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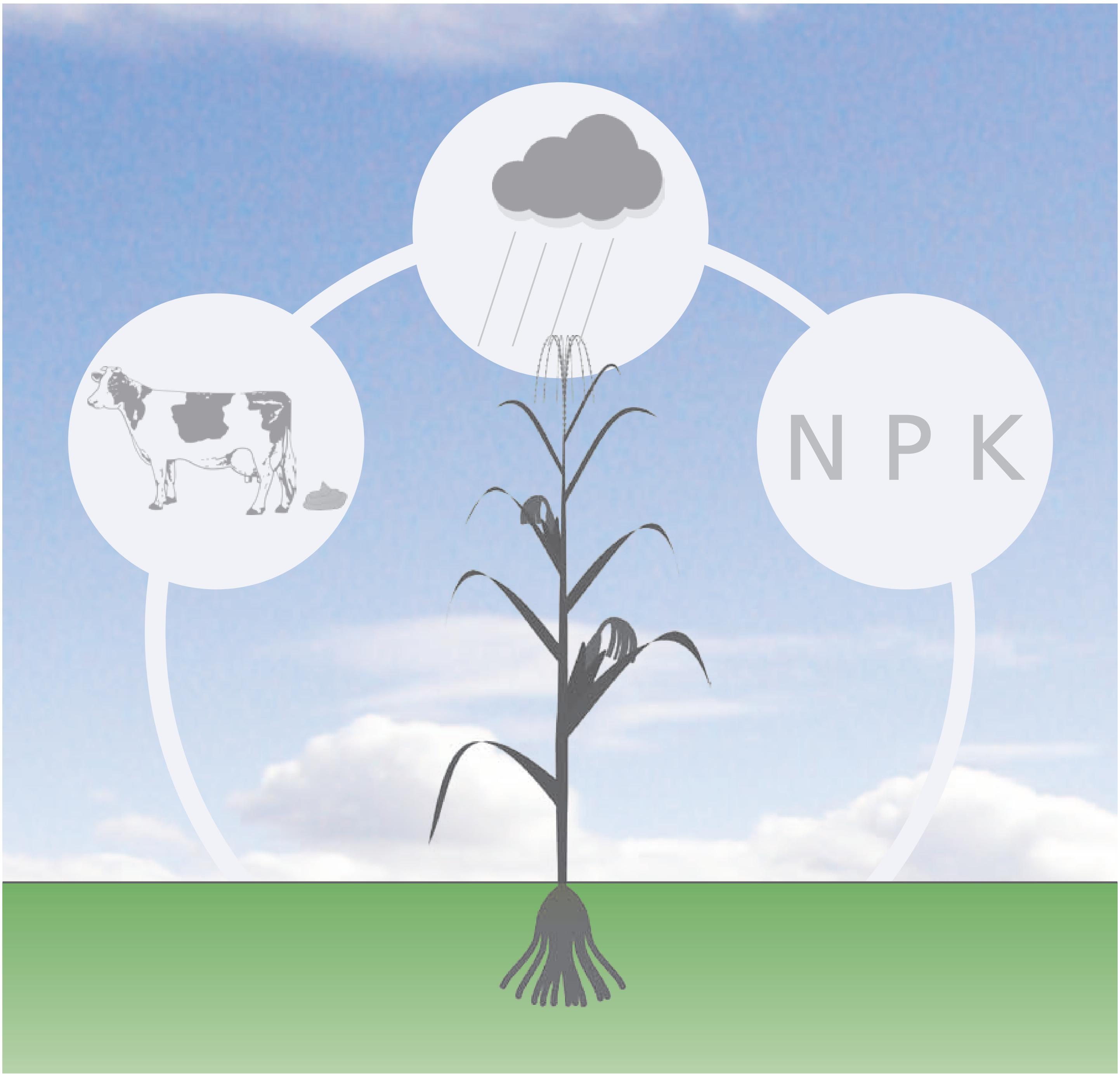

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nzipim NZ Institute of Primary Industry Management

