Again the strength of the dairy model enabled dairy farmers to compete for this land. Converting grazing and feed costs into interest payments was readily supported by their debt providers. Valuers needed to consider that, although the land might not sustain a dairy conversion, its highest and best use would still ultimately move from sheep to dairy support activities and it needed to be valued on this potential.

A new era

The announcement of a dairy payout forecast of $7 a kg of milk solids in June 2007 for the season had signalled the start of a whole chain of events. This forecast was a 57 per cent increase over the final payout of $4.46 for the 2006/07 season, and dairy industry commentators suggested that this heralded a new income level for dairying that was here to stay.

Virtually overnight the demand for dairy farms increased, and over 35 dairy farms were sold in Canterbury alone in the 2007/08 season. Properties that had failed to sell the previous season were now selling for levels greater than the original listing. It was very much a sellers' market. As the supply of dairy farms was insufficient to meet the demand, established dairy farmers keen to capitalise on this new level began converting their irrigated run-off blocks for dairy while others bought land for conversion.

With the arrival of new independent milk processors Synlait and New Zealand Dairies, a new arbitrage opportunity was created. This was for existing dairy farmers to release capital by selling their Fonterra shares and using the proceeds to buy more land, converting the land and supplying milk to the new independent or in some instances, even continuing to supply Fonterra under a contract. The small differential between the contract price versus the cooperative price suggested that Fonterra shares did not give a return equal to their cost of capital. That then raised the question – What would a farm sell for without Fonterra shares?

Knock on effects

This demand for conversion land was like a stone thrown into the middle of a pond and the ripples beginning to spread to other areas. Sheep farmers in Canterbury and Southland were able to sell their often smaller farms for very good money. Many being too young to retire, or wanting to set the next generation up on the land, moved into the foothills and areas without irrigation. This in turn drove up the value of sheep and beef properties in those localities. Throughout Canterbury irrigated pastoral land suitable for conversion sold for in excess of $2,000 a stock unit, but $1,000 a stock unit was achievable on foothills properties.

Dairying was not the only influence on these foothill property values. Land purchased for viticulture development in Marlborough also saw a number of farmers from Marlborough being able to relocate on to larger units in Canterbury. At the same time the buoyancy of the residential property market saw land in the Waimakariri District experiencing strong demand from developers for subdivision into rural lifestyle blocks. This also saw a number of farmers in the Waimakariri District being able to relocate to other parts of North Canterbury. Valuers operating in the Waimakariri district had to understand the relative returns of competing land uses of dairy and subdivision potential as each competed for different land holdings throughout the district.

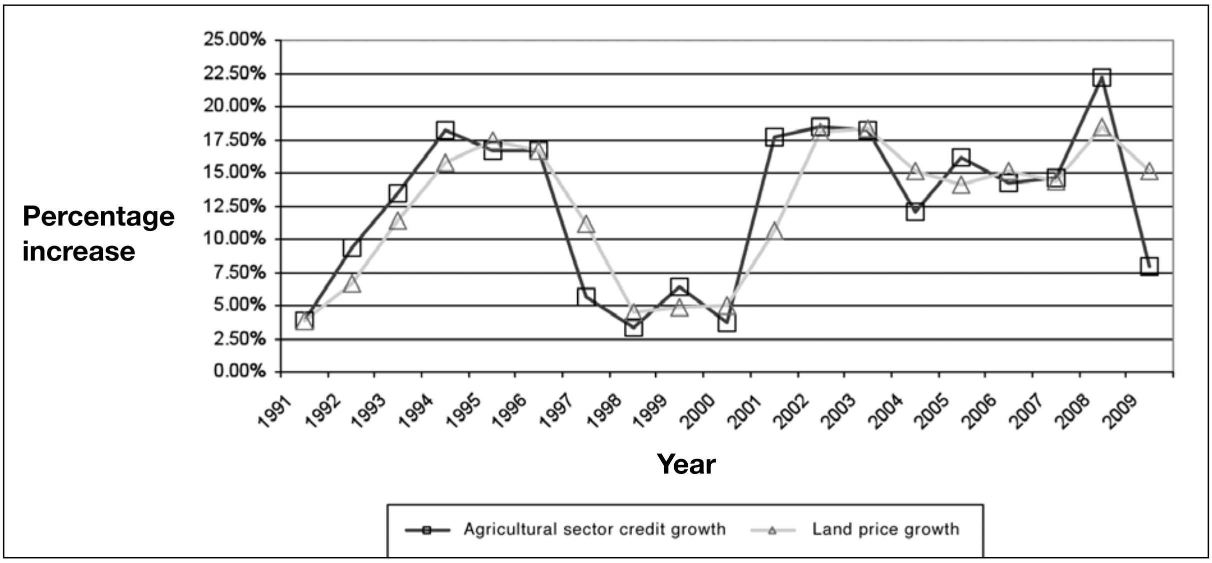
The best use

Canterbury sheep and beef farmers on irrigated land or in higher rainfall areas were increasingly looking to dairy conversion or dairy support activities for greater economic returns. Dairy conversions began in non-traditional dairy areas. Cowsheds began to go up in the Fairlie basin at 350 metres above sea level with the tussock waving in the background. Marginal land with this potential could be purchased for $1,000 a stock unit.

Valuers needed to consider that the production levels were never going to be as high as on irrigated land, the season would be shorter, the level of conserved feed inputs would be higher and the market value on completion would not be at the same level as on the Canterbury plains dairy units. The question had to be considered – was this the highest and best use of the land for all the pastoral farms in this locality?

It was of little consequence to the market participants that any increase in dairy farm returns was quickly capitalised into rising land prices and that costs were also rapidly rising. The banks were keen to lend, supported by the rising land prices, with less consideration of viability, risk and volatility. The arable sector too began to benefit from the increased payout forecast as dairy farmers looked for feed wheat and barley to increase their production. Sheep and beef farmers contemplated dairy support activities because winter grazing

Credit growth versus land price appreciation



and young stock grazing were now also required from an even greater number of dairy farms – now that much of the previous support land had also been converted.

Opportunities for biodiesel production also saw changing land use. Biodiesel New Zealand, offering contracts for oil seed rape, saw demand for land suitable for arable activities in the most unlikely places – although mainly leased. Again, the valuer had to consider the question – was this new land use the next highest and best use of this land?

Nobody rings a bell at the top

Just when it all seemed too good to be true, September 2008 brought the collapse of Lehman Brothers on Wall Street and the impending global financial crisis. All of a sudden international milk powder prices fell, as did the payout forecast. Liquidity became extremely tight as banks struggled to meet capital adequacy requirements and the rural land market lost confidence.

From the initial forecast payout reduction announced in October 2008, the volume of dairy farm sales in Canterbury plummeted to just six sales in the latter part of 2008/09 and six in 2009/10. Viticulture demand also dropped due to an over supply of grapes. Lifestyle block sales dried up and developers no longer set the value for land in the Waimakariri. So what was a sheep farm now really worth without the transfer of capital from other areas?

History no real help

Prudent valuers considered that, with substantially different economic returns forecast, historical sales evidence could no longer be considered the correct benchmark for determining market value levels. In the absence of any volume of sales transactions valuers needed to consider a productive valuation model as a means of determining current market values.

Eight years of analysed sales data in Canterbury indicated a cash return to dairy land of around six per cent after accounting for all other factors of production such as stock, plant and shares. However this return had occurred over a time of strongly appreciating land values, so a discount rate needed to apply when there was no land appreciation.

The above graph suggests that land appreciation over the previous period had been strongly linked to the growth of rural credit and this source of capital was now restricted. Those that had their own sources of capital were also unlikely to pay any more than they needed to for any acquisition.

A productive valuation model was adopted for dairy farms, assuming they were reasonably homogenous properties which had a standard set of infrastructural assets, a single product and a clearly defined income stream. The model suggested $40,000 to $45,000 a hectare inclusive of shares, or $30 to $31.50 per kilogram of milk solids might be the new level the market would operate in.

Six months later a limited number of sales suggested the productive valuation model was indeed a good guide, and has continued to be so. However, while production parameters and costs can be determined with a reasonable degree of certainty, assumptions have to be made around the required rate of return sought by the market and what medium term payout expectation the market was working off.

The third wave

With dairy prospects looking brighter again in 2010/2011 conversions are set to continue. However this time it is the existing sheep or cropping farmers looking to convert due to poor returns from their respective industries. Often these are the above average farmers frustrated by poor profitability and a resistance to change within their industry.

Lending criteria are stricter now, but often these farmers have good equity levels hampered by poor liquidity and cash flow. Dairying, although requiring large amounts of capital for a cowshed and shares, has the ability to generate cash flow and provide prospects for a viable business and options for inter-generational transfer. Banks are now focused on strong cash flows and the ability of borrowers to handle volatility.

The future

You can expect to see the dairy model continue to roll out across Canterbury. This is evidenced by Synlait's intention to build a second plant and Fonterra's decision to build a new factory at Darfield. Clearly both companies are anticipating continued growth of dairying in the region.

Successful implementation of the Canterbury Water Management Strategy will see better use of the water resource. A main part of the implementation will be a distribution system that allows the water resource to be transferred and traded to wherever the greatest economic return can be derived. However ,while the growth in dairying may continue, there are a number of factors that need to be taken into account when valuing rural land, and these mainly revolve around water.

Hungry for water

Is there always going to be sufficient water for dairying? Dairying is water hungry and dairying only works where water is not limiting. What happens as ECan, under the Natural Resources Regional Plan, moves towards seasonal allocations? Does the conversion property being valued have a sufficient water resource to irrigate throughout the season or will all the water under an annual volume be used up by the third week in January with the driest months of the year still to go? It is no longer sufficient to look at the maximum or average daily take. The annual volume usable within the consent in cubic metres of water a year also needs to be considered.

There are also different water use efficiencies between pivot irrigation and rotorainer, and clearly there are greater efficiencies gained under a pivot irrigating little and often. One of the inherent weaknesses of rotorainers is the length of the return period. Rainfall immediately after watering with a rotorainer is effectively lost under a seasonal volume regime. Valuers therefore need to consider the irrigation system employed when considering the value implications of an irrigated property under a seasonal allocation. Consideration also needs to be given to energy costs in comparing deep wells with surface water.

More efficiency

Analysis of dairy farm market data in the Canterbury and North Otago regions clearly indicates that many market participants are now placing a very high emphasis on the quality and level of farm infrastructure and the core physical resources of soil quality and water resources. This relates to the substantial cost increases associated with developing or upgrading infrastructure and the energy efficiencies associated with surface and shallow ground water resources.

Piping of water distribution systems on the Canterbury Plains will see increased efficiencies that will lower energy costs and potentially allow more land to be irrigated by reducing water losses incurred from the open channel system. Dairy farms will need to become more efficient in their water use. When water is limiting, cropping makes better use of the existing water resource under a seasonal allocation where there is a different demand profile that tends to taper off after Christmas as harvest approaches.

Water quality may in fact become the most significant factor in any future land use in Canterbury. The time may come when dairying no longer gives the greatest economic return if water quality is a limiting factor of production. On the better soils of Canterbury we are already seeing evidence that greater returns can be obtained from specialist crops, although these are not without their risks and challenges.

Other land use changes

As always, land use change in Canterbury seems to revolve around water and dairying. All the indications are this trend will continue in the foreseeable future, but there are some other aspects of changing resource use that also need to be given due consideration. With the natural fall on the Canterbury Plains, and availability of water and water distribution systems, it seems likely that there will be further development in the areas of water storage in the foothills, hydro power generation within races and piped systems on the plains. Already some farmers are using the gradient of the Canterbury Plains as a way of reducing the energy costs of running centre pivots.

There may be also be opportunities in some hill country areas for carbon sequestration and renewable energy generation in the form of wind farms. Both could have the potential to generate greater economic returns than currently being achieved on some of this land.

Long term risks

Carbon sequestration on some hill country land appears to offer an arbitrage opportunity in the short term from the sale of credits. However, there are potentially risks further out with regard to the cost of units at the time of harvest when the majority of the units will need to be redeemed.

One of the most significant implications of land with tracts of forestry for valuers will be ascertaining the level of credits that have already been allocated to the forests. In some instances the potential liability may be such that it will never

be economic to harvest the trees and the land will effectively be rendered of little value or encumbered by a liability.

Wind farms are also in their infancy in Canterbury and to date seem to face strident opposition wherever proposed. However it seems likely that, in time, these too could provide a complementary income stream to a number of farming operations. There are already value implications around the probability of the success of consentability of such proposals and the relative economic returns of the various agreements being struck between energy companies and land owners.

While not strictly encouraging land use change, the following factors will also be of significance to the value of rural land in Canterbury –

- The eventual lifting of the Dairy Industry Restructuring Act 2001 regulations
- The availability of capital
- The required rate of return of the market.

Dairy Industry Restructuring Act

The market equilibrium may change markedly when the Dairy Industry Restructuring Act triggers levels for supply. There are two reasons why this may occur –

- Fonterra will have no requirement to supply up to five per cent of its raw milk to independents at a regulated price
- Fonterra will not be required to operate an open entry and exit regime, or be subject to restraints on contractual terms within a regional area.

Trigger levels are reached when 20 per cent of market share is held by independent milk processors, excluding Westland. At this point the independent processing companies will lose the arbitrage opportunity to extract processing efficiencies currently obtained from receiving a proportion of their supply from Fonterra at a regulated price.

Fonterra may choose to refuse to accept new suppliers or may offer differential pricing for milk in regions that have alternative supply options. When the trigger levels are met and the safety net of Fonterra supply no longer exists, we may see a situation where the market reassesses the value of Fonterra shares and the value of alterative supply contracts based on the different income streams relative to the market's risk assessment of the alternative supply options.

Availability of capital

New Zealand has a recent history of being short on equity capital and a propensity for debt funded capital. The fact of the matter is that bank lending requirements have now changed and the level of debt funding, in the foreseeable future will be different from what operated in the past.

This change is expected to constrain the rural land market and vendors may have to accept a lower value than in previous times, unless there are other external sources of capital. There is recent market evidence to suggest that international capital from Asia, Europe and the United States is being used to lead the market in securing property within New Zealand. Not only do these countries have greater availability of capital, there may also be other factors at play, including the desire to secure a source of safe food, the perceived safety of the investment in land as opposed to equities, and the required rate of return of these market participants.

Required rate of return

Depending on your point of view there could be the requirement for a higher rate of return in future to offset lower returns from capital gain and to account for greater levels of risk regarding volatility of returns. The requirement for a greater return will enviably lead to lower land values although market participants relying on debt funded capital will still be able to compete in the market.

The other point of view is that some of the sources of external capital may be prepared to accept a lower rate of return. This would be due to a desire to secure a source of safe food, the perceived safety of the investment in land as opposed to equities or their expectation of future returns from land used for food production. In this case a lower required rate of return would see values increase. Market participants within New Zealand reliant on debt funding will not be able to compete and we may see a gradual change of land ownership to international institutional investors.

Conclusion

Land use in Canterbury will continue to change. It will not be sufficient to analyse a sale on the basis of sale price divided by hectares to equal sale price per hectare. Valuers will need to recognise and understand the changes within the market. Economic or income methods will become increasingly important as an alternative or cross-check to the comparable sales approach.

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Bob Engelbrecht

An overview of the implications and effects of land use changes and water issues in Canterbury

To understand the effect of land use changes and water issues in Canterbury over the past 20 to 50 years, it is important to understand the development of the Canterbury Plains land over the past 100 to 150 years of farm development. The following article endeavours to presents a background on farm development in Canterbury and North Otago plains region. My logic for including the North Otago plains in this article is that its characteristics are very similar to the Canterbury Plains to the north.

My focus is particularly on Ashburton District. This is primarily because it is the area where irrigation has been developed over a long period of time, has a larger irrigated area than any other part of east coast South Island plains and probably has had more influence on irrigation development and land use changes, not only within Canterbury, but probably throughout all low rainfall areas in New Zealand.

The fundamentals

Canterbury plains land has an annual average rainfall ranging from as low as 400 mm in some coastal localities, up to 1000 mm along the foothills, but averaging around 700 mm over much of the region. However, this rainfall is not only very erratic between seasons, but also within seasons. Monthly rainfall at Winchmore Irrigation Research Station has varied from less than one millimetre a month through to over 250 mm a month for almost every month of the year since records began in 1950.

Most of the plains land soils are stony silty soils of relatively low moisture holding capacity, particularly in their dry land state. The region is subject to strong drying north-west winds in almost any month throughout the year, but particularly in spring, summer and autumn. The combined effect of these factors provides an erratic and unreliable climate for intensive farming.

History

During the second half of the 19th century there were around 22 large pastoral runs on the Ashburton district plains, averaging approximately 12,000 hectares. These stations ran low numbers of sheep mainly for wool production. When these runs were eventually subdivided into farms, they remained quite large dry land properties running relatively low numbers of sheep. Even then, there was unpredictability of livestock performance and farm incomes. This is the reason that, when these farms were irrigated, many became transformed into strong economic farm units with rapid build-up of soil fertility over a relatively short time.

Irrigation development was trialled in parts of Ashburton district in the late 1800s, but for various reasons never progressed at that time. In the late 1930s and early 1940s, when New Zealand was recovering from a major recession, the government of the day, planned a work scheme for Ashburton district, led by the Honorable Bob Semple. This resulted in the construction of the Rangitata diversion race. It was 66 km long and carried up to 30 cubic metres per second of water from the Rangitata River, across the top of the plains, through the Highbank power station into the Rakaia River.

This allowed for irrigation for seven months of the year and hydro-electricity generation for five months. From this opportunity, the three flood irrigation schemes of Mayfield-Hinds, Valetta and Ashburton-Lyndhurst, a total of 64,000 hectares, progressively developed. Much of the irrigation knowledge in Canterbury and New Zealand has been gained from this over the past 65 years.

It is interesting to read Bob Semple's foreword in a publication dated February 1945 about the Rangitata diversion race project. For those involved in farming and irrigation today, many of these words would still be considered very appropriate.

FOREWORD

THE grim events of the last few years have convinced me, and I am sure most New-Zealanders, of the vital necessity of greater population if this land is to remain the heritage of our kith and kin.

Population cannot expand faster than the rate at which productive and congenial employment becomes available.

I have always been impressed with the advantages which irrigation offers in this respect, especially in the vast open spaces of Canterbury and Otago. When it is possible, as in this instance, to generate electric power as well, a double blessing is conferred upon the land.

To all fair-minded critics of irrigation I offer this booklet in the hope that they will eventually be supporters. To those who are awaiting information on which to base their judgment these facts should be of assistance, and to the hundreds of progressive men and women who are already preparing for irrigation I hope this booklet will give added stimulus.

For the last thirty years the rural production and population of the Canterbury Plains has remained practically stationary. We as a nation cannot afford the continued idleness of such extensive resources not only for our own good, but for the benefit of the world at large.

However bright the future prospects of irrigation in Canterbury may appear from these pages, little can be achieved without the willing co-operation and effort of all concerned.

Let us therefore go forward into the era of hope that will follow the war, fully resolved to achieve the objectives that lie within our grasp.

R Semple

Bob Semple's foreword

Changes in irrigation technology

From a slow beginning in the mid 1940s to mid 1960s, irrigation development on individual farms was a real challenge. For individual farmers, managing the irrigation water was hard and laborious work. For month after month during the late spring, summer and early autumn it involved, hauling heavy wet wooden frames and large canvas sheets up and down the headraces, often day and night. Professor Sir James Stewart from Lincoln College prepared a report in 1974 indicating that for many if not most farmers, irrigation was not profitable. However, as has subsequently been very clearly demonstrated, the lack of profitability was a consequence of limited knowledge and understanding of irrigation technology.

Over the past 35 to 40 years, irrigation knowledge and development has been constantly evolving to the farming technologies and understanding of plant water requirements of the present day. During this period, many farming families will have had personal and practical experience of progressively changing their farms from wild flood irrigation, to manual surface-flood border-dykes, to semi-automatic and wide border-dykes. Then it moved to overhead spray irrigation such as hand-shift, end-tow, side-roll sprayline systems, to rotorainers and other similar mobile irrigators. Now we take for granted today's computer controlled centre pivot and lateral-move irrigators.

Many farmers have had the additional development costs of changing from one watering system to another over this long period. They have also had the benefits of those changes. We can anticipate that further technologies will continue to develop over the next decade or two, perhaps even at a faster rate. It is probable that, in future, irrigation water will be increasingly traded between irrigators, so that the greatest value per unit volume may be achieved.

Better performances

The main benefits of these technological changes has been to achieve better physical and financial performances from the farm, from both livestock and arable programmes, using less water from increasingly more precise application systems. New technologies currently under development are now bringing water to plants at different application rates and to soils of differing depths and soil moisture holding capacity as the irrigator moves over an individual paddock. This reduces the overall water application as well as limiting the water required and reducing the risk of loss of irrigation as drainage to groundwater.

All of this development and progress has been achieved with the co-operation of scientists, technicians, researchers and farmers, as well as the involvement of the region's water resource managers and regulators. The development and operational costs of these changes in technology, particularly over the past decade, have been very significant for the individual farmer. But so too have been the benefits.

Community benefits

What has not been well understood about irrigation development by the general public is the fact that benefits, particularly in the early years, are likely to be greater to the farm servicing and wider business sector and the community at large, than to the individual farmer with irrigation. Farm production not only increases, but becomes more constant between seasons, encouraging more stability and confidence in local businesses. This results in more employment and community wealth as farm production changes from less intensive to more intensive options.

For the individual farmer, with very significant increases in debt required to fund the more modern irrigation technology, the payback period can be many years and is frequently inter-generational. The costs include ancillary developments such as changes in farm layout and facilities, staff housing, increased plant and equipment, changes in livestock types, numbers and value. The major benefit the individual farm business achieves in the short term, is the certainty and reliability of production in terms of higher quantities, higher quality and delivery on time. These are factors that are increasingly required in today's high-pressure business environment.

Risk of failure

Even less well understood by the non-farming population, and frequently the authorities managing irrigation water supply, is that providing a limited resource does not result in a more efficient use of that resource. In fact, with a limited water supply there is a greater risk of failure, particularly where a farm business has geared up with high inputs on the expectation or hope that water will be available when required. Only the reliability and certainty of water supply enables optimal management decision making by an individual farmer or irrigator, as Andrew Curtis has also identified in his article on page seven of this issue.

Development of irrigation over the past 10 to 15 years has expanded rapidly throughout Ashburton district, as well as other parts of Canterbury and North Otago. Most new developments incorporate the latest technology. This, while normally requiring a significant increase in capital, can provide major savings in water, energy and labour, as well as a more reliable and higher quality end product.

Many irrigation schemes

Other irrigation schemes developed throughout Canterbury, mainly in the 1960s and 1970s, include Amuri Plains in North Canterbury, and Levels Plains, Morven-Glenavy, and Lower Waitaki to the south, as well as some smaller group schemes. Most of these schemes were developed with significant central government financial support, both on and off farm. In more recent years, schemes such as Opuha and Waimakariri have been developed, but with only limited financial assistance. All these irrigation schemes have made major contributions to their local communities, as well as to the wider Canterbury region and New Zealand as a whole.

Over the years farmer irrigators in these schemes have continued to involve new technology as it became available. Most farmers, as businessmen, are relatively quick to adopt new ideas and techniques, providing there is an economic or other benefit, in the short to medium term. With modern spray irrigation systems, we can grow higher yields of pastures and crops, using much less water to achieve these productivity gains.

This community irrigation scheme development continued to progressing throughout Canterbury. From the mid to late 1960s, farmers who could not access irrigation from any other source, particularly on the lower plains of Ashburton district, began to install deep wells up to 300 metres in depth, to access groundwater. In these early years particularly, this activity was very much an act of faith, and very risky as there was no guarantee that water would be found. Progressively over the past 40 years, irrigation from groundwater sources has been developed mainly by individual farmers, not only in Ashburton district but over the whole Canterbury region.

No water left

By my estimation, between 70 per cent and 75 per cent of Ashburton district's 250,000 hectares of plains land is now irrigated, to a greater or lesser degree. The development of irrigation from groundwater has now progressed to the extent where, by Environment Canterbury's assessment, there is no available water remaining, except in a few localities, for example the Mayfield-Hinds groundwater zone. By some estimates, groundwater is now over-allocated in many districts.

At the same time, other farmers and farmer groups throughout the whole of Canterbury have been researching and planning for further irrigation development. The hope is that the remaining dry land areas of the plains may be irrigated in the relatively near future.

As Irrigation New Zealand has suggested, for this target to be achieved, it will be necessary to develop large scale water storage in the hill and high country to the west of Canterbury plains. This storage needs to be built as rapidly as possible. This would allow other farmers on the plains areas of Canterbury and their surrounding communities to benefit from the availability of irrigation, the increased production and general standard of living, and also have the benefit of energy saving options from water brought to farms in pressurised pipes. Such development would relieve the pressure on our region's groundwater resources. In turn, this initiative could enhance the environment by limiting the water take from rivers and streams. In addition, there is the opportunity for recreational water developments, further environmental enhancement and the opportunity for other multiple uses of water.

More planning

Along with many others involved in irrigation, I have been suggesting for the last 20 or 30 years that planning for large scale water storage for irrigation and multiple other uses,

should have been investigated, planned and constructed. By waiting until now the existing water resource has come under much pressure. The *Economist* identifies that New Zealand has close to the highest volume of fresh water per head of population in the world, second only to Norway.

It is unfortunate that in recent years many farmers, in their enthusiasm and drive for more efficient and effective irrigation water use, have developed on-farm buffer ponds, usually in association with centre pivot irrigation. In the longer term, without the benefit of piped water from storage under pressure, they may not be able to capture the benefit of the lower energy cost and more efficient irrigation that could have been possible if large scale water storage had been developed some years earlier. Currently the farmers and management of the combined Rangitata diversion race schemes are planning to expand the irrigated area to at least 80,000 hectares over the next few years by better water management and using the available water more effectively. This process is progressively happening throughout Canterbury, both in community schemes and individual farmer schemes, from most water sources.

The significant water savings that will be released from the development of more efficient irrigation technology will provide opportunities for existing dry land farmers in Canterbury, along with the expansion of existing group or individual farmer schemes. However, there will still be shortfalls in water available for further irrigation development throughout the Canterbury Plains, shortfalls that could be addressed with large scale water storage.

Land use changes

In the 1960s and early 1970s, sheep farming was the predominant farming activity throughout Canterbury. Farmers produced wool and prime lambs for export, usually associated with a limited area of cash cropping as part of the rotation following the provision of supplementary feed crops for livestock. However, farmers were conservative in their farming systems and the intensity of farming, particularly in the lower and more unreliable rainfall areas. They recognised that droughts which were sometimes long and severe, could occur without warning.

When central government promoted the Livestock Incentive Scheme and Land Development Encouragement Grant Scheme in the early 1970s, some farmers tended to compromise sensible farm management practices, at least for a time. Moderately intensive cash cropping as a main farming enterprise was limited mainly to the deeper soils and higher rainfall districts.

The collapse of the strong wool price in 1967 led to a rethink of farming programmes over the next few years. With the development of irrigation, more intensive livestock farming including more beef cattle finishing expanded on the flood irrigated and border-dyke schemes, while more intensive cropping developed on the deeper spray irrigated soils.

Progressively as irrigation expanded, farming practices intensified in both livestock and arable farming, with the emphasis changing from time-to-time as the profitability of alterative land uses changed. Until the late 1970s or early 1980s, dairy farming was mostly for town supply purposes, with a limited number of factory supply farms on the deeper soils usually adjoining the rivers and in higher rainfall foothill areas.

Incidentally, there was a trial dairy farm in the early 1950s at Winchmore Irrigation Research Station. However local farmer interest was limited, with the perceived more desirable choices of sheep and beef farming, and arable cropping and seeds being preferred.

More dairying

In the early 1980s, a small number of innovative dairy farmers from the North Island decided that dairying in irrigated Canterbury was a worthwhile option, so more new dairy farms were developed on mainly border-dyke irrigated farm units. Farmers recognised that the technological changes made through those years had eliminated the drudgery associated with dairy farming in earlier decades.

With the ups and downs of conventional sheep, beef and deer farming through from mid 1970s to mid 1990s, progressive farmers considered alternatives, including conversion to dairy farming. They recognised that irrigated east coast Canterbury and North Otago had the potential to achieve the highest milk solids production per cow and per hectare of any district in New Zealand a status it has continued to maintain. There was also the advantage of large scale reliable milk production and now the average dairy farm in Ashburton district milks 800 cows.

In addition, the development of a co-operative milk export marketing system would remove many of the uncertainties and risks associated with other land uses, particularly with the intensive cash cropping and small seeds farming and the related cash flow problems. The decline in profitability of sheep, beef and deer farming with odd seasons of exceptions was a further factor which encouraged many irrigation farmers to look for more reliable and profitable alternatives.

Dairying the simpler option?

Over the past two decades, the profitability of intensive cash cropping, and conventional livestock farming have all had their ups and downs. However the general trend in profitability has been on the decline, despite the fact that at the same time, farm performance and productivity was improving and the trend in farm land values has been increasing.

To have a high performance intensive arable farming system today requires a significant level of skills over a wide range of technical and practical tasks. Also needed is an increasingly demanding workload and attention to detail with increasing production costs and cash flow constraints, even to achieve a consistently moderate level of profitability. My successful arable farmer clients eat, drink and breathe their farming businesses.

While growing a successful crop or seed may be demanding enough, to market it at a reasonable price and achieve a satisfactory cash flow can be even more challenging. I can hear the contrary comments coming from some readers, but my local dairy farmer clients would not even consider returning to their more complex mixed farming systems.

Continuing decline of sheep

Throughout irrigated Canterbury today, breeding ewe flocks are disappearing quite rapidly. The main involvement of sheep farming is in finishing store lambs sourced from hill and high country farms and other sheep breeding areas throughout the South Island. This activity mainly occurs as an off-season component of mixed arable farming systems. The finishing of prime beef cattle has also expanded as a recognition of the less intensive workload of such an option compared with sheep farming.

Dairy farming in Ashburton district now occupies some 45 per cent to 50 per cent of the plains land. Most dairy farms locally operate as milking platforms with replacement heifer calves and heifers from weaning to pre-calving spending their youth on dairy support farms, as well as the dairy cows grazing off-site for the two month winter period. There are less than ten dairy farms in the district that operate as dry land units.

The ready availability of feed supplements, such as wheat and barley grain, along with the use of crop residues, including cereal and ryegrass straws, undoubtedly contributes to the high average farm production. With reliable irrigation, particularly through the summer and autumn periods, milk production is very reliable and predictable in a 280 to 300 day lactation for most cows.

Cooperative processing

Having a co-operative processing and marketing organisation working to achieve the best result for the individual farmers, their products and their business success, is also an attractive component of the business. There is some publicity on the difficulty in obtaining and retaining quality staff, but most competent dairy farm employees have reasonable success with the people they hire. For the 2010/11 production season, we have 300 dairy farms in Ashburton District, each averaging 800 milking cows. With modern rotary milking platforms, grain feeding facilities, automatic cup removers, individual cow identification and milk meters, large scale dairy farming has become a very desirable and profitable land use.

By comparison, in recent years arable farming has become increasingly complex, with a move into a wide range of specialist crops and seeds. It is doubtful that the specialist arable programme can be sustainable without the involvement of the traditional crops of wheat, barley, peas, ryegrass and white clover seed in most farm rotations, just as they were 40 years ago.

Other factors affecting farming in Canterbury

Farm values have increased significantly in Ashburton district and throughout irrigated Canterbury both in nominal and real terms over the past 40 years, with a degree of decline in value since 2008. However, the value margin between irrigated and dry land farms has continued to widen in real terms, particularly since 1990.

There has been an increase in the size of farm properties. The perception and experience is that, subject to acceptable individual farm debt levels, larger farms are stronger and more secure business units. They certainly have more leverage in dealing with the farm service industries.

Most farm sales during the past six to nine months have been additional land purchases, though not necessarily adjoining land. In the mid to late 1960s an average farm would be approximately 150 to 180 hectares, carrying 1400 ewes, 300 ewe hoggets and a paddock or two of crop. Today, the average farm would be between 300 and 350 hectares and much more intensive. This trend is expected to continue.

Around 20 years ago, most farmers would have been happy to be able to irrigate half of their property, with the

Date	Total farms	Increase in dairy farms	Total cows	Increase in cow numbers	Average herd size	Average farm size	Average cows per hectare	Average kg milk solids per hectare	Average kg milk solids per cow
95/96	106		47,600		449	166	2.8	796	283
96/97	115	9	53,500	5,900	465	170	2.8	836	297
97/98	131	16	67,400	13,900	515	177	3.0	869	295
98/99	146	15	76,000	8,600	521	187	2.9	869	302
99/00	141	-5	76,800	800	544	186	3.0	1036	342
00/01	147	6	84,300	7,500	573	186	3.1	1043	335
01/02	166	19	103,500	19,200	623	206	3.0	1061	348
02/03	181	15	114,500	11,000	632	211	3.0	1100	372
03/04	184	3	125,400	10,900	682	216	3.2	1167	370
04/05	192	8	137,000	11,600	714	219	3.3	1184	362
05/06	205	13	151,100	14,100	737	220	3.3	1219	365
06/07	215	10	167,500	16,400	779	234	3.4	1263	381
07/08	233	18	186,500	19,000	800	236	3.4	1310	381
08/09	274	41	217,350	30,850	793	243	3.4	1227	368
09/10 (Est)	295	21	234,150	16,800	794				
10/11 (Est)	315	20	250,150	16,000	794				

dry land balance being complemented by the irrigated area. There is now a desire by most farmers to irrigate all their farm to provide the reliability and versatility of land use options required for a strong viable farm unit.

Future land use

I doubt that many of our local population, including farmers, would wish to see wall-to-wall dairy farming in Ashburton district, or in any other part of Canterbury. Our diversity of land use and range of farming options has always been the strength of farming in Canterbury, even before irrigation developed over such a large area. The various land uses have always complemented one another. However, farm land will always move to its highest and best use.