NZ Institute of Primary Industry Management

National Office
Level 2
Johnston Street
Wellington
PO Box 25-603, Wellington 6146
Phone (04) 939 9134
Facsimile (04) 939 9135
Website www.nzipim.co.nz
Email admin@nzipim.co.nz

President Hilton Collier
Chief Executive Stephen Macaulay

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Contents

Julian Bateson

More relevance for nutrient management

Nutrient management, particularly for dairy farms, is not a new subject but it has increasing relevance. This is especially so with the recent release of the report by the Parliamentary Commissioner for the Environment *Water quality in New Zealand: Land use and nutrient pollution*. The report points out what we already know, that many sheep and beef farms have been converted to dairy farms. As the land use changes, it means that increasing amounts of nitrogen and phosphorous are lost from the land into streams and rivers.

The report modelling shows annual nitrogen loads in fresh water continue to rise in virtually every region of New Zealand. These increasing amounts correlate with the expansion of dairy farming, particularly in Canterbury, Southland and Otago. The report also suggests that although mitigation may be able to reduce nutrient loss, it cannot offset the increases from large-scale changes to more intensive land use.

The first four articles in this issue of *Primary Industry Management* continue the theme of nutrient management. Mathew Newman and Sam Howard look at some of the economic consequences of nutrient management. They conclude that there need to be some smart solutions on farms as the options are often limited. Each farm is unique and adjustments will be required because what may be viable for one farm may not be for another.

Ants Roberts et al in their article take a close look at Overseer, New Zealand agriculture's main nutrient management model. The aim of Overseer is to be practical and to model most major farm systems across New Zealand. The authors conclude that Overseer is the best method available for constructing a nutrient budget.

The theme continues with Peter Taylor, from Horizons Regional Council, who outlines some nutrient management options in Horizon's One Plan with regard to water quality. Leaching from cow urine patches is still their most challenging problem and the one which costs the most to reduce. However, the effort is not just on farming activities but on sewage plant upgrades and a continuing commitment to riparian planting. The conclusion is that the long term results are promising. The final article in the nutrient management theme, by Jacqueline Rowarth and Doug Edmeades, looks at the value of modelling in agriculture, specifically the Hurley pasture model and Overseer.

Getting more students into agriculture training is becoming more difficult and in his article, Jaime Thomson of Lincoln University outlines some of the problems. A team from Lincoln travel the country promoting academic and vocational education in agriculture. There is an increasing awareness of the general disconnection with agriculture by the urban population. In the following article, Donovan Wearing from Taratahi Agricultural Training Centre indicates how their school liaison officers continue to struggle for access to secondary schools to show the career opportunities available in agriculture. There seems to be a perception that the industry is a dumping ground for students who struggle with literacy and numeracy. Mike Styles, a literacy and numeracy adviser for Primary ITO, continues with this concern. He notes that 55 per cent of the primary industry workforce do not have the literacy and numeracy skills to do their work effectively. These figures are not significantly different from Australia or the UK where the assumption there is that even just a one per cent improvement would contribute billions of dollars to the economy.

The article by David Baker on common terminology used for measuring productivity confirms that a good understanding figures is vital for successful farm management. He also makes it clear that for benchmarking farms, if the figures obtained are not accurate and factual, the results will be worthless.

Later in the journal Keith Woodford and Xiaomeng Lucock continue with their series of articles on primary industry in China. In this issue they look at the horticultural opportunities in China and conclude that the low cost of production is a significant barrier to the commodity sector. However there could well be opportunities in patented or trade-marked New Zealand produce. Only time will tell.

Matthew Newman and Sam Howard

Economic assessment of reducing on-farm nutrient leaching

Under the National Policy Statement for Freshwater Management, regional councils are required to set water quality and water quantity limits which will maintain or improve freshwater within their respective regions. This requires the establishment of the current state of each freshwater body in New Zealand and the appropriate water quality attributes to be determined.