The risk of a long term decline in the price of milk is a factor that must be considered. Given the scale of dairy farms in Canterbury and the high productivity, combined with the fact that most dairy farms in the region have been developed in the past 25 years with modern technology, our local farmers are likely to have viability advantages compared with most dairy farmers in New Zealand. We should not forget that the New Zealand economy has a strong vested interest in the continuing success of dairy farming.

Most Canterbury dairy farmers maintain a very high standard of soil fertility, so the land could be readily converted to many other land uses if that were necessary. In my view, dairy farming is a very kind land use, compared with many farming alternatives. It requires fewer chemicals and energy in the on-farm programme and after a few years, once the farm development has been consolidated, requires less fertiliser to maintain production. The publicised negative features of dairy farming including water quality, nitrates and effluent management can be addressed, given the appropriate incentives and encouragement.

Comparison with arable production

The change to dairy farming will probably increase the total seasonal demand for irrigation water to some extent. It will certainly be a more constant demand throughout any season. However, providing that any irrigation restrictions are not for prolonged periods or occur too early in a season, irrigation restrictions can have a smaller effect on a dairy farm.

Such irrigation restrictions may be more of an issue for an arable farmer. An intensive arable farmer will commit inputs such as fertiliser, weed, pest and disease control to the crops or seeds but may face irrigation water restrictions in the last two weeks of plant development before entering the pre-harvest ripening phase. In this case the farmer would have been better to not have started the exercise of growing that crop in the first place. The effect on such a crop, with a short term restriction in irrigation water at a critical stage of development, could be devastating.

The future of irrigation in Canterbury

For Canterbury, the situation confronting irrigation planning, development and management at the present time is both complex and dynamic. Currently there is a large number of farmer groups and individual farmers contemplating irrigation development if and when it is possible.

The Canterbury Strategic Water Management strategy has been developed over the past decade in an endeavour to satisfy the aspirations of all stakeholders. The appointment of seven experienced Environment Canterbury Commissioners in April this year, chaired by Dame Margaret Bazley, is an attempt to achieve some progress in managing the region's water resources.

If the objective is for a successful and acceptable result for our region, there needs to be co-operation and communication between Environment Canterbury, irrigators and the public at large – all the stakeholders involved. It will not be achieved with a confrontational or adversarial approach, as has happened in the recent past.

To some extent the negative consequences of irrigation have been over-played significantly, particularly by the media and the anti-irrigation lobby. Those who have witnessed the development of Ashburton borough, and the district as a whole over the past 30 or 40 years, would probably not wish the district to return to its earlier days of drought crisis, employment losses and erratic stop-start business fortunes.

If New Zealand is to contribute, even in a small way, to a hungry world and increasing population, we need to recognise and value the standard of living that we have. We need to contribute to New Zealand's economic growth, to preserve and to maintain for everyone in our fortunate country – a lifestyle that many people throughout the world would envy.

Perhaps, we could all reflect again on the wise words of Bob Semple, recorded around 65 years ago.

Nick Taylor

Social effects of land use change as a result of irrigation

The power of water managed by irrigation can transform the land and landscapes. What is less recognised is that transformed land and landscapes are almost inevitably associated with land use changes and new farming systems.

Irrigation development is a complex task involving changes to landscape and physical structures, farming systems, the local and regional economy, and social life. Planning for irrigation developments should take into account the implications that changes in both engineering and farming systems will have on social life. This article considers recent experiences with land use change under irrigation in the Canterbury region.

Irrigation as drought insurance

The available research shows that when irrigation water reached pastoral farmers in the 1970s and 1980s, with major community irrigation schemes in the Lower Waitaki, Amuri and Waipara areas, they had few expectations of radically changing their farming systems to dairying or grapes. Water was seen then mainly as insurance against drought.

When irrigation was first proposed for the Amuri, for example, it was not envisaged that there would be land use change to dairying, just more intensive sheep and beef farming systems. The New Zealand Planning Council and the Centre for Agricultural Policy Studies at Massey University suggested tentatively that irrigation might make dairying more attractive. Their report acknowledged that most farmers believed that irrigation would lead to more intensive sheep systems, with some possibility of land sub-divided for horticulture.

Realising the potential

Our research shows a clear lesson learned by farmers and rural communities. It is that substantial investment throughout Canterbury and North Otago in the use of water resources for irrigation should not be seen simply as an insurance against a perverse climate. With sophisticated irrigation technology such as spray and sprinkler systems, the full potential of water application can now be realised by farmers.

The application of water becomes a central new farm function with substantial associated technology, capital investment and changes in patterns of work. Therefore irrigation is often linked to youth and enthusiasm, and in many instances to new farmers, particularly dairy farmers. In terms of life style changes, families moving to irrigation typically did not anticipate fully the farming system changes that would eventuate. In contrast to pastoral farmers, the dairy farmers in dry environments always see irrigation as a basic management tool in their farming system.

Successive ownership and land use changes came in waves after the introduction of irrigation. On the Waitaki Plains, for instance, many established, dry land sheep farming families sold their farms and were replaced by younger families. These new farmers modified traditional farming systems with the support of an accessible and regular water supply. They invested heavily in farm improvements, upgrading pasture for cropping and sheep, and later for dairying, and building bigger and better homes and farm buildings. The Amuri area later replicated the Waitaki experience with farms there changing ownership along with a substantial move to dairying. Other areas such as Ashburton district followed suit.

Model of change

Drawing on the research base, my colleagues and I developed a general descriptive model of land use change and social change that is associated with irrigation. It should be noted that this model has evolved through a number of research papers and reports as more information has become available. It is also important to reflect changing attitudes and responses by farmers towards investment in irrigation, irrigation technology and farming systems, particularly dairying.

To summarise the typical model of change.

- Initially, existing pastoral farmers improve their traditional farming base of stock breeding, meat and wool production, and some cropping. They view on-farm irrigation as labour and capital expensive. Older farmers are reluctant to incur additional or new debt and can find the work too physically demanding, so they retire in favour of the next generation.
- The new generation farmers make major investments in irrigation plant and structures. They increase stock numbers and productivity but generally retain the same

production base. These farmers discover that pastoral farming and irrigation are not always compatible, some suffer from the results of over-capitalisation, so they sell their properties to other irrigation farmers.

- Some farmers, and the subsequent generation on their family farms, radically change the production base to incorporate more intensive arable farming, dairying or horticulture. They realise that the full potential of land and water lies in new land uses. The move to dairying may be achieved from interim changes, such as bull beef raising, winter dairy run-off, contract farming and share milkers. It is probable that these farmers will not make the total change to new forms of farming such as dairying themselves, electing eventually to sell, retire or farm elsewhere.
- By now, widespread changes in land use and farm ownership have taken place. Newcomers have bought into converted farms or directly convert them once they take over a property. They are usually dairy farmers by choice and experience and frequently arrive in the district from an established dairying area. This wave of irrigation farmers reinforces the dairy economy in the host district.

A picture of this change is found in the numbers of dairy farmers and dairy farm workers coming into a district.

Percentage of dairy farmers and dairy workers in the farmers and farm workers occupation group

	1981	1986	1991	1996	2001
Lower Waitaki	5.7	19.4	39.7	48.7	56.8
Amuri	–	2.6	9.5	36.3	45.1

Succesion affected

The fundamental dynamic of these waves of irrigation development is the interlinked changes of farm ownership and land use. Ownership changes affect the characteristics of farm families, demographics and the social structure of the host community, its settlements and small service towns.

In districts where generational farming is a common practice, the process of farm succession provides continuity for farm families and the host community alike. Therefore the introduction of irrigation to a district can challenge both traditional farming production systems and community stability. New land uses demand a different set of farming skills and frequently attract farmers with different occupational values and work schedules. The new farmers also have a more utilitarian view of the ownership of farm land.

On the other hand, newcomers to the community may create additional demand for struggling rural services such as primary schools and medical centres. Dairy farming families are often in their lower to middle life cycle and sharemilkers frequently have young children. As a result, declining school rolls are turned around, especially in the junior classes. An increased school roll can revitalise a community, particularly where the school acts as a focus for the district's identity. As roll and staff numbers increase, the school continues to operate as a centre for educational, recreational and social activities in the community, including for new farm families.

Numbers and age

Changes in land use can trigger a local perception that the population base of the district has 'exploded' as a result of the commercial and employment opportunities offered by irrigation. However, in reality, the growth of the population has been more modest. For example, between 1981 and 2001, the population of the Lower Waitaki area in North Otago increased by 15.4 per cent, compared with the overall New Zealand growth rate of 18.9 per cent. The growth in population of irrigated areas becomes highly significant when compared with the typical decline in population experienced in many non-irrigated farming districts.

Land use change may also affect the age structure of a district's population. In both the Lower Waitaki and the Amuri it can be seen in the table below that there was a significant increase in the percentage of the population aged 14 years and under, following the main wave of dairying conversions.

Percentage of usually resident population 14 years and under

	1981	1986	1991	1996	2001
Lower Waitaki	33	27.7	22.8	23	26
Amuri	30	30.3	31.4	27.5	27.9

Most importantly from the point of view of farm innovation and new work practices, the introduction of younger families means there is also a fall in the age of farmers and farm workers in a district, with the proportion aged under 30 years increasing. Typically the age of this occupation group is noticeably younger than for the country as a whole. Associated with this change is an increase in the educational qualifications of farmers and farm workers.

Social divisions

Districts with irrigation development and associated conversion to dairy farming undergo considerable community change as the old families move out and are replaced by new and younger families. Potential social divisions can be created as the first dairy families arrive from outside the district. Dairy farming can be viewed by other farmers as a different social status from traditional sheep and beef farming. It has very different work patterns with a relatively high level of farm workers per farm. The continual migration of dairy farm workers on gypsy day can also create feelings of dislocation among long-term residents of the district.

While the average age of the community may become younger, the expectation that youth and enthusiasm will result in a higher rate of participation in community activities may not necessarily be fulfilled. The transient nature of sharemilking and dairy farm work can mean that some families take little part in community activities – often a cause of criticism from more established community members. In addition, newcomers, including workers from other countries, often find it difficult to settle into a new community and ways of life. These findings suggest that communities will benefit from community development initiatives and support programmes, such as the settlement support service run by Venture Southland.

More opportunities

A related issue for planning irrigation development is the capacity of the district to take advantage of flow-on effects from the new land use activity, increased workforce and changes in population. Opportunities will be created for irrigation contractors and supplies, building contractors and supplies, dairy equipment, veterinary services, transport. Some farm workers and local contractors will have to change their skills to take advantage of these opportunities, or in some cases, to survive where demands for previous occupations such as shearing are reduced. There is a pattern with local economic benefits syphoned off to larger centres. Training and enterprise development programmes can assist communities to adapt and maximise local benefits.

The potential rate of conversion to dairying in new irrigation schemes is another issue for planning of new schemes. While dairying may not be a new form of land use in the district concerned, farmers usually are familiar with current irrigation technology. If dairy conversions are already taking place in the command area, the rate of land use change will probably be much faster than experienced with the irrigation projects mentioned.

There is also potential for change amongst sheep farmers who have experienced a long period of difficult economic conditions and are getting older, with farm succession not as strong a drive for families as in the past. These farms could potentially change their land use or ownership relatively quickly. For example a study of the Opuha scheme found that in just five years there was a change from no dairying in the area to 27 per cent of respondents reporting they were dairy farming.

Many other effects

The main focus of this article is on social impacts of land use change, but the comparative cases identify other social effects to consider, such as those of constructing reservoirs and canals on host communities, visual effects, changes in water quality and water based recreation. In addition, social impacts will vary over the life cycle of an irrigation project, including planning which can involve uncertainties over an extended period, construction and operation.

Infrastructure changes off farm are also important, such as transport associated with intensified production of dairying where heavy transport loads are created with daily tanker movements to farms. Small rural roads and bridges are often not built with such use in mind. Then there are the potential effects, particularly to the local economy and available employment, when dairy processing plants are constructed, as happened recently with the new factory near Waimate.

In conclusion, the available research confirms that the introduction of irrigation into farming systems can create distinct social effects as a result of changed and new farming systems, particularly dairying. Widespread demographic and community changes follow.

A full list of references used in the researching and writing of this article is available from the editor of* Primary Industry Management *or directly from the author.

Letter to the Editor

Earthworm predation question

Over the years I have been a reader of PIM, and its predecessors, and gained much intellectual stimulation and worthwhile information from a host of contributors.

The June issue was a 'cracker'. My sincere appreciation goes to all concerned.

Having had some interest in Murray Stockdill's earthworm introduction work at Hindon, Otago, years ago, made the 'Earthworms the forgotten workers' article highly interesting.

It did raise some questions about earthworm colonisation of soils under pasture beside the harmful effects of surface pasture management with biopesticides, compaction etc.

My question concerns earthworm predation from the new fly on the block *Pollonia pseudorudis* aka cluster flies that have spread throughout NZ in the past 30 years. They are an earthworm parasite with the larvae seeking out earthworms. It is possible to have four generations between winters (Harris A., entomologist, *Otago Daily Times* 19/12/08).

Then there is the aggressive native flatworm *Arthurdendyus triangulates,* which, since the arrival of the European earthworm has been presented with a much wider diet.

In a biological tit-for-tat, *Authurdendyus* has migrated to Britain where it now eats earthworms on their own turf (Johns P., Canterbury zoologist, Dr Boag B., ex Crop Research Institute, Chch Press, Fraser K., 20/12/07).

The question that some reader(s) might care to answer is why farmers should get worried about European earthworm populations under their 'hocked hectare' when predation is so poorly understood.

Jim Moffat, Dunedin

Andrew Curtis

Irrigation – New Zealand's greatest threat or an opportunity?

Most of us are by now familiar with the forecast that there will be around 9.2 billion people in the world by 2050. However human history dictates it will not stop there, and our numbers are forecast to keep on climbing, reaching at least 11.4 billion by the mid 2060s. Equally, the world economy will not stop growing, and China, India and other advancing economies will demand more protein food.

Global demand for food will more than double over the next half a century as we add another 4.7 billion people. Together they will eat an estimated 600 quadrillion calories a day, the equivalent of feeding around 14 billion people at today's nutritional levels. Therefore, the pivotal issue for the human race in the coming half century is whether humanity can achieve and sustain such a harvest.

Critical constraints

To complicate this scenario still further, agriculture as we know it faces a whole constellation of interlinked critical constraints. Today the world faces looming scarcities of just about everything required to produce high yields of food – water, land, nutrients, oil, technology, skills, fish and stable climates, each compounding the others.

This paints a disturbing picture for the future of many nations, and as a result, food security now features prominently on their agenda. However as always in life, there will be winners that emerge from this scenario – countries which, with strategic leadership, have the potential to prosper.

Abundant water

I am sure you have heard it all before – New Zealand has abundant freshwater resources. New Zealand's annual average rainfall of 2,000 mm is 2.5 times more than the global average of 800 mm. When annual average run-off is compared, the statistics become more impressive, with 80,000 cubic metres of water per person contrasted with a global average of 7,100 cubic metres. New Zealand also has large tracts of fertile summer-dry soils in the form of alluvial plains and rolling downland. When irrigated these become some of the most productive soils on the planet.

Water is to New Zealand as minerals are to Australia. It is our key strategic advantage and in light of the current global picture it will guarantee us a clean, healthy and prosperous future if we manage it well.

I expect the thoughts foremost in many people's minds are that we know New Zealand has plenty of freshwater and land where it can be applied. This could make New Zealand wealthy, but can we use these resources in a sustainable manner? Current state of the environment monitoring in Canterbury, despite some of its obvious flaws, is depicting declining trends in both surface and ground water quality. This in most instances can be linked to recent land use change and more intensive practices. This poses the question that has to be answered if land use change and intensification is to continue. Can irrigators minimise their environmental footprint to long-term socially acceptable levels?

Irrigation NZ is confident that the answer to this question is a clear and resounding yes. So why do we say this?

World leading

New Zealand has world leading farming and irrigation technologies that are continuously improving, driven by the innovative Kiwi culture. This was confirmed at our recent conference by comments made from all our international speakers – including representatives from Australia, the United States and a selection of European countries. Precision irrigation technologies will be the norm 20 years from now, although with the current decline in water quality trends, the challenge is how do we reduce this to five years?

The question Irrigation NZ is currently asking is how do we encourage and promote the quick uptake of proven irrigation technologies to minimise our environmental footprint. To do this you have to first understand why farmers need irrigation. New Zealand has abundant water resources but its not always there at the right time. That is the simplistic answer, but of course, the real answer is far more complex.

Consistent supply

One of the main reasons for irrigation expansion is the reality of modern food production. If farmers want to compete, particularly in the high value environmentally conscious markets which we like to promote as New Zealand's future, they need to supply consistent amounts of quality produce. Traditional variable weather patterns, coupled with climate change effects, mean extreme weather has become more prevalent. The boom and bust of traditional dry land farming does not cut the mustard in these markets. To even be in the market, farmers need certainty, and certainty can mean irrigation.

So how do we ensure our farming systems are sustainable? The answer involves enabling and incentivising technology uptake and good management practice – lifting the bar when it comes to irrigation performance. I have always been a believer in the saying that to understand someone you have to walk around in their shoes for a while. Here is a very brief insight into irrigation performance.

Irrigation performance

The main point that has to be understood about irrigation is that reliability is vital. Reliability enables a change to optimal management decision making – a move from just in case to just in time. Water use efficiency depends on reliability.

I often use the analogy of water being cut off at home to illustrate this point. Water supply is usually 100 per cent reliable. You turn on the tap and water comes out. However what happens when you get are going to be cut off? You fill up the bath, buckets and saucepans to make sure you get through. Naturally a fair amount then gets poured away when the water returns.

Run-of-river irrigation with its risk of cut-offs invokes the same behaviour among irrigators. The soil is kept topped up while it can be so that farmers can get through the dry times. When water for irrigation is reliable, farmers will run their soils a bit drier, hoping that rain might top them up for nothing. If you know the water will be there when you need it, you leave it in the river, the well or dam until the last minute. Uncertainty encourages a less efficient, precautionary approach, whereas certainty equals an efficient one.

Certainty important

Reliability has massive flow-on effects. Certainty allows investment in better, more expensive technology and a change to just in time management, only applying the irrigation required to replace plant evapo-transpiration water losses while maximising rainfall. This reduces power requirements from pumping which uses energy which reduces hydro water use as the majority of rural power in New Zealand comes from hydroelectric generation. There is also less pressure on river flows with less water abstraction per hectare irrigated.

Greater efficiency also results in reduced losses from nutrient leaching and run-off as more water and nutrients are retained in the rooting zone to be used by the plant. This is obviously strongly correlated with improved water quality. There are also other links to community resilience, from increased crop diversity, ability to produce higher value crops and realisation of added value.

So what does reliability require? In New Zealand, reliability requires water storage, a term currently likened to blasphemy.

To lift New Zealand's agricultural productivity and maintain and enhance natural systems, we need water storage, and preferably, particularly in the case of Canterbury, a few large ones. This would give irrigators reliability while protecting the majority of New Zealand's iconic river systems that we all know and love. Water storage is an essential part of the equation – it is not a reward for good behaviour.

Water storage in Canterbury would also provide additional bonuses as regards farm profitability and environmental restoration. Reconfiguring the current irrigation system, by bringing stored alpine water at the farm gate under pressure, would result in restoring lowland stream flows, which would also help dilute nutrient losses while minimising irrigation energy costs.

However, under the current management system, narrow focused policy development coupled with the varied interpretation of the accompanying regulatory framework has resulted in silo water management. As a result the water management solution of large dams storing alpine water has become a lengthy, problematic and unachievable process.

No winners

Overall no one wins. There are expensive electricity bills for irrigators, with the average irrigator pumping deep ground water costing over $200,000 a year. Combined with this are declines in the flows of lowland stream ecosystems. Significant attention is currently being directed towards the resolution of this conundrum. At the regional level this is through the development and implementation of the Canterbury Water Management Strategy which has now been given effect, and the recent ECan Act. At the national level this is from initiatives such as the Land and Water Forum which will hopefully provide a template for a new way forward.

Along with the construction of water storage, the industry must also put into place management systems that link to community driven environmental standards and penalise non-performance, potentially from the loss of water supply to those laggards who consistently drag the chain. This process is already under way, being integrated with a number of new scheme developments and it will probably be the norm in the not too distant future. If this is then combined with the introduction of audited self-management programmes where regulatory compliance functions are transferred to users harnessing their energy and knowledge, this becomes a very cost effective solution.

Maximising global advantage

In summary, there are significant opportunities that exist from the better management of New Zealand's freshwater resource, especially in Canterbury – particularly when analysed on a global scale. New Zealand has the potential to cement itself as a clean, healthy and prosperous nation.

Reliability is the key to it all. This allows the required investment in proven technologies that will guarantee New Zealand maximises its global strategic advantage.

Andrew Curtis is CEO of Irrigation New Zealand.

Dan Coup

What is greenhouse gas footprinting and why is it so important?

Regardless of what you think about man-made climate change, there can be little denying that the issue is real for many of the primary sector's most important customers. Those customers are starting to question how the products they buy from New Zealand affect climate change. Answering such questions is not straightforward.
This article considers some of the issues facing New Zealand's primary sector in relation to how customers and commentators perceive the effect of our products on climate change. The recent experience of the meat industry in communicating the results of a greenhouse gas footprint study of exported New Zealand lamb serves as a useful case study.

In April 2010, Meat Industry Association Chairman Bill Falconer released a public report. It described the results of an AgResearch study aimed at quantifying the greenhouse gas footprint of New Zealand lamb exported to, and consumed in, the industry's most important lamb market – the UK. The year-long study was commissioned by the Meat Industry Association, Landcorp, Ballance and MAF with key data provided by meat companies, Landcorp and Meat & Wool New Zealand. Investment in the study was considered of sufficient priority for these industry organisations for a variety of reasons, including –

- Specific customers were asking for data on the greenhouse gas footprint of our products
- Industry needs to be prepared with robust analysis and data to rebuff any future discriminatory food miles claims against our products
- Industry wants to be proactive in understanding the climate change effect of its products and identifying the most fruitful opportunities for improvement.

What is a greenhouse gas footprint?

Greenhouse gas footprinting, also known as carbon footprinting, comes in two varieties. Throughout this article, it will refer to product greenhouse gas footprinting, whereby an attempt is made to calculate the climate change effect of a given product – in our case a 100 gram serving of lamb meat. The other variety involves estimating the annual greenhouse gas emissions associated with a given entity such as a company, site or household.

A greenhouse gas footprint is a calculated figure that is intended to describe the amount of greenhouse gas emissions that the production process for a given product is responsible for. That responsibility stretches from production of raw materials, such as fertiliser, through on-farm activities, processing, transport, consumption and waste disposal in the market.

Helping choice

The underlying rationale for greenhouse gas footprinting is that customers are able to consider their purchase decisions with the effect of that decision on climate change. Therefore you might envisage a supermarket shopper picking up two similar products, such as two cartons of orange juice, and compare the quantitative greenhouse gas footprint information displayed on both as well as the price, nutritional values, additives, fair-trade qualifications and organic status.

If so inclined, they can choose the product with the lower climate change effect. The shopper could also make comparisons between quite dissimilar products, perhaps deciding on the basis of the greenhouse gas footprint to avoid orange juice altogether, in favour of lemonade.

In the modern food industry, retailers are undoubtedly amongst the most powerful decision makers. Some retailers, including most notably Tesco in the UK, have the exact vision outlined above, of shoppers given information that allows them to choose low climate change effect products if they want to. Tesco has a stated objective of having greenhouse gas footprint labels, expressed precisely in terms of grams of carbon dioxide equivalent, on every product it stocks. Given the challenges that we will outline below, this is a very ambitious objective.

Different strategies

Many other major retailers have a very strong focus on the greenhouse gas footprint of the products that they sell, but have adopted different strategies from Tesco. Many would prefer not to place the responsibility for decision making around the greenhouse gas footprint of products on to their customers, but instead provide assurances that the retailer has already done this work on behalf of the shoppers. This retailer responsibility approach is arguably best demonstrated by the worlds largest retailer Wal-Mart. This company has a stated strategy of encouraging its global suppliers to study the greenhouse gas footprint of supplied products and to reduce them. Wal-Mart is then able to provide a blanket commitment to its customers that it is working on behalf of customers to reduce the greenhouse gas footprint of what they buy.

Between Wal-Mart and Tesco, there is a range of intermediary climate change strategies for retailers. One commonly discussed approach involves traffic-light labels on products that show whether that brand performs good, bad or average compared with the median for that particular product category. Another possibility is choice editing whereby retailers decide not to stock a certain product on the basis that they perform poorly on greenhouse gas footprinting. Customers can then shop, safe in the knowledge that their retailer has taken care of all the tough climate change decisions.

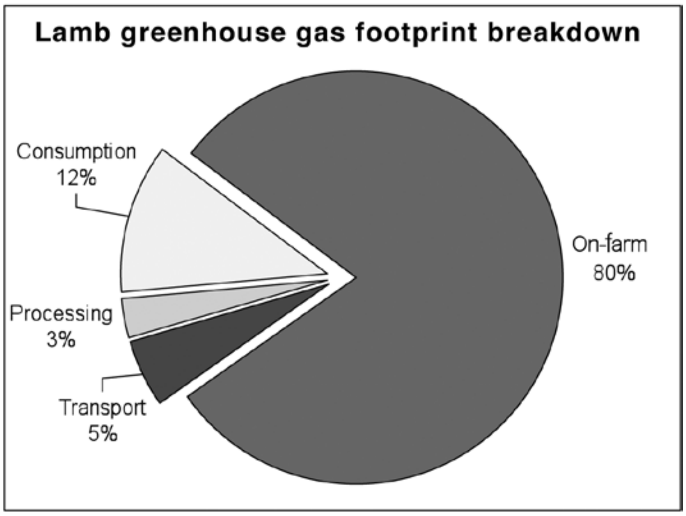
Some may question the level of interest that the average supermarket shopper has in the greenhouse gas footprint of what they buy. It should be noted, however, that modern retailers are very large and sophisticated organisations and that across the developed markets of North America and Europe, most major retailers have stated some approach to understanding the greenhouse gas footprint of products sold.

Government supported, and in some instances mandated, schemes for greenhouse gas footprinting have also recently been initiated in Japan, Taiwan and South Korea. It seems unlikely that greenhouse gas footprints for New Zealand food exports will cease to be of any relevance to retailers in the near future.

The lamb footprint study

The AgResearch study of exported New Zealand lamb was unprecedented in its breadth and the level of detail that it considered. It was based on a lifecycle assessment and complied with the British Standard that is currently the most broadly accepted and applied method for conducting greenhouse gas footprint studies. The study aimed to calculate the amount of greenhouse gas emissions that a 100 gram serving of lamb is responsible for throughout its lifecycle. This is from conception of the lamb on-farm, through to the treatment of sewerage from the household where it was consumed, and with all stages in between. The study considered the average of all New Zealand lambs produced over a given year, processed at an average lamb plant and through a typical chilled supply chain to a UK supermarket customer.

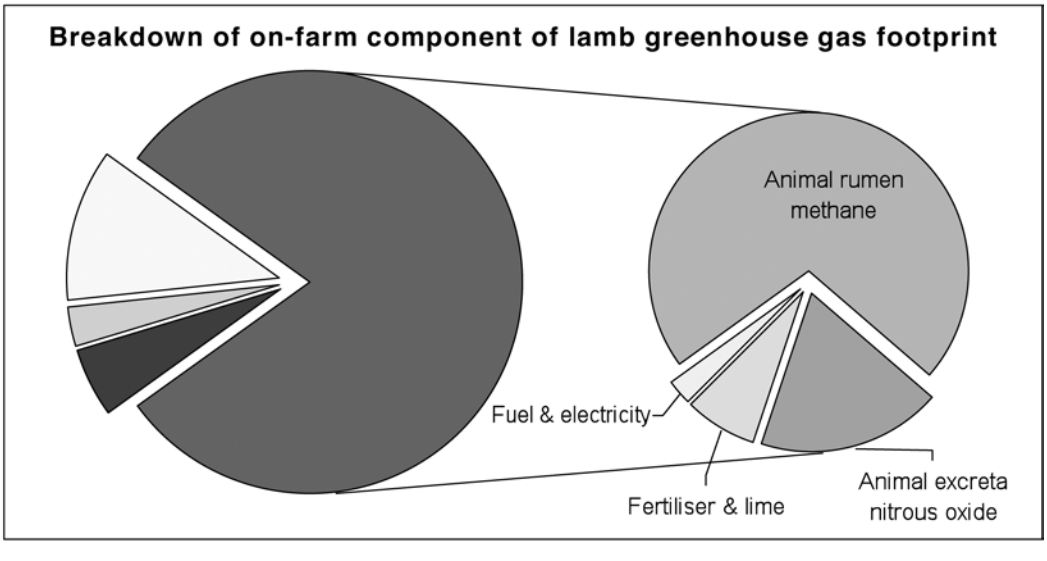
Based on the chosen method and main assumptions, the study determined that the greenhouse gas footprint of a 100 gram serving of lamb was 1.9 kilograms of carbon dioxide equivalents. The use of carbon dioxide equivalents means that non-carbon dioxide greenhouse gases have been multiplied by their relevant global warming potential such that they can be expressed in terms of the amount of carbon dioxide that would produce the equivalent global warming effect. This headline figure, and the breakdown of the figure were within the ballpark expectations of industry, based on other published studies of livestock products.



As illustrated in the diagram above, the main contributions to the calculated greenhouse gas footprint occur on the farm. Perhaps surprisingly, the next most important set of contributions to the lamb greenhouse gas footprint relate to the consumption phase – most importantly cooking.

Processing and international shipping of lamb are relatively small components. There have been previous although less detailed, overseas studies of lamb published, along with studies of beef and milk. These studies of ruminant livestock products show a reasonably consistent emissions picture – dominated by on-farm biological emissions sources.

The diagram below shows that methane arising from ruminant digestion is by far the most important part of the



on-farm component of the lamb greenhouse gas footprint. Both rumen methane and nitrous oxide from animal excreta on pastoral soils make significantly greater contributions than emissions associated with on-farm energy or fertiliser use.

Issues with greenhouse gas footprint studies?

The 1.9 kilograms of carbon dioxide equivalent per 100 gram serving result of the lamb study perhaps suggests a level of certainty and precision that is not really appropriate. This answer is heavily dependent on a range of methods and assumptions that need to be adopted. Changing these assumptions can have quite significant effects on the answer.

Two key issues are outlined below. One is the difficulty of application of greenhouse gas footprint to agricultural products and the other is the effect of the coarseness of the internationally agreed United Nations methods for accounting greenhouse gases.

The agricultural context

Lifecycle assessment is an approach designed to measure the cradle-to-grave environmental effects of the production of certain goods or services. The approach is complex but manageable in a manufacturing setting, in which a range of ingredients are combined and transformed to create a finished product. In manufacturing, the individual footprints of each of the ingredients can be added up, and combined with the effect created by the manufacturing process itself, to produce a relatively stable greenhouse gas footprint for the finished product.

The production of livestock products, such as meat, is somewhat different from a manufacturing process. The differences that make calculations most challenging are –

- The wide array of different products being produced from the same base system
- The variability of the outputs of the process on the basis of, for example, weather, pests or disease.

Nitrous oxide effects

To demonstrate how these factors affect the greenhouse gas footprint calculations, consider the element of the lamb greenhouse gas footprint that is contributed by nitrous oxide emissions. Nitrous oxide is a greenhouse gas created by the decomposition of other nitrogenous compounds, such as urea, ammonia or plant proteins, which mainly takes place in pastoral soils. The amount of nitrous oxide emitted from a pasture can vary considerably, based on soil type, fertiliser application, moisture levels, pasture species and grazing intensity.

If we assume that it is possible to estimate an annual amount of nitrous oxide emitted, we must then consider how responsibility for that amount should be allocated between the breeding cows, steers, heifers, ewes or other stock that may have grazed the relevant pasture. Bear in mind that the number of each type of stock will vary from year to year. Once we have decided how much of the nitrous oxide any given lamb should take responsibility for, there is a further set of decisions to allocate the total lamb responsibility amongst the products that arise from that animal, such as meat, offal, pelt, wool and rendered products.

These allocation decisions are a challenge and especially difficult in livestock-derived products. In many cases the default basis for allocation of emissions is on the basis of the economic value of output products. Therefore most of the lamb emissions load is allocated to lamb meat, on the basis that it is the most valuable component of the animal. While this is probably the most appropriate basis for allocation decisions, it also adds another layer of difficulty because the relative prices are constantly changing.

In theory every single lamb chop could have a slightly different greenhouse gas footprint on the basis of where, when and how it was raised, what route it took to market, and how well it was cooked. To provide a manageable result, a greenhouse gas footprint study needs to apply some sort of averaging. The lamb study considered the average lamb produced over a year, which is a logical approach but ignores some reasonable questions such as seasonality. In studies of fruit, for example, there can be significant differences in greenhouse gas footprint between fruit consumed in-season versus out of season. An annual average ignores such differences.

Rules for accounting greenhouse gases

The inter-relationship between greenhouse gas footprint methods and accounting methods is complex and problematic. The few available methods, including the PAS2050 adopted for the lamb study, tend to defer to the greenhouse gas accounting approaches agreed internationally through United Nations processes that include the Kyoto protocol.

International greenhouse gas accounting rules have been designed and agreed by UN member states. Those rules have been designed with the objective of being robust, easy to verify performance against, producing simple and easily comparable performance measures, and being broadly accurate at a national level. These features do not necessarily match the requirements of a study where a very fine level of definition is required and a more detailed investigation of specific emissions sources and sinks is possible.

There are two notable areas where the reliance of a greenhouse gas footprint study on internationally applied accounting rules is problematic. They are in relation to determining –

- Which sources of emissions and removals are included in the study, and which are not
- The equivalence of different greenhouse gases.

Included and excluded emissions

The international accounting rules include a number of technicalities which mean that accounted emissions and removals are not exactly reflective of actual emissions and removals.

When calculating their national inventory of greenhouse gas emissions and removals, signatories to the UN's Framework Convention on Climate Change are required to estimate emissions and removals of greenhouse gases by all significant activities in their country for which there are reasonably reliable mechanisms of estimation.