The focus then turns to how these quality limits can be met. Where a waterway does not meet the defined limits it is said to be over-allocated. In the case of nutrient loads, this situation will require councils to set a target which will describe how and when the over-allocation is to be wound back.

Under section 32 of the Resource Management Act, a regional plan must include a cost benefit analysis which evaluates all methods of meeting objectives, including alternatives. The analysis should examine the extent to which each policy change is appropriate in achieving the results efficiently and effectively and should not disadvantage one group in the community over another. New legislation yet to be passed by Parliament strengthens these requirements by using the term 'if practicable, quantify the costs and benefits' of the effects anticipated from the proposal being evaluated.

Why are nutrient limits needed?

New Zealand communities have made it clear that water quality is important and freshwater needs to be carefully managed. There is substantial evidence linking land use intensity with nutrient loads in waterways. We also know that excessive nutrients, for example nitrogen and phosphorous, can have adverse effects on freshwater. Where elevated nutrients cause unacceptable effects on waterways, significant reductions are required.

In many cases, problems with phosphorus loads can be dealt with using appropriate land management practices, although phosphorus controls can involve significant capital expenditure. In contrast, reducing nitrogen leaching has the potential to significantly affect the profitability and sustainability of dairy farms. Some of the early limits set by councils have focused more specifically on nitrogen loss from agriculture, so most of our analysis has tended to concentrate on nitrogen loss rather than phosphorus.

Nitrate leaching occurs when nitrogen is lost below the plant's root zone and is therefore no longer available for plant growth. This nitrogen will make its way to groundwater and eventually a surface water body. The time it takes for nitrate to move through the soil to groundwater, and then to a surface water body, will depend on a number of factors including –

- Soil profile, such as stony versus clay
- Climate, for example, higher volumes of rainfall can increase the rate at which nitrate is flushed beyond the plant's root zone.

The effects that this nitrogen may have on surface water quality will depend on the nature of the waterway, the values the community are trying to protect such as recreation, habitats or traditional food gathering, and the current nutrient status of the waterway. We need to ensure smart solutions are developed for improved water quality while increasing economic and social benefits from a thriving New Zealand dairy industry. Policies need to make sense and contribute to improving water quality at a catchment level. In over-allocated catchments this may mean protecting and allowing those already established to continue to farm before considering new investment in dairy.

Models for on-farm analysis

To make sure that a policy is required and makes sense, a reasonable amount of scientific and economic technical research needs to be conducted for a catchment. Where this is carried out with regional councils, industries, large businesses, farmers, iwi, recreational water users and local communities, it is more likely to lead to an agreed and reasonable solution. It is also more likely to reduce the debate on the method and models used in the analysis.

The starting point for any economic modelling to consider the effect of changes on the farm has to be reliable physical, financial and environmental data for a wide variety of farms within a catchment. DairyNZ has invested in expanding the depth of farm data and number of farms available for industry analysis in the DairyBase National Baseline project.

The aim is to visit 500 additional owner-operator farms throughout the country to expand the DairyBase information. This will increase data available for environmental economic projects, and will improve numbers for regional and district benchmarking, while providing a chance for farms to identify opportunities to improve performance.

Some farmers will need to consider changes on-farm to reduce their level of nitrogen leaching in the near future. Due to the diversity of farm systems, biophysical conditions, and farmer objectives, there is no silver bullet or simple solution. It is important to identify all of the potential implications of any changes considered.

Simulation and optimisation

The calculations required can be complex, but a farm systems model can help to overcome these calculation difficulties. The models are constructed using equations designed to simulate a real farming system. A number of assumptions are necessary to allow the model to operate, and it is important to consider these in the interpretation of the results.

So far, in its economic policy work, DairyNZ has worked with both the Farmax Dairy Pro and Grazing Systems Limited farm systems models. They take quite different approaches. The first is a simulation model where the user inputs the farm management changes to be undertaken. The second is an optimisation model which highlights to the user where beneficial changes to farm management could be made within certain parameters.