Most countries are not required to account for certain activities, and in New Zealand's case, an example of one of these omitted categories is soil carbon sequestration. The reason that New Zealand and many other countries does not account for the carbon dioxide that is either emitted or sequestered by soils is that the process is poorly understood by scientists, making a national estimation of total emissions or removals impossible. However, from the perspective of a greenhouse gas footprint study for a pastoral livestock product, soil carbon sequestration could make a significant difference to the net emissions associated with the production of that product.

The most widely applied activity for sequestration of carbon dioxide is growing vegetation, particularly forests, which can capture a significant amount of carbon in woody mass. Under United Nations agreements, the carbon dioxide removed from the atmosphere by trees while they grow can be accounted as a removal with a matching emission if the trees are felled.

However, because international negotiators were concerned that this mechanism for generating carbon credits might be abused, they set strict thresholds determining what constituted a forest. These thresholds apply to the minimum total area, width and canopy cover of the forest. Much of the tree planting on sheep and beef farms, such as wind-breaks, poplars and willows for erosion control and fenced regenerating bush, does not meet the forest definition. Therefore it does not get credit for any carbon that is being genuinely sequestered from the atmosphere. Once again, if considered, non-forest tree plantings on sheep and beef farms could have a positive effect on the greenhouse gas footprint of lamb, but they are omitted from both international accounting rules and the greenhouse gas footprint methodology.

Equivalence of greenhouse gases

In international negotiations, the UN representatives understandably sought a basis on which they could sum all of each country's greenhouse gases and compare countries like-for-like, regardless of any country's particular mix of greenhouse gas types. The problem with this approach is that the greenhouse gases – most importantly water vapour, carbon dioxide, methane and nitrous oxide – are quite different beasts. They each behave differently in terms of how much infrared radiation they absorb and therefore their warming effect, how they interact with other chemicals in the atmosphere and how long they survive in the atmosphere.

The approach that the UN has adopted is firstly to exclude water vapour, on the basis that humans are unable to influence the cycling of water through the atmosphere. Secondly it is, to measure the effect of the other greenhouse gases over a 100 year time frame. Carbon dioxide is considered the benchmark greenhouse gas and the other gases are measured relative to carbon dioxide. Methane, for example, can actually absorb infrared radiation hundreds of times more effectively than carbon dioxide, but it also only survives in the atmosphere for about 12 years, before decaying into carbon dioxide and water. This is not a simple or stable relationship.

Over the 100 year time scale, it has a very strong effect for a short period, but no significant effect over the remainder, so is considered to be about 25 times as bad as carbon dioxide. Methane is assigned a 100 year global warming potential of 25.

From a greenhouse gas footprint perspective, the global warming potential system used to approximate equivalence between greenhouse gases could be argued to give a misleading representation of the product's effect on climate change. If, for instance, a family has been farming the same sized flock for a hundred years, then the atmospheric methane created by that flock will be in a reasonably steady state – neither increasing nor decreasing significantly, with new methane replacing old methane as it decays after about 12 years. Therefore the continuation of the farming activity does not contribute incrementally to climate change. Only the addition or subtraction of animals, or changing the efficiency of those animals, actually makes a net contribution to climate change.

On this basis, it could be argued that those flocks which are making continuous improvements in the efficiency of production – meat per methane emitted – could show significant emissions credits in their greenhouse gas footprint. On the other hand, if not purchasing that meat can be shown to result in a smaller flock, then there is a significant overall climate change benefit that arises from marginally reducing the methane contributed by that flock. That reduction is, however, a one-off gain and is reversed if the size of the flock is subsequently increased.

The behaviour of different greenhouse gases in the atmosphere is by no means as simple as the global warming potential system infers. For greenhouse gas footprint studies of agricultural products, where the bulk of emissions are in the form of non-carbon dioxide gases, the coarseness of the global warming potential approach has a significant effect.

Mechanisms for describing and communicating the net effect of methane producing systems on climate change may need to be tailored to the specific communication purpose for which they are intended. The global warming potential approach might be considered appropriate when calculating national level inventories of greenhouse gases. For greenhouse gas footprinting, a more nuanced approach that best directs the target audience's decision-making may need to be developed.

The value if greenhouse gas footprint information

Given the challenges discussed, one can certainly question whether greenhouse gas footprinting is a mature enough technique that can be sensibly applied to create credible labels for every item on a supermarket shelf. While the greenhouse gas footprint answer is uncertain and assumption-dependent, the process of undertaking a greenhouse gas footprint study can be valuable.

In the lamb study, a sample of meat processors and farm units collected data on sources of emissions, including the use of fuels, electricity and other inputs such as fertiliser. In the farm component of the study, a range of farm system and productivity scenarios were explored for their effect on emissions. The partners who participated in the study finished the work with a much stronger understanding of their emissions sources and their emissions performance relative to peers. They also have a numeric benchmark against they can measure their improvement over time.

Reducing the footprint

For meat processors, there are a number of reasonably well understood processes that can be done to reduce contributions to the greenhouse gas footprint, mostly around using energy more efficiently, reduced wastage, improved insulation of refrigerated spaces as well as reduced losses of refrigerants and alternative wastewater systems. There is often a trade-off to be decided between more emissions efficient processing and requirement for a capital investment to achieve that efficiency. In some cases energy savings can pay for themselves quite readily, so having an understanding of where the most substantial improvements are available has proved useful.

For sheep farmers, the options available for reducing emissions are limited. Improvements in productivity produce the greatest available improvements in the lamb greenhouse gas footprint. But these improvements in, for example, lambing percentage or growth rates, are things that farmers will be striving for anyway. Apart from productivity, other on-farm measures that might reduce emissions include the careful use of nitrogen fertilisers and reduced fuel usage. There is a significant research programme under way in New Zealand to identify tools that may reduce the amount of methane produced by sheep and cattle from the process of enteric fermentation, but as yet there are no quick fixes on the horizon.

Undertaking a greenhouse gas footprint study helps each participant in a value chain to understand what contribution to the emissions profile of the product they are making. In many cases this will lead to actions that reduce the overall emissions profile, and may even help to reduce those participants' energy bills, particularly now that New Zealand has implemented its emissions trading scheme.

What happens next?

In broad terms, consumer concern about climate change does not seem likely to disappear as an issue from important markets. International negotiations to agree national-level emissions reduction obligations may be struggling, but we could argue that this makes unilateral action on our products by big retailers or countries more likely, not less.

Countries that feel they are doing their bit on climate change could conceivably take action to limit or penalise imports from countries or producers that are not doing their bit. The threat of border measures such as duties or bans, while feasible, does not appear imminent at this time. Mandatory greenhouse gas footprint labelling might be a more politically tenable unilateral policy measure on climate change.

Uncertain effect

To what extent retailers will continue to see value in taking responsibility for understanding the emissions associated with their customers' purchases is uncertain. If there is a lack of global action from Kyoto-type agreements, then retailers may perceive a responsibility vacuum which they can gain credit by stepping into. The Tesco strategy of customer empowerment may not prove to be sustainable, but it seems likely that many major retailers will require their suppliers to have some sort of consciousness of their emissions performance for the foreseeable future.

Investment benefits

From the meat industry's perspective, there is benefit in investing to understand the emissions profile of our products and also the method and assumptions required to quantify that profile. This allows us to provide well-considered information to customers, refute any unsubstantiated claims about our products, and identify the best opportunities to reduce the product's emissions profile. The partners involved in the lamb greenhouse gas footprint study have also commissioned a similar study of New Zealand beef exported to key markets in North Asia and the US. A report on that study is expected later this year.

In beef there will probably be some even more complex issues than in the lamb study, particularly relating to the different production methods possible for very similar products. Manufacturing grade beef to the US may be from cull cows, Friesian bulls or lesser cuts of prime animals – each of which will carry quite different emissions profiles.

There are already signs of a global debate around the greenhouse gas footprint of beef, with American agricultural interests beginning to promote the idea that intensive grain-feeding operations produce beef with a lower greenhouse gas footprint than pasture fed systems. If it wishes to influence, or even understand these sorts of debates, New Zealand will need to continue to invest in understanding the emissions associated with key export products and the methods associated with calculating greenhouse gas footprints.

Dan Coup is Trade and Economic Manager for the Meat Industry Association. His role includes representing the Association's interests on trade policy matters and domestic climate change policy as well as coordinating industry input into recent greenhouse gas footprint studies.

John Paul-Praat and Bob Thomson

Making cents for Northland farms with the ETS

The Emissions Trading Scheme (ETS) imposes increased costs on everyone so no-one thinks that is fair, farmers included. However, what is less well understood is that the ETS presents some farmers with opportunities to make money. But that depends.

The potential effect of the ETS on two Northland properties was compared. Two aspects were made clear by the work. Firstly, the importance of assessing land use capability and profitability in order to maximise the benefits from integrating a carbon management strategy. Secondly, farms with existing post-1989 forests have valuable risk management options.

Background

New Zealand has implemented the ETS to meet its responsibilities as a signatory to the Kyoto Protocol. Under the protocol New Zealand agrees to take responsibility for greenhouse gas emissions above 1990 levels. Between 1990 and 2008 New Zealand's emissions increased by 23 per cent which is about 14 million tonnes of carbon dioxide. Since 1990 this responsibility has been taken care of by new forest plantings which absorb and store atmospheric carbon dioxide. Additional planting will be required to balance expected deficits as those forests are harvested and replanted.

Under the ETS, the energy and industrial sectors are currently required to purchase carbon credits to offset half of their emissions – the level of this obligation will increase in 2013. This requirement creates a market for carbon credits in New Zealand.

Agriculture will also be required to buy carbon credits from 2015, although initially to offset only 10 per cent of total livestock emissions. Meat and milk processors will purchase carbon credits on behalf of farmers and will probably pass the cost on as a levy on produce.

Forestry generates carbon credits which can be entered into the ETS and used to offset emissions, or traded for cash. Carbon credits have been available annually since 2008 for forests planted after 1990 on land not previously in forest.

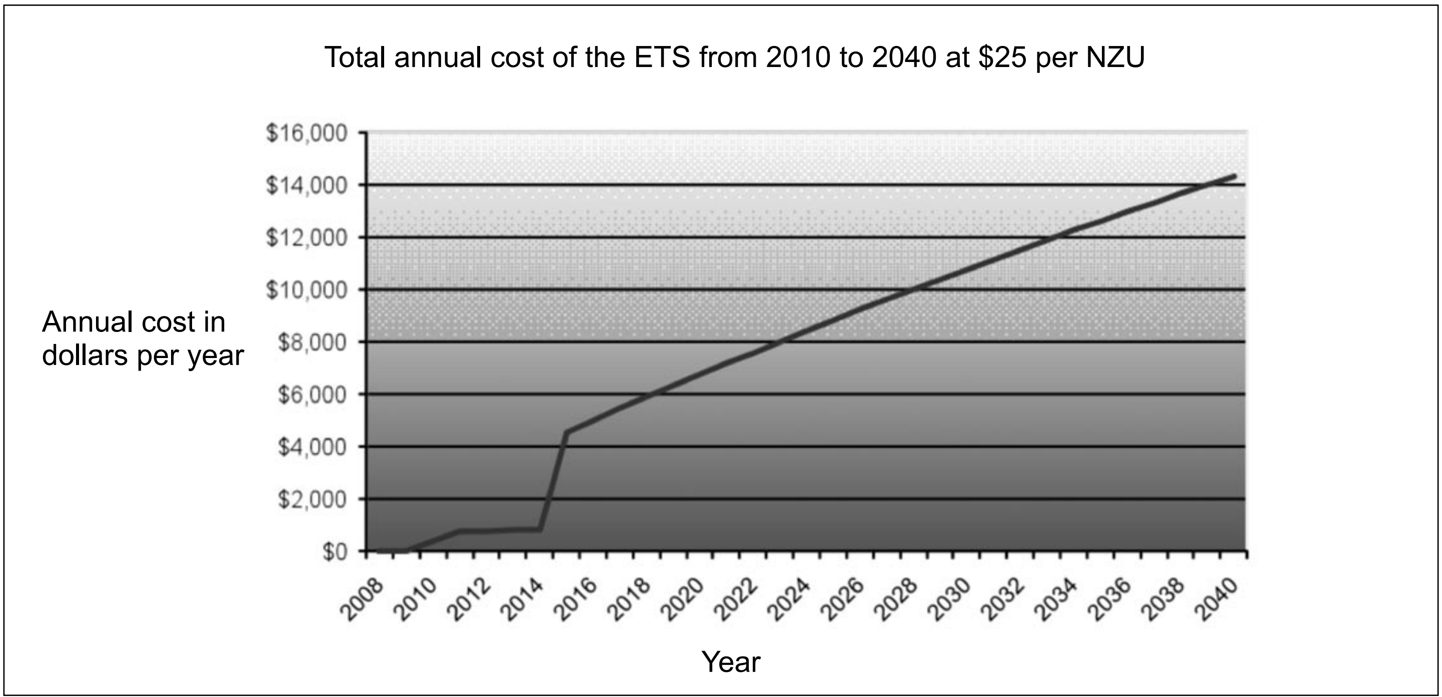
Pohoatua sheep and beef farm

Pohoatua is a traditional sheep and beef operation with around 4,500 stock units, situated about 25 km west of Whangarei. The farm has an effective grazing area of 360 hectares with a mixture of flats and rolling country and the photograph shows some of the more broken country on the farm.

The farm's production base is 850 ewes along with 620 cattle, ranging from heifer calves to two-year bulls and beef cows. Annual greenhouse gas emissions from the farm are shown in the table below. Livestock are the source of 96 per cent of emissions – 1,476 of the total of 1,540 New Zealand Units.

Greenhouse gas source annual emissions		Tonnes of carbon dioxide New Zealand Units
Petrol	4,300 litres	10
Diesel	270 litres	1
Electricity	6,183 kWh	1
Nitrogen	9.2 tonnes	45
Sheep	1,466	484
Cattle	580	992
Total		**1,540**

The ETS will initially result in some cost increases to farmers as suppliers of, for example, diesel, electricity and fertiliser pass on their own carbon liability costs. Farmers'



Cost of the ETS to Pohoatua between 2010 and 2040

liability for livestock emissions will initially be limited to 10 per cent. At $25 per NZU this will amount to a levy in 2015 for Pohoatua of about three cents per kilogram of beef and six cents per kilogram of sheep meat.

This equates to 154 NZUs, increasing by 1.3 per cent year on year from 2016 onwards. The total annual cost to the farm between 2010 and 2040, including energy and fertiliser, is shown in the graph above. In 2011 the annual cost at the farm gate will be $802 reflecting increased supplier costs, in 2015 the cost will be $4,553 and by 2040 the cost could be $14,336, depending on the carbon price at that time.

Potential credits and carbon price effects

There is little that can be done to reduce livestock emissions immediately without reducing stock numbers so we have assumed emissions remain constant in the short term over the new 20 years or so. Changes in the carbon price will have a direct effect on the final costs of any scheme.

Carbon credits can be claimed for forests planted after 1989 on land not previously forested. Access to these credits reduces a farm's exposure to future increases in the carbon price, significantly reducing business risk, and helping to build a resilient farm. Because Pohoatua lacks suitable existing forest, and the farmer wants to address the carbon imbalance, we suggest a forestry regime to generate carbon credits sufficient to offset emission liabilities for the next 30 years.

Forest carbon management and carbon farming are new areas of expertise, so it is important to understand some basics such as the units used. A cubic metre of stem wood from a radiata pine tree approximates to a tonne of carbon dioxide which equals an NZU, which makes calculations easy. A pine tree can accumulate about 2.5 tonnes of carbon dioxide equivalent in 30 years.

Forest management

The rate of carbon accumulation or sequestration varies with species, climate, age and management regime. Standardised look-up tables describe accumulated carbon based on species, age and, in some cases, region. These are used to calculate carbon credits accumulated during a forest's life, as well as liabilities at harvest time.

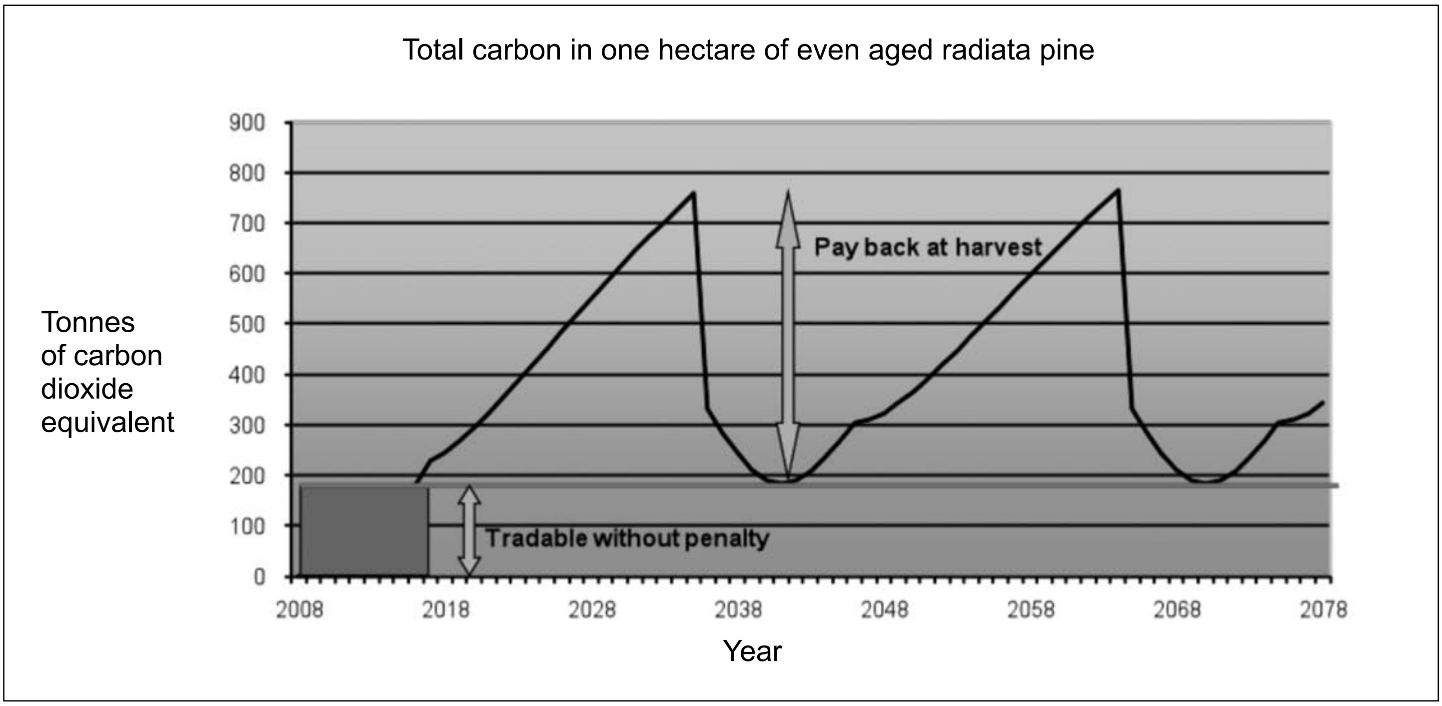
Manipulating these can have a significant effect on the value of forestry carbon credits to a farm business. A key management aspect from a carbon trading point of view is a forest's age structure.

Varying tree planting

Traditionally, farmers have planted small woodlots, usually established all at once, using a single species. This strategy results in an even-aged stand which can be managed for timber in the most efficient manner. The forest is planted, pruned, thinned, harvested and replanted as a single unit. However this even-aged regime limits opportunities for carbon forest management.

Under the current ETS rules, timber removed at harvest creates a carbon deficit and must be paid back. This is demonstrated in the graph on the next page.

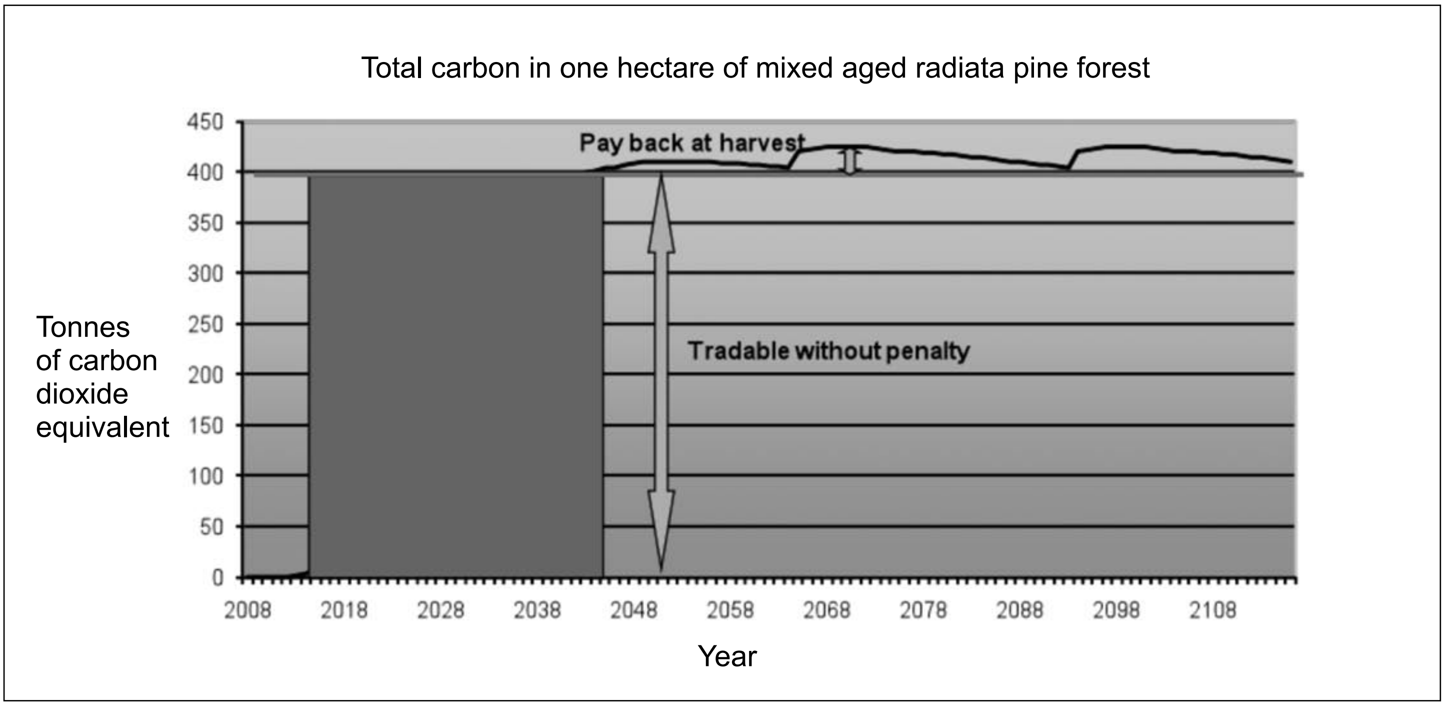
The solid line represents accumulated carbon within an even-aged stand. At harvest the carbon in logs is removed but some remains on site. Stumps, branches and roots slowly break down and are replaced by the new growing forest. This is why the black line does not drop back to zero at harvest. In the example shown, the first crop retains around 185 tonnes of carbon dioxide equivalent per hectare, which would remain tradable without the requirement to pay it back at the time of harvest. This base quantity of stored carbon is a one-off and once claimed and sold, cannot be sold again.



Carbon storage during growth and harvest of an even-aged radiata pine forest

A way to store more carbon for trading and to avoid or reduce the requirement to repay carbon credits at harvest is to establish a new forest, or manipulate an existing forest, into a mixed-aged stand. There are various ways to achieve a mixed-aged forest. The best approach will depend on the amount of available land, topography and soil types.

In the theoretical example shown in the graph below, one hectare is planted every year for 30 years. Each year after the thirtieth year, one hectare is harvested and replanted. As the graph shows, the forest owner will be able to sell 400 carbon credits per hectare without having to repay any of those at harvest. These credits are effectively a permanent carbon sink. The figures are conservative and such a mixed-aged stand provides far more carbon credits which can be sold without the need to repay at harvest than does the even-aged stand shown in the previous graph.



Carbon storage during growth and harvest of a mixed-age radiata pine forest

Carbon trading and area required

Assuming a conservative approach to carbon trading is desirable, then only that portion of forest carbon which is safe to trade without incurring a harvest penalty should be sold to offset farm emissions liabilities. To safely offset these liabilities, an even-aged forest would need to be more than twice the size of a mixed-age forest.

Total emissions liabilities for Pohoatua between 2010 and 2040 will be 10,327 NZUs. We calculate that, at 400 NZUs per hectare, 26 hectares of new mixed age forest would offset this amount.

Carbon (NZU) price	Total cost to 2040 No forestry	Total cost to 2040 With 26 hectares of forestry
$25	$255,525	Cost of forest approximately $60,000
$50	$551,050	Cost of forestry approximately $60,000

At $25 per NZU the total cost of emission liabilities to the farm until 2040 will be $255,525 or about $8,500 a year, double this if the price rises to $50 per NZU. The addition of forestry to offset emissions could play an important role in reducing the cost of the ETS to the farm, but how much will it cost the farm?

Farmax computer modelling was used to assess the effect on the livestock operation of converting 26 hectares of grazing land to forestry at around $2,300 a hectare including establishment and basic tending. Several paddocks estimated to be producing pasture at only 70 per cent of the farm's average rate per hectare were identified for planting in trees. The table at the top of the next column shows the effect on farm financials.

	Current	Less 26 hectares	Difference
Revenue – sales less purchases	$271,410	$257,657	-$13,754
Expenditure – animal health, shearing, nitrogen, feed, interest on livestock capital, excluding fertiliser and weed control	$66,517	$63,755	-$2,762
Gross margin	$204,894	$193,902	-$10,992
Gross margin per hectare	$569	$581	+$11

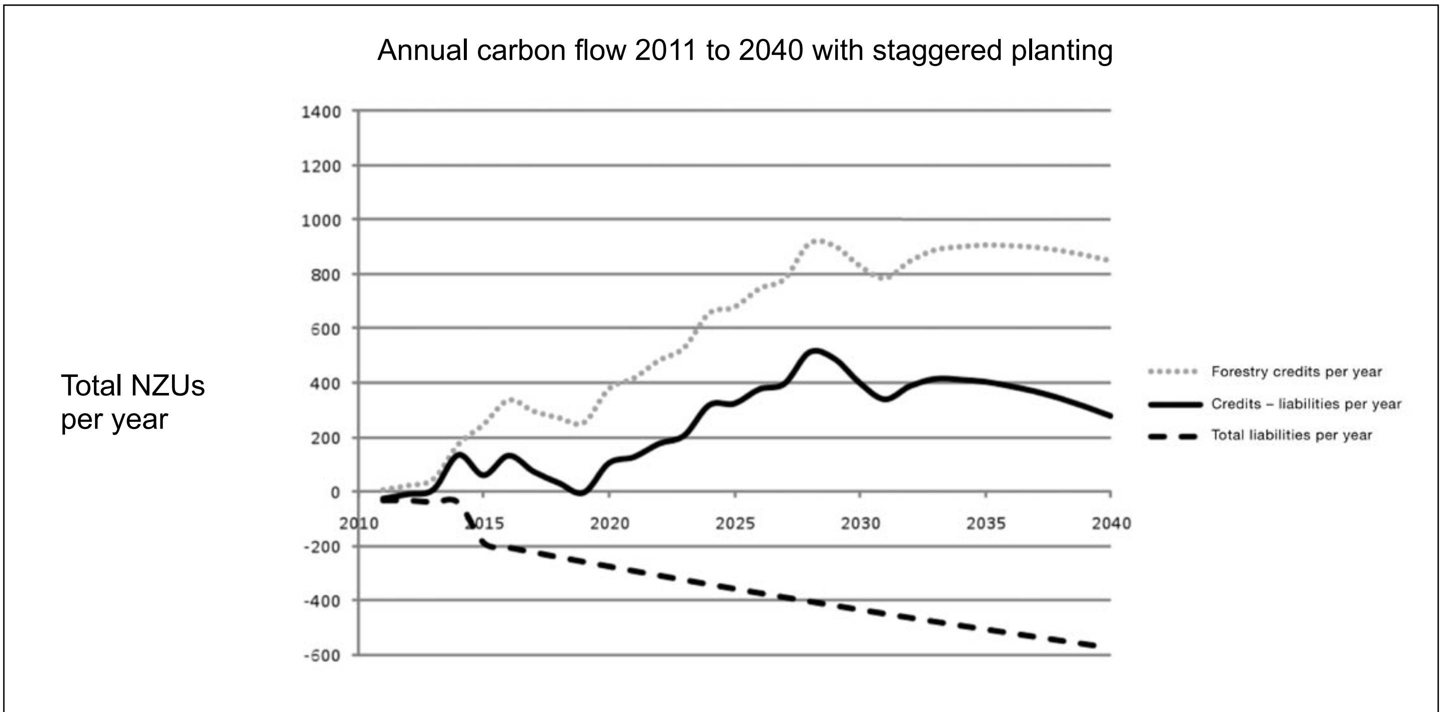
On the face of it, the forestry would save an average of $8,500 a year but would cost the farm $10,992 in reduced gross margin. Therefore the investment in forestry does not stack up at current prices. We calculate that the investment would break even at $32 per NZU. However, also worth considering is the potential value of the forestry as another source of income to offset the cost.

Staggering the planting

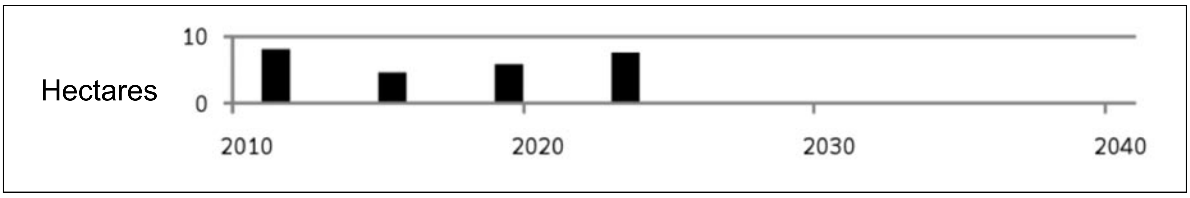
To achieve a mixed age forest, we suggest that planting should be staggered so that five to six hectares is planted every five years. If the harvest age varied between 25 and 35 years of age, this would potentially yield an average return from timber of around $20,000 per hectare each year, which would compensate for the lost gross margin from livestock.

The next graph shows the balance between farm emission liabilities and forestry credits for such a staggered planting of radiata pine. This regime would generate sufficient carbon credits to offset farm emission liabilities, provided the balance of credits minus liabilities, the solid line, remains above zero.

This staggered approach would allow a farmer to start integrating forestry into the business, reducing the risk of future increases in the price of carbon while remaining responsive to ETS and market requirements as they develop.



Effect of planting date and area on balance of forestry carbon credits and farm emission liabilities



Planting date and area

After 30 years, once the mixed-age forest enters the phase of periodic harvest and replanting, a new area of forest will be required to sequester further emissions. Alternatively, rotation length could be extended to increase the quantity of carbon permanently stored. This might happen in cases where the price of carbon is high and the price of timber is low.

Millbrook Station

The other farm we assessed was Millbrook Station, a sheep and beef farm with around 4,100 stock units in May 2010, fewer than usual due to drought conditions. The farm, located at Pakiri on the east coast near Wellsford, was involved in the Meat and Wool Monitor Farm Programme.

Valuable information was available for the property, which has been used to investigate a range of future farm management options. The effective grazing area is 478 hectares and the current livestock base is 628 ewes along with 702 cattle, including 134 beef cows. Total annual greenhouse gas emissions from Millbrook Station are 1,401 NZUs. Livestock are the source of 97 per cent of emissions. The total annual cost of the ETS to Millbrook Station was calculated to be $557 in 2011, $4,259 in 2015 and $12,951 in 2040.

Existing forestry

Millbrook Station is eligible to claim carbon credits under the ETS for existing forest established after 1989 on non-previously forested land. This existing forest comprises 20 hectares of radiata pine planted in 1995. In addition, the farm can claim credits for 166 hectares which have been retired to native forest reversion.

In 1990 that land was being grazed by goats and sheep and had some gorse but no significant forest. Critically, less than 30 per cent of the area was covered with forest species and the prevailing grazing management would have prevented it reverting to forest. Had there been 30 per cent or more cover of forest species including manuka or kanuka, the land would have been classed as forest and would not be eligible for carbon credits under the ETS.

Calculating carbon credits

At present, carbon credits can be claimed for carbon accumulated from January 2008 onwards. Radiata pine will accumulate approximately 22 tonnes of carbon dioxide equivalent per hectare per year if left to grow for 50 years. At present a figure of three tonnes per hectare per year is used to calculate accumulation by native reversion, although a newly proposed rate amounts to approximately twice that.

Using the look-up tables, we calculate that the forest areas on the station are currently accumulating approximately 1,268 NZUs a year. When agriculture first enters the ETS in 2015 it must meet 10 per cent of its emissions. In Millbrook's case, 10 per cent of emissions will amount to 140 NZUs. This will be more than offset by its annual credits from forestry and native reversion. Over the period between 2008 and 2015 Millbrook will potentially be able to claim a surplus of 8,666 NZUs – these may be sold, or could be retained.

Matching land use capability with production

A wide range of land types occur within the 1,087 hectares of Millbrook Station. A land use capability survey detailed the productivity of the land resource. Five distinct land management units were identified. Pasture growth, cover and quality has been closely monitored on Millbrook over the past two years. Results for three broad land type categories are shown in the table below.

Land type	Annual production kg dry matter per hectare from June 2008 to May 2010
Flat/easy land	12, 950
Rolling hills	8,776
Steep hills	4,947

The flat easy land had annual production of almost three times that of the steep hills. This low productivity steep land was also being spraying every three years to kill gorse at a cost of $600 a hectare. The combination of low productivity and high cost resulted in a negative gross margin on this land type.

From this land use analysis, 100 hectares of the steeper land was identified for establishment of new forest. The proposal was to plant a range of species including radiata pine, poplar, eucalypts, Japanese cedar and redwood.

Proposed new productivity

Farmax was used to assess the effect on the livestock operation productivity and profitability of converting 100 hectares of steep grazing land to forest. The analysis showed that the gross margin for the farm would be reduced by only $17,939 or 8.5 per cent. Offsetting this small decline in farm income would require a very modest increase in return of $47.50 per hectare per year across the balance of the farm.