Both of these farm systems models operate at the energy intake level where the amount of energy a cow consumes in feed contributes to its milk production. Pasture cover, along with feed demand and supply throughout the season can be balanced by the application of fertiliser, supplementary feeding and cropping so that the farm is biologically feasible all the time. Farm revenues and costs can then be estimated based on the amount of milk produced, livestock or meat sold, and the input and overhead costs involved with the farm's operation.

These farm system models do not incorporate a nutrient budgeting or soils and climate module. This means that the nitrogen leached from the farm system cannot be estimated using Farmax Dairy Pro or Grazing Systems Limited. To estimate the effect of various management changes on nitrogen leaching, the modeller must also run Overseer nutrient budgeting along with the farm systems model.

DairyNZ and industry partners, have developed a protocol for the use of Overseer which is the New Zealand Dairy Industry Audited Nutrient Management Scheme. This helps to improve comparability and consistency by setting out the important data requirements and assumptions that should be used for measuring, modelling and auditing nitrogen information for dairy farms.

The method used

Following the set-up of the base farm file in the farm systems model and Overseer, the user can undertake farm management changes to investigate the effects on the level of nitrogen leaching from the farm and the financial and management implications. The modeller should have extensive farm systems knowledge so that any changes are logical and possible. The benefit of using a farm systems model is that it can ensure the system is biologically feasible. For example, there needs to be enough feed for the cows to produce at a certain level.

To reduce nitrogen leaching, the farmer must either constrain nitrogen surpluses or constrain drainage. Where nitrate is present in the soil profile during drainage, nitrate ions will be flushed through the soil in drainage water. Where the farmer cannot control drainage, such as in non-irrigated farms, there is a nitrogen surplus. A careful assessment of nitrogen inputs and outputs and efficiency of use reveals where there are surpluses and where management could target changes.

The main inputs of nitrogen to the farm system are from fertiliser and imported feed. Of this most will be consumed by the cows, which can be used for maintenance or the production of milk, with the remainder excreted in urine. The nitrogen applied to the soil in urine is at a concentration greater than that required for plant uptake. Nitrate leaching occurs when nitrogen is lost below the plant's root zone and is therefore no longer available for plant growth.

Farm management changes which affect the inputs of nitrogen to the farm system need to be carefully analysed to assess how the reduced nitrogen inputs will be managed. For example, reducing nitrogen fertiliser input is likely to reduce the pasture grown on-farm and therefore feed demand will exceed supply. The farmer can increase supply by importing supplementary feed, or reduce demand by perhaps altering the stocking rate or grazing cows off the platform. The benefits of a farm systems model operating along with Overseer nutrient budgeting are that the modeller can assess the nitrogen leaching changes, and the financial implications of the farm management also change.

Options for reducing nitrogen leaching

Some potential options for reducing nitrogen leaching on the farm are set out in the list below. It is not exhaustive and options need to be analysed on an individual farm basis. A farm systems model, used in conjunction with Overseer, can provide valuable information on the implications of these changes for a farming business.

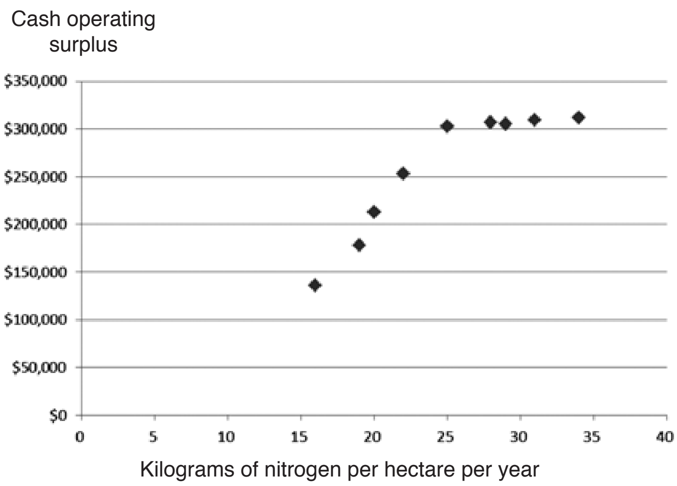
- Adjust rates and timing of nitrogen fertiliser application
- Assess nitrogen inputs block by block – fertiliser, effluent and soil type
- Increase the area of effluent block if it is small
- Conserve feed from the effluent block
- Management of the crop, including cultivation and crop choice
- Irrigation management
- Winter management
- Riparian fencing and wetlands
- Capture urine and spread more thinly
- Reassess stocking rate
- Feeding low protein supplementary feed.

Results and implications

The results of running scenarios through a farm systems model and Overseer can be set out in graph form, as shown in the abatement curve in the graph below. It is important that in interpreting the results of this data, the changes occurring are carefully considered. The graph suggests that for this particular farm there are some changes that can be made to farm operations which will not have major financial implications but will reduce nitrogen leaching – from 34 kilograms of nitrogen per hectare each year to 25.

However, it appears to become more difficult to reduce leaching once below this point, as the model shows that any further reductions to nitrogen leaching become very expensive. This is because in its attempt to reduce more nitrogen leaching, the model has reduced stocking rate to 2.2 cows per hectare, from the original 2.8, and removed all added nitrogen from the farm system. The lowered stocking rate is now not sufficient to maintain pasture quality without feed wastage, and any further reductions to the stocking rate become even more expensive on this farm.

There are various risks associated with changing farm systems to this extent. Running a system with low stocking rates requires exceptional pasture management skills, and this needs to be developed with a considerable amount of learning for current and future generations. Income and production levels are reduced, squeezing out any ability for slackness in cost control and eliminating discretionary spending in most situations, with implications for many local businesses. Cash surpluses are already squeezed, so if milk price declines or input prices rise, there is little scope to adjust, exposing the farm to increased risk.



Nitrogen leaching abatement curve

All farms are different

On many farms there are likely to be possible improvements to the farm's nitrogen leaching which can be undertaken without large financial implications. However, there will be a point for each farm where further reducing nitrogen leaching will become very costly, as the management changes involved will cause the farm nitrogen cycle to be significantly affected.

Identifying the 'easy wins' is crucial for all farmers because the different options for reducing leaching will have very different farm management and financial implications. All farms are different and will need to be considered individually to determine how much nitrogen leaching could be reduced and what financial effects the changes will have.

Understanding the different abatement curves for a wide range of farms is essential to any analysis of the economic implications of a policy to control nitrogen leaching within a catchment. Without the insights generated by such farm systems modelling, there is a risk that a policy could be implemented which would cause unintended financial hardship for farmers and the community by requiring farmers to reach an unrealistic leaching target.

Viability concern

Unintended economic consequences of reducing nitrogen leaching on-farm would be a reduction in revenue due to less milk production and employment. Neither of these is desirable as they are the cornerstone of any regional economy. The revenue from milk allows farms to spend working expenses in the local community as well as re-invest in farm infrastructure and technologies. Less milk also means lower export earnings, but the government is aiming to increase these.

Once the farm abatement curves are constructed, it is possible to develop catchment level models to analyse the policies needed to reduce nitrogen leaching at the catchment level on an individual farm basis. Graeme Doole from the

continued on page 10>>

Ants Roberts, Mike Freeman, Ian Power, Mark Shepherd and David Wheeler

Overseer, New Zealand agriculture's principal nutrient management model

Ravensdown, Ballance Agri-Nutrients and AgResearch scientists have combined to produce the first of two articles on the nutrient management model Overseer.

A farm nutrient budget is a summary of nutrient inputs and outputs. An early application of nutrient budgets was to determine whether inputs of nutrients were inadequate relative to outputs, leading to a decline in soil nutrients. On the other hand, a nutrient budget identified if excess nutrients were being applied and accumulating above the required levels. Nutrient management plans could be developed to solve such inefficiencies, with benefits to the farm's bottom line.