In addition, as previously indicated, the cost of maintaining the steep land in pasture exceeded the returns. An average of $20,000 a year may be saved on gorse control. It is expected a further $20,000 could be added to farm income by diverting the effort expended on the hills to 100 hectares of the more productive areas of the farm.

This extra income would result from the adoption of intensive beef systems which could easily result in an increase of more than $200 per hectare per year. Farmax analysis also showed a less than five per cent reduction in overall farm productivity resulting from a 20 per cent reduction in the area grazed.

This analysis is conservative as no account has been taken of potential income from carbon or timber. Such income could be significant in the future because the planting includes long-lived trees producing relatively high value timber, enabling maximisation of the value of both carbon and timber. The analysis shows that focusing livestock production on the better land and producing timber and carbon on less productive land will improve overall profits, probably reduce work requirements, and improve overall farm efficiency.

	Current	Less 26 hectares	Difference
Revenue – sales less purchases	$298,897	$269,367	-$29,530
Expenditure – animal health, shearing, nitrogen, feed, interest on livestock capital, excluding fertiliser and weed control	$86,809	$75,218	-$11,597
Gross margin	$212,088	$194,150	-$17,939
Gross margin per hectare	$444	$514	$70

Funding the new forest

Given the range of species and areas of the proposed planting, and assuming the entire 100 hectares is planted in 2011, accumulation of 23,893 NZUs is possible during the first 10 years. At a current market value of $20 for each NZU this equates to a gross return of $480 per hectare per year, similar to current returns from livestock.

Cash flow is required for forest establishment, which is usually the sticking point for forestry investment given the long wait for returns. However, assuming an average establishment cost of $2,000 a hectare and the NZU price of $20, Millbrook Station will have sufficient surplus carbon credits to sell from existing forestry to fund the proposed new forest over the next six years. There will also be sufficient credits available to address the expected harvest liabilities from the 20 hectares of existing pine in 2025.

In contrast to Pohoatua, Millbrook Station is ideally placed to capitalise on the potential returns from carbon while minimising the risks. Establishing the new forest could be done over several years and funded directly from carbon sales so that no extra capital would be required.

A range of other benefits from forestry can also add value to the farm, including protecting waterways, reducing soil erosion, providing shade and shelter for livestock, increasing biodiversity, diversifying income from carbon and timber and improving the amenity value of a property.

Conclusion – a contrasting effect

The contrasting potential effect of the ETS on these two farms clearly shows that detailed analysis of land productivity and profitability is critical to making the best land management decisions. For example accurate information on pasture and livestock production for individual sites is vital to comparing continued investment in livestock production when diversifying and adding forest production to the business.

On the basis of this work we suggest a rule of thumb. This could be that for areas of pasture producing less than 50 per cent per hectare of the farm's average rate, afforestation should be seriously considered. In the present environment, short term income from carbon could fund sensible land use changes. The Millbrook Station example shows how farms with existing post-1989 forestry have ideal, low risk opportunities to achieve this.

In a wider sense, access to carbon credits insulates a farm business from the potential cost of liabilities from livestock emissions. This neutralises carbon price effects over the medium term of 30 to 50 years while technological solutions to livestock emissions are developed and implemented. This could be especially valuable if future carbon prices are high.

Average gross margin and productivity is predicted to improve at Millbrook Station as a result of retiring less productive areas of the farm to forestry and focussing inputs on the more productive areas. The decision to implement this plan makes economic sense independent of the ETS.

Forestry provides multiple benefits and forms part of a sustainable land management strategy with positive environmental and economic outcomes. Farming operations which already include forestry planted after 1989 are not only more resilient to climatic change in the form of droughts and floods, but will be ideally placed to address any increase in costs imposed by the ETS.

John-Paul Praat works for PA Handford and Associates and Bob Thomson for AgFirst Northland

Chris Karamea Insley

Maori issues and opportunities arising out of the ETS

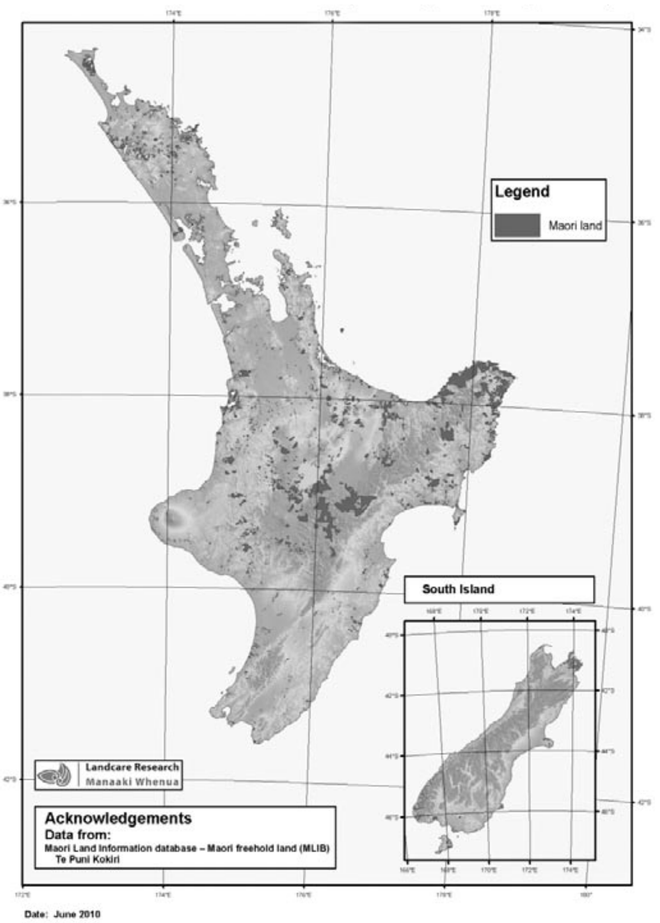
To begin to understand the ETS and its effects on Maori, it is appropriate to first understand the cultural context of Maori. In particular is the enduring and perpetual association that Maori have with ancestral lands, where these lands and associated rivers, forests and the sea form part of the fundamental fabric of Maori culture. These lands and other treasures (taonga) are not privately owned. Instead they are communally owned, often with trustees appointed to represent the best interests of all individual owners that can number in the hundreds or thousands of individual owners.

The lands and other taonga often bear the names of ancestors or significant historic events related to iwi, hapu and whanau. These names are often passed on to children, grand-children and future generations and therefore there becomes a very strong unbreakable and inter-generational association with the lands. Given these communal ownership and ancestral land associations, Maori generally will never contemplate the selling of tribal lands.

The map shows that much Maori land is concentrated in the Waikato, central North Island and the East Cape, with reasonably strong holdings in Northland.

The Te Ture Whenua Maori Land Act is an important feature of Maori land ownership, management and administration. It places particular emphasis on preserving the individual shareholder interests of Maori land with especially stringent rules that prevent the sale of Maori land. A key feature of Maori land is that the landscape is dominated by many smallholdings, often where lands are not surveyed, with limited to non-existent governance and technical management functions, and often with limited liquidity on the balance sheet. The table shows data from the Maori Land Court but statistical data on Maori land is not very good.

The principles of sustainability are held strongly by Maori as it relates to these lands, forests, rivers and seas, where these lands historically were the food basket that sustained Maori marae and communities. As a result the future of Maori



Maori collectively owned land

Land Court District	Total number of blocks	Area in hectares	Average area per block in hectares
Aotea	3,753.0	165,741.0	44.2
Waiariki	5,231.0	139,678.0	26.7
Tairawhiti	5,313.0	108,514.7	20.4
Takitimu	5,460.0	61,344.0	11.2
Waikato-Maniapoto	3,781.0	50,376.5	13.3
Taitokerau	1,359.0	36,652.0	27.0
Te waipounamu	1,848.0	27,856.5	15.1
Total	**26,745.0**	**590,162.7**	**22.1**

Maori land profile

as a people is inextricably tied to the guardianship applied to the management and use of these assets.

In this respect, there is very strong alignment between the principles and objectives of cap and trade systems like New Zealand's ETS which aim to reduce or eliminate the effect of greenhouse gases on the environment and the planet. This point was acknowledged by the 2009 Select Committee panel who commented that the Maori submissions were the most inclusive and forward thinking of all submissions they heard.

Historic Maori land use

The Maori land development initiatives of the 1950s and 1960s led by Sir Apirana Ngata saw large tracts of Maori lands, especially on the East Coast in the early stages, converted from forests to farmland, especially sheep and beef. These initiatives spread out to other parts of the country on Maori land.

The 1970s saw a further period of major land development on Maori land with the central government's policy to incentivise the planting of new exotic forests, mainly radiata pine. This programme saw tens of thousands of hectares of Maori land leased by government and national and international private sector investors. These leases were typically for terms of up 99 years, or three thirty-year crops. The first of these crops is being harvested now and will be replanted. In addition, most of these forests will be pre-1990 forests as defined by the ETS. A main point here is that historically, Maori land development options were concentrated in the primary sector and limited to both sheep and beef farming and exotic forestry.

Maori interests today and the ETS

Maori interests today continue to be very much concentrated in the primary sector where, as a result of treaty settlements, Maori own or control 50 per cent of the fishing sector via quota ownership. Maori also own or control 50 per cent of the exotic forestry sector with in particular, the Central North Island Treaty settlement over the large Kaingaroa forest and related adjoining smaller forests.

In the farming sector, Maori continue to have a very large direct footprint from examples such as Mangatu and Parikinihi ki Waitotara and others, but also with indirect interests and associations such as via Fonterra. While there is definite evidence of Maori looking to diversify interests into other sectors, the Maori footprint in the primary sectors will remain very large and is likely to increase over the next few decades.

There is no one size fits all in terms of Maori interests and exposures to the ETS. That is, Maori interests are not homogenous in respect of the ETS. The mix of primary sector interests varies from iwi to iwi, region to region and land block to land block. Maori interests also vary in terms of readiness to respond to the effects of the ETS. Maori, with established and advanced post-Treaty settlement processes, probably will be better able than most Maori who either do not have or have not completed their own Treaty negotiations.

New Zealand has adopted an all sectors, all gases approach to its ETS design with amended enabling legislation passed in late 2009. Some sectors, such as forestry, are already in the system and farming and agriculture are scheduled to enter the system in 2015. Given the substantial Maori presence in the primary sector, Maori will be significantly exposed to the new risks presented by the ETS. They will also be exposed to a raft of new development opportunities as the government pushes forward its programme to reduce emissions from the New Zealand economy to meet its international obligations.

The risks of the ETS

The development of international rules continues to be a source of risk to those involved in New Zealand's ETS. This will remain so as countries jostle and negotiate rules beyond 2012, especially in relation to individual country emission reduction targets and financing commitments to developing countries.

World carbon markets are still immature and highly volatile, as major countries are still yet to finalise their international commitments and internal domestic policy programmes. Within New Zealand it is still not that easy to track down large numbers of actual carbon sale transactions. It is probable that this volatility in carbon markets will remain for many years to come, at least until there are substantive international rules in place binding both developed and developing countries. Smaller Maori land owners will be especially exposed and vulnerable to these risks given their governance and management deficiencies.

New Zealand's new regulatory certainty, by way of the ETS, will be a source of new risk for Maori. The ETS will attract international interest from those looking to take advantage of the opportunity to either accumulate NZUs being allocated to owners of pre-1990 forests and to invest in either emissions reduction technologies related to the primary sectors or in establishing new carbon sink developments. They could cash in on the early carbon years and then exit in later years as carbon accumulations fall away, leaving behind the liabilities with Maori landowners.

This has the potential to lock up land use for decades and in some cases in perpetuity. Remember the lessons of the 1970s, where Maori were locked into almost 100 year legal leases, effectively alienated from ancestral lands for meagre annual rental rewards.

In forestry, and especially pre-1990 forests, Maori landowners will be eligible to receive NZU allocations. There is a real risk with these allocations, which for some will amount to several millions of dollars as a one-off transaction.

With these NZU allocations will go an estimated $20,000 per hectare liability to reforest the lands after harvest. In the central North Island forests, the NZU allocations will amount to several hundred million dollars. The related liability will amount to several billion dollars. The particular risk here is time. The NZUs are transferred today, but the burden of the liability may not occur for 30 years into the future. This will probably lead to short-termism fever around the NZU allocations, hyped no doubt by speculative investors promoting projects that are relatively short term, perhaps 10 to 20 years, inconsistent with Maori inter-generational planning horizons.

New opportunities for Maori

As the government moves to implement its climate change plans, either directly by way of policy initiatives or indirectly as a consequence of new policy, a host of new development options will emerge over the next few months and years. The new certainty will encourage new investment, especially into new technology options aimed at reducing carbon emissions from existing practices, sectors and industries, and in the development of low emission products and services. The following list illustrates where some of the new emphasis may occur –

- Emerging carbon markets as forest sinks
- Biochar
- Methane reduction technology
- Anaerobic digestion and reduction
- Improved nutrient use and budgeting
- Nitrous oxide abatement such as nitrification inhibitors
- Emission measurement in the form of soil carbon capture
- Wood energy as liquid biofuels,
- Energy efficiency and carbon neutral products
- Sustainable wood production
- Environmental services
- Biodiversity credits
- Ecotourism

This is not an exhaustive list but does begin to illustrate the emerging new development options arising out of the ETS for Maori. Conservatively, the payback for effective implementation of some or all of these new development opportunities will dwarf Treaty settlements, with new carbon sink, biofuels and forestry projects alone estimated to be worth between $500 million and $1 billion.

The government policy includes a suite of important complementary measures aimed at incentivising and helping players to adopt some of the emerging new options. These complementary measures include the following initiatives.

Afforestation incentives would involve –

- East Coast Forestry Project for land stabilisation
- Afforestation Grant Scheme for more forests
- Permanent Forest Sink Initiative
- Afforestation partnership option by the Crown

At the time of writing, the government is reviewing these measures for the opportunity to rationalise the various schemes.

Investment in research and new technologies includes

- Global Research Alliance on agricultural greenhouse gases
- Primary Growth Partnership including the Centre for Agricultural Greenhouse Gas Research
- Pastoral Greenhouse Gas Research Consortium

Using these measures the government will invest hundreds of millions of dollars over the next few years.

Summary and conclusions

Given Maori ancestral ties to traditional lands along with legal restrictions and impediments, Maori traditionally take a longer term and inter-generational approach to land and community development founded on the principles of sustainable development. This philosophy is consistent with the objectives of new international and domestic climate change policy that aims to reduce or eliminate the effects of greenhouse gases over the medium to longer term. It will be important for both Maori and non-Maori alike to maintain such a medium to long term focus while exploring new development options posed by the ETS.

This will come under real pressure in the next year or two of implementation. In particular are the one-off allocation of NZUs and pressure from the inevitable speculative investor groups. They will be looking to exploit the new development options, cashing in on early year cash flows with the intention of exiting development projects as carbon accumulations reduce in later years.

The ETS will create many new development options for Maori landowners, but only a few larger Maori owners will be able to navigate the ETS. Realistically many smaller Maori landowners will not have the necessary arrangements, in-house technical capabilities and cash to respond to offsetting the new risks or exploiting the new development options posed by the ETS.

In this respect, the ETS will not so much create new risks for Maori land owners, but instead amplify existing risks for Maori land owners. The government's implementation programme will be aggressive over the next few years, not allowing sufficient time for Maori land owners to train and equip themselves with the necessary structures and skills.

One option for Maori is to explore the opportutnies to create scale by aggregating together where there is common interest, assets, geography and in many cases, whakapapa. Such an option would enable the best technical skills to map out and create options that minimise new risks while exploiting the new substantial developments to realise the opportunities the ETS presents to Maori across the country.

Such an option will be equally important for Maori landowners to access the new government funds. They will need to use the technical capabilities across the New Zealand science system which has historically not been accessible and responsive to the science needs of Maori.

Given the very large 'footprint' that Maori have in farming and agriculture, the source of half of New Zealand's emissions, and the inter-generational planning horizon of Maori, commitment to investment in new low carbon technology solutions will rest well with Maori. Maori success in navigating the new and complex ETS territory is not only good for Maori, but good for New Zealand's long term future, as the gains and benefits made by Maori will stay in Aotearoa for ever.

Chris Karamea Insley is principal of 37 Degrees South, a consultancy providing sustainable economic development and asset development strategies for businesses and indigenous communities in New Zealand and overseas.

Nick Pyke

Overview and future opportunities for the New Zealand arable industry

The New Zealand arable industry produces grains, seeds and forage for New Zealand and the world. Every day the industry supplies 1.1 million New Zealanders with their daily bread and provides the pasture seed, the forage seeds and the feed for the $9 billion export dairy industry. It also helps feed the poultry and the pigs, supplies the starch for glues, the malt for New Zealand produced beers, and a range of breakfast cereals.

Exports of seeds have increased markedly in recent years. Herbage seed exports are in excess of $70 million, vegetable seed exports around $100 million and grain based products are approximately $130 million.

New Zealand is a very small arable producer in the global scene, producing only a million tonnes of grain and approximately 50,000 tonnes of herbage and vegetable seeds. Although New Zealand is a small producer of most products, it is the largest producing nation of white clover and carrot seed and is the third largest producer of grass seed. Yields are extremely high due to the favourable climate, effective use of irrigation and skilled producers. A New Zealand farmer holds the world record for wheat production at 15.6 tonnes a hectare, and perennial ryegrass seed yields are often in excess of two tonnes a hectare, well above yields elsewhere in the world.

High yields

Maize, grain and silage yields are also frequently well in excess of those achieved by dedicated corn growers elsewhere in the world. Productivity increases in the last 12 years have been significant. Wheat yields have increased by four per cent a year or 250 kg per hectare and ryegrass three per cent a year at 42 kg per hectare per year. Yields for some crops, such as maize, appear to have stagnated even though there is continuing genetic improvement.

In parallel with increased yields are reduced inputs and improvements from greater efficiency of tillage and better timed and targeted fertiliser, water and agrichemicals. The quality produced has also improved significantly, particularly seed quality. Here not only is there a requirement for high viability and purity, but for many grass seed products there is a requirement for high endophyte viability as well.

The environmental footprint from arable production is small. A good understanding of nutrient, water and other production requirements, has meant that it is possible to use good management practices developed over recent years to ensure effects on the environment are minimised.

Low profile

Many developments have remained under the radar as rapidly changing primary industries, such as dairy and wine, receive markedly greater publicity. It is a little known fact that the New Zealand Health Strategy food and nutrition targets, which had a recommendation resulting in the vegetable industry promotion of five plus a day, included a recommendation that 75 per cent of New Zealand population needed to consume at least six servings of cereal based products a day, a significant increase on what is currently consumed.

All of our grain and seed production is from a relatively small area of the total primary production area in New Zealand, and by approximately 2,200 farmers. These farmers are highly skilled, often growing in excess of eight different crop species in any season. The farmers are using new technologies such as precision agriculture, new irrigation technologies, non-inversion tillage and crop models.

Issues and opportunities

What are the main issues for the New Zealand arable industry and what opportunities are there to supply products to New Zealand and the world? It comes down to looking at what the New Zealand and the world's food, fuel and leisure requirements will be in the future. We also need to know how the land and climate of New Zealand can be used to supply high quality products more effectively than competing producers elsewhere in the world.

Some of the main external and internal trends which will influence the New Zealand Arable Industry are –

- Population – the world population is predicted to increase from 6.5 billion to at least 9 billion. These people have eat. The wealth, ethnicity and age of the world and New Zealand population are also changing.
- Affluence – the number of people with money is increasing and they have leisure pursuits which include food, beverages, sport and travel.
- Food production – there are changing trends in food production to cater for the people who are eating different foods.
- Energy – demand for energy continues to increase and demand for green fuels is expected to increase.
- Water – competing demands from cities and industries means that water is becoming increasingly scarce in many countries.
- Climate change – the effects of climate change could be very significant on a number of food producing nations, particularly if climates get drier or sea levels rise.
- Food safety – consumers are demanding safe food and often this is associated with New Zealand grown.

These trends provide the New Zealand arable industry with some significant advantages over other seed and grain producers in the world and we need to do better to capture and capitalise on these advantages. As well as these broad trends we need to capitalise on what we have and do now.

Climate

There are very few places in the world that have the climate and the available water required to produce high quality arable products, such as seeds, grain and high quality vegetable products. We already grow the best vegetable seeds and herbage seeds in the world. So we should be producing high value cereal seed for Australia, if there were no biosecurity constraints, as their dry climate often precludes high quality seed production.

What about maize seed or other high value seeds for export to the northern hemisphere to ensure availability of high quality seed? New Zealand could produce a broad range of high value seed crops and these would integrate very effectively with vegetables, grain crops and forage production in an arable farming system. In addition the climate and water enables the production of high quality grains which meet exacting end user specification. There are opportunities to produce grain to meet the specification of specialist end users elsewhere in the world from the ability to manage protein, grain size and starch.

Environmental management

The arable industry has a broad range of tools and practices available to ensure we can sustainably produce crops under the increased scrutiny of the international and the New Zealand public. Research over recent years now enables us to bring water, nutrients and agrichemicals to our crops at the rates and timings which optimise crop performance and also minimise the environmental effect.

The Foundation for Arable Research has developed tools, such as the wheat calculator, AmaizeN, and aquaTRAC the cropping farm irrigation calculator. Practices such as reduced tillage allow accurate use of inputs and provide us with the confidence that we are minimising any negative environmental effects.

The uptake of new technologies by arable farmers has been significant and over 80 per cent of farmers have changed their nutrient management practices in response to knowledge supplied from the wheat calculator. Similarly, the shift to reduced tillage practices has also been rapid and interest in the recently released aquaTRAC has been very high. As an industry it is essential to convey these messages to other industries and the broader public.

Products

What will New Zealanders and the world be eating and doing in five to 10 years from now?

Many food products are made using proteins from milk. These same proteins could often be produced from plants more cost effectively and with fewer environmental concerns. A number of products can be made from grain and can have the same taste and texture as products from milk. For example, an ice-cream can be made from oats.

More food products made without needing cows could eliminate the energy loss and some environmental concerns associated with producing protein from milk. Edible protein per unit land area is a measure of agricultural productivity. There is a range of values reported for the percentage of useable protein from a wide range of food products and the values used in the table below are in the mid range of those listed, with estimates for New Zealand production near the top. The protein production per hectare for three arable products and milk shown in the table below shows growing grain, and in particular Faba beans, can be a very effective way of producing protein.

	Yield	Protein percentage	Percentage of useable protein	Usable protein kg per hectare
Maize	12 tonnes per hectare	10	0.38	456
Wheat	11 tonnes per hectare	11	0.54	653
Faba beans	7 tonnes per hectare	25	0.68	1200
Milk	19,500 litres per hectare	3.40	0.91	603

Expected changes

As the world population grows and eating habits change, particularly in Asia and India with the consumption of pork, poultry, fish and grain increasing in these areas, what could be the flow-on effect for New Zealand? As the ethnic population in New Zealand changes, will demands for some foods change?

- Commodity grains from big producing nations will increasingly be exported to Asia and India. Will New Zealand need to become more self sufficient in grain?
- As Asia is unable to produce or source low volumes of high quality grains, will there be opportunities to supply containers of specialist grains to specialist mills in Asia?
- New Zealand's growing consumption of pork will increasingly be supplied by pork produced in close proximity to grain producers. Will some areas of New Zealand be specialist grain and pork producing centres for New Zealand consumers as exports from the major pork producers, such as Canada, are fully used by the new developed world?
- Will increases in production of farmed fish in New Zealand waters be needed to help meet the demand for high quality fish foods? Currently approximately 40 per cent of the world demand for fish is supplied from farmed fish, mostly farmed and sold within Asia.

There will be increasing demands for high quality seeds. These seeds will not only be high in viability and purity, but will also have specific endophytes, seed treatments and seed coats which can be tailored to specific uses and markets. Current investments in research and development are targeted at markedly improving the ability to produce seeds. Four programmes stand out here.

Deterrent grass for wildlife and insect management This programme aims to produce ryegrass and fescue with endophytes that will reduce herbivorous birds and insects and so have uses at airports, parks, reserves, golf courses and in horticulture.

Cereal endophytes The project looks at the potential for endophytes to provide tolerance to insects, reduce disease and provide drought or other stress tolerance.

Advanced seed production This project aims to understand flowering of indeterminate species, such as brassicas and clover, to improve seed production.

Smart seeds Aims to add value to seeds, such as brassicas, through natural associations with microbes that provide biocontrol.

We have the skills

Without an arable industry, New Zealand would not produce any seed for the pastures of New Zealand or for the brassica, maize and cereal forage crops grown for the dairy industry. We have the skills, the reputation, the land and the farming systems to produce high quality seed products for the world and need to determine how we will continue to produce for these markets to meet the changing demands.

Feed protein demands in the world are increasing and the need for New Zealand to produce protein for the animal industries is increasing. Crops such as Faba beans are well positioned to fill this gap. Horticulture, and particularly vegetable production, is compatible with arable cropping and a greater effort is required to build on these synergies for these closely related industries. Demands for vegetables which can be shipped throughout the world from New Zealand should only increase.

Feed for the dairy industry

Maintaining productivity, reducing nitrate in urine, reducing methane emissions and improving reproductive rates are all critical to the dairy industry, and ensuring cows have the right feed is integral to this. The arable industry needs to ensure it can produce the right products for the dairy industry in the right part of the country as required.

Supplemental feed will always have a place for the dairy industry to help manage the effect of bad weather. However the demand is expected to be for high quality feed which can complement existing feed such as pasture, to optimise animal performance and minimise environmental effects. These feeds may be grain based, forage based or blends of both. In addition, arable farmers may produce crops on dairy farms to provide high quality feed for the dairy farm. This would be to effectively use nutrients that have leached below the pasture root zone. This would involve deep rooted plants, such as wheat or maize, reducing nutrient loses to ground water and effectively re-pasturing the dairy farm with high quality pasture.

Promising future

What is the expectation of New Zealand with regard to land use? The arable industry is well positioned to help bridge the urban and rural divide and to provide farming systems which are seen as an accepted part of the sustainable rural network within New Zealand.

The New Zealand arable industry has an extremely promising long term future. It is essential there is the vision, the enthusiasm, the energy and the optimism to drive the industry forward to a new future. It cannot afford to dwell in the past, the recent poor performance of the industry or to listen to the doomsayers and those promoting other land uses, if the industry is to develop. New Zealand's other primary industries and New Zealand Inc. need a profitable, resilient and future driven arable industry.

There is the opportunity, the potential products, the climate, the soils and the drive to achieve it. There is a need to invest in the research, extension, product development and marketing to get there and a need to not be constrained within the way things have been and the way the industry operates currently. There needs to be improved vision of the industry requirements, better planning, improved collaboration and a clear focus on achieving a common goal if the arable industry is to continue to increase productivity by four to five per cent each year.

Nick Pyke is the Chief Executive for the Foundation for Arable Research

Member Profile
Elizabeth Burtt, Life Member NZIPIM

For NZIPIM Life Member Elizabeth Burtt, teaching in the agricultural sector was not an obvious career move. The senior tutor with Lincoln University's farm management group was pretty much a city kid, born and brought up in Eastbourne, Wellington. To this day she says she is still not quite sure where the farming came from, but over the years she has been something of a quiet trailblazer for women in the profession.

How did you first get interested in farm management?

Both my parents were from London, neither of my brothers was interested, it just sort of happened really. I wanted to do something with animals, but I wasn't quite sure what, until the liaison officer from Lincoln College (as it was in those days) came to Hutt Valley High School, and I was pretty much sold.

It must have been 1974 that I started at Lincoln, and apart from seven or eight months in the UK in the mid-1980s, essentially I never left. It certainly seemed right to me. I did the B Ag Sci degree, but in about my third year David Lamb really fired my interest in farm management so I became quite interested in that. It drew everything together – all the animals and the plants were fine, but on their own they did not mean a lot. Farm management brought it together and you understood how a farm really worked.

How difficult was the career choice?

I was thinking about going into consulting but in those days MAF did not accept women. They never actually gave me a reason, but this was the mid-1970s and they just did not accept women.

So instead I stayed at Lincoln and did a masters degree in agronomy. Why not farm management? Well, you had to be invited to do a masters, and I was invited to do agronomy. I don't want to get into the politics of it now, but possibly there were people in the farm management department at that time who did not think that women had a career in farm management. Attitudes have changed since then, the university certainly has.

What was your first job?

In the last year of my masters I had a part-time tutorship with the farm management department and things grew from there. It was about that time I started my involvement with the *Budget Manual*. That was probably my first job in the department, as a summer student working on the *Budget Manual*.

Lincoln University's financial *Budget Manual*, produced annually since the early 1970s and now published every two years, is as its name suggests, a budgeting manual. It is for farmers, growers, consultants, farm accountants and anyone involved in the agricultural sector providing up-to-date cost, price, income, taxation, and other data. My involvement with the *Budget Manual* has meant it has been a perfect place to observe the changes in the agricultural sector over nearly three decades. I was involved in that for 28 years, first of all as a summer student, then I became co-editor in about 1983, then editor until four years ago.

I have been around long enough to know that everything in farming goes in cycles. Sometimes it's sheep, sometimes dairying, with the trend now certainly dairying. That is probably the major change and I assume that the *Budget Manual* has reflected this.

What was your next role?

The *Budget Manual* was the summer job every year, and I had various part time and casual positions, and then in 1984 I was appointed as an assistant lecturer. I was mostly involved teaching the farm management component of the rural secretarial practice course that we taught then.

It was mostly for women who were intending to become rural secretaries and they did a lot of other classes at Lincoln as well as farm management separately. I think they were mostly doing it with the diploma classes. However there were only small numbers in the classes and unfortunately the course folded two years later.

Do you prefer lecturing or tutoring?

After six months off in England, I came back to a casual tutoring position again. I much prefer tutoring to lecturing. I am better on a one-to-one small group basis than I am with a big class, and one of the things I really like about one-to-one teaching is being able to see students respond individually.

Now I work during the teaching year only, and my main role is organising field trips and case studies for farm management students, and the subsequent marking of assignments, along with other general teaching assistance. I get to do other work the rest of the time. Birds are my special thing. I am very much into wildlife photography, and I've been doing quite a bit of overseas travel in recent years.

What changes do you see?

Just as farming goes in cycles, so do student numbers and the two are related. The late 1980s were not so good for farming and there is always a bit of a lag but that was reflected in poor student numbers. Now we seem to be in a rapidly expanding phase.

However I don't think the students have changed much. We have always had a core of students from farming backgrounds, along with a number from the cities as well, like me. There are increasing numbers of female students, which is good, but there are probably still fewer than 25 per cent once they get into their final years on farm management.

Our numbers are pretty good at the moment, but they are not like the late 1970s when there were up to 250 diploma students. That must have been a nightmare to teach, there would have been seven busloads going on a field trip whereas now it is just two. Although that is probably better for the students, and easier on the staff, we would still like to see more young people coming in to the industry.

Is the teaching different?

While our teaching has reflected the changes in the industry, I think the fundamentals remain the same. However there is a lot more emphasis on the off-farm aspects – the whole agri-business environment. Agri-business subjects and subjects such as investment analysis were always available but now they are regarded as a lot more important.

When I did my degree, farm management was taught separately to agricultural science and agricultural commerce students, and there was probably a slightly different emphasis. Now they are taught together. That was mainly due to dwindling student numbers in the 1980s, and with numbers increasing again there is some suggestion they should be separated out again. But apart from a class size aspect, I do not think that should happen.

How are skills changing?

One thing that has come more and more into our farm management teaching is computer technology, as computers and word processing have become essential. When I was doing my degree, computers weren't a tool at all. I used one for some analysis for my master's thesis but they were uncommon, and the farming community did not use them or the software we have these days. We now expect students to leave Lincoln with those skills highly developed.

I hope our students go out with a wider perspective now. You see students developing through their career and that is something I get a big buzz out of. It is one of the great things about being a tutor, I see them from year one through to their final year and some of them come back as post-graduates, so I do see them right through their academic career.

Fewer of our graduates are going into farming now, even though probably 75 per cent are from rural backgrounds. At a guess 30 to 40 per cent will go into or return to farming, but almost all will do something else first. They will have careers with the banks or consulting, but not so much MAF these days, but more places like Dairy NZ. The majority of our diploma students will be farming eventually, but a lot of them now will be going into career management rather than their own farms.

When did you join the Institute?

I joined the Institute of Primary Industry Management in about 1983 when I got the assistant lecturing position. A couple of years later the then branch secretary went off to Fiji suddenly and dropped me in it. So I have been involved in the branch committee ever since.

I was a councillor for five or six years, but my involvement has mostly been at branch level. Canterbury Westland is probably one of the stronger branches. Over the years we have had the numbers, so we have had a good history of branch activities. We are not quite as active as we used to be but that is probably a reflection of the wider Institute, which also has an aging membership. But there are a few more young members coming in and I think with NZIPIM really encouraging student membership I hope a good number of those will stay on.

Membership retention after they leave university is critical, but we do seem to have a few ex student members who are beginning to come branch field days. The main thing is to give them the contacts and getting them interested, encouraging them to take advantage of all the NZIPIM has to offer.

A few younger members are coming on to the branch committee too now, which is good. There was a period when the younger members just were not joining which is why Council has been encouraging students to sign up. We have always encouraged student membership but more recently we have had a much bigger push for this.

Who in particular has influenced your career?

Quite a few people have been influential, such as David Lamb, from when I was at Lincoln. But it is difficult to name some people and avoid leaving someone else out. Barry Croucher and Phill Everest would be two I probably should mention. Barry was the one who encouraged me to become a Council member and to become involved more outside the committee. There are lot of people who I have met either through Lincoln or through the Institute who have influenced me and encouraged me.

Being made a Life Member of NZIPIM was an honour and a privilege - I was very surprised, and I think I was the first female.

There are a few more female members of the Institute now. Occasionally I used to be the only woman at a field day or a conference, now there are increasing numbers. There is also a much wider membership. To start with it was just farm consultants but now there are many other farming industries involved. I have always got a lot out of the field days and conferences. We learn a lot from each other. I am looking forward to the international conference next year.