The challenge is how to calculate a nutrient budget, particularly in complex farm systems. This is especially the case with pastoral systems where nutrient transfer is mediated by grazing animals. Overseer Nutrient Budgets version 6 is owned by the Ministry for Primary Industries, the Fertiliser Association and AgResearch. The software models these complexities to calculate a farm nutrient budget. It has been used for many years by the fertiliser industry to underpin fertiliser recommendations on pastoral farms.

An important component of a nutrient budget is the loss of nutrients from the farm, either as removal in products or as losses in gaseous emissions, leaching or run-off. Overseer has recently been used in a planning and regulatory context to inform and implement regional council water quality nutrient management plans and as part of industry audited self-management processes.

The objective of this article is to provide an overview of how Overseer works. The next instalment in a future issue of *Primary Industry Management* will highlight the main considerations in its use.

Overseer basic description

Overseer aims to be practical, relying on input data which is readily obtained, and aims to model most major farm systems across all regions of New Zealand. Its scope and underlying assumptions are well documented on the Overseer website.

- It can model many enterprises including dairy, sheep, beef, deer, dairy goats, fruit, vegetables and arable crops
- It models nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, sodium and hydrogen ions
- It calculates annual average nutrient budgets for systems assumed to be at 'quasi-equilibrium'
- It estimates losses of nutrients to the edge of the farm, and the bottom of the root zone, but it does not model what subsequently happens to these nutrients or the effects they might have on the environment
- It assumes that good farm management practices are implemented
- It is designed to be an expert system, and users should understand nutrient management science and farm systems and only model realistic farm systems.

What this means for the user

Quasi-equilibrium

The model assumes that inputs and farm management practices are in near equilibrium with farm production – animals grazed, products removed such as supplements, milk, live weight, wool and crop yields. Therefore it does not model a farm conversion from a sheep and beef farm to dairy farm or from conventional fertiliser to slow-release fertiliser.

Annual average

For a specified farm system, the nutrient budget is an estimate of the annual average outputs for the given climate pattern if the management system described remained in place. Overseer is not a short-term tactical model and therefore does not show within and between years short-term climatic, production or management variability.

Good practice

Generally, Overseer assumes that a range of good management practices have been, and are being, implemented. For example, if effluent is applied, it assumes that daily management follows good management practice. If fertiliser or effluent are applied, Overseer assumes the stated rate is applied evenly over the whole area indicated at the time stated, with no poor management which would result in large discharges.

Overseer does allow modelling of some poor practice, for example –

- Applying large amounts of nitrogen fertiliser in the winter or applying more than is required for the level of production
- Over-irrigating and causing extra drainage and leaching.

Losses to the edge of the farm

Overseer estimates nutrient losses from a farm, which is what leaves the root zone, flows over the soil surface beyond the farm boundary or volatilises into the atmosphere. Products, supplements or effluent imported or exported are also accounted for when they cross the farm boundary. Overseer does not model processes which may affect nutrients beyond these boundaries. Examples are dilution, dispersion, assimilation and other attenuation processes which may increase or decrease the concentration of nitrogen or phosphorus in any eventual receiving water.

Expert system

There will always be a conflict between having the model accurate and able to adequately follow complex farm

Kilograms per hectare per year	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	132	35	28	43	103	0	1
Rain/clover N fixation	107	0	2	5	3	6	32
Irrigation	0	0	0	0	0	0	0
Supplements	27	4	21	3	5	2	1
Nutrients removed							
As products	88	15	20	5	21	2	6
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	57	0	0	0	0	0	0
To water	26	1.2	17	40	63	8	19
Leaching - urine patches	20	0.0	7	0	16	0	0
Leaching - other	5	0.4	9	40	47	7	19
Runoff	0	0.9	1	0	0	0	0
Direct (animals, drains)	0	0.0	0	0	0	0	0
Direct pond discharge	0	0.0	0	0	0	0	0
Border dyke outwash	0	0.0	0	0	0	0	0
Septic tank outflow	0	0.0	0	0	0	0	0
Change in farm pools							
Standing plant material	0	0	0	0	0	0	0
Organic pool	94	12	3	5	1	0	0
Inorganic mineral	0	3	-21	0	-2	-3	-3
Inorganic soil pool	0	7	34	0	28	2	12

Expanded nutrient budget report for a flat South Island dairy farm

systems, and the desire for one which is easy to use. To obtain meaningful results, Overseer should be used by trained and qualified people following generally accepted practices and with a sound knowledge of New Zealand farm systems.

How does Overseer calculate a nutrient budget?

The example nutrient budget in the table on the previous page shows the results of the calculations, reporting sources of nutrient inputs, estimated removals in produce, exported manures and losses as well as changes to nutrient stocks in the soil. These calculations can be reported for an individual management block or at the whole-farm level – area-weighted average of the blocks along with non-block losses such as those from effluent storage.

As an example of nutrient movement around the farm, fertiliser nutrients applied and taken up by the pasture in one part of the farm will be consumed by the grazing animal and could be transferred to another part of the farm. That animal is either moved and excretes in another paddock, or if excretion occurs in the farm dairy or feed pad, it will be obtained as effluent and spread on to a farm block or exported off the farm.

In terms of pastoral agriculture, the central model is not based on pasture growth or soil fertility but is an animal intake model. It calculates the energy requirements of the block or farm based on the livestock information of milk production, management, stock numbers and classes provided by the user.

With this information, along with an energy calculation from any supplementary or crop feed used, the model then estimates the amount of pasture dry matter, taking into account pasture quality that must have been consumed. It also considers how much has been grown, by using default data.

Combination of models

Nutrient intake by the herd is calculated from the dry matter intake and estimates of nutrient content of pasture and feeds from Overseer databases. Estimates of nutrients removed in products allow calculation of excreted nutrients and their division between faeces and urine. In addition to this, other data is required to describe the farm system so that the model can estimate how much nutrient is deposited directly back to paddocks and how much is obtained as effluent.

The modelling of the nutrient transfers is about estimating how much nutrient is deposited, as well as when and where. A range of nutrient sub-models are then applied to this information to estimate the fate of those nutrients.

Overseer is a combination of sub-models, many of which have been published and peer reviewed. Most are adaptations of published models such as hydrology, animal metabolism, soil nutrient and phosphorus run-off, but some are specific to Overseer such as for nitrogen leaching and arable crops.

The innovation around Overseer is all about –

- Obtaining nutrient transfers at the farm scale
- How these individual small-scale models are combined to be able to scale up to a block or farm
- The development of databases, such as climate and temporal variation in pasture nutrient content, which underpin the model
- The development of ways of dealing with challenging topics such as nutrient deposition in laneways and hard surfaces where published information is generally lacking.

Nitrogen as an example

The nutrient budget report table shows that Overseer calculates nitrogen inputs from fertiliser at 132 kilograms of nitrogen per hectare and imported feed supplements at 27 kilograms of nitrogen per hectare. It estimates that 107 kilograms of nitrogen per hectare come mainly from biological nitrogen fixation in clover. Based on production data entered by the user, it therefore estimates a removal of 88 kilograms of nitrogen per hectare in milk production.

Overseer would have estimated nitrogen excretion and partitioning of nitrogen between directly voided urine and faeces and that retained and spread as effluent. Therefore it has calculated how much, where, when and in what form nitrogen has been deposited. Sub-models are then applied to these sources to estimate losses.

The result is a total estimated loss of nitrogen of 83 kilograms of nitrogen per hectare, with about two-thirds in gaseous form as ammonia, nitrogen gas and nitrous oxide. The example in the table is typical of most grazed pastoral systems where the greatest proportion of nitrogen lost by leaching is from urine deposition.

Leaching risk increases with decreasing soil available water capacity, less nutrient retentive soil, and increasing drainage. For example, with two soils, one with an available water capacity of 120 mm and one with 40 mm, along with 160 mm of drainage, the soil with the higher available water capacity will only be flushed 1.3 times compared to four times for the soil with the low available water capacity. This increase in flushing will raise the proportion of total nitrogen leached. Given the sensitivity of nitrogen leaching estimates to this soil property and drainage, it emphasises the need for the user to use accurate information for these variables.

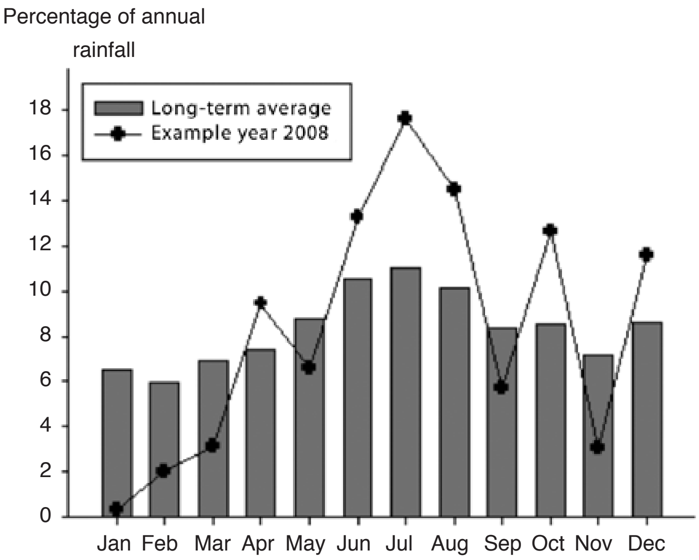
Soil available water capacity

Overseer has a database of soil properties provided by Landcare Research. Selecting soil series, soil order or soil group invokes default soil properties, including available water capacity, from the database. These can be further modified by selecting a soil depth and the nature of the subsoil.

Selecting the correct soil type representative of the block is vital. This becomes even more important on shallow soils where small changes in estimated available water capacity can have a big influence on nitrogen leaching estimates. As a result, guidelines for defining shallow soils in the Canterbury region have been developed and a soil map integration facility is being developed.

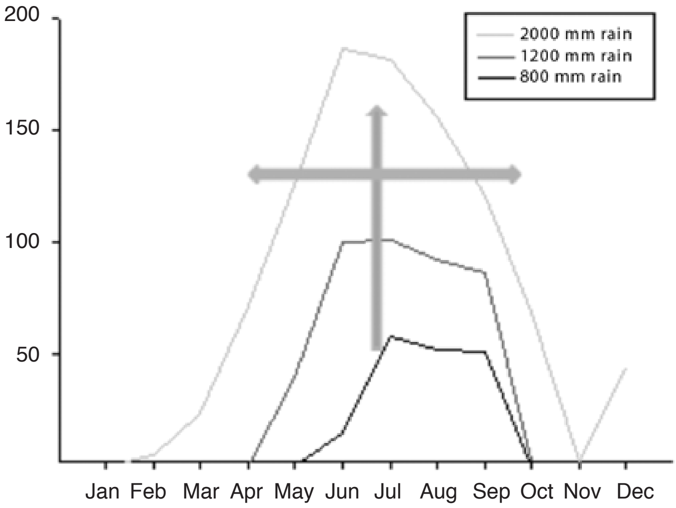
Drainage

Drainage is estimated by Overseer using a hydrology model developed by the NIWA and AgResearch scientists. Overseer needs an annual rainfall input. The model then uses a set of typical average regional distributions of that rainfall to calculate daily rainfall in a normal year. The drainage model is then applied to this daily distribution. The difference between long-term average rainfall and an individual year is illustrated below.



Difference between the distribution of long-term average rainfall and individual years in Waikato

The typical average year rainfall patterns result in calculated drainage peaks in the winter months, making urine deposited in autumn and early winter most susceptible to leaching. As rainfall increases the estimate of nitrogen loss increases because total drainage is higher and there is an increase in the number of months in which drainage occurs.



The effect of annual rainfall on monthly drainage

Irrigation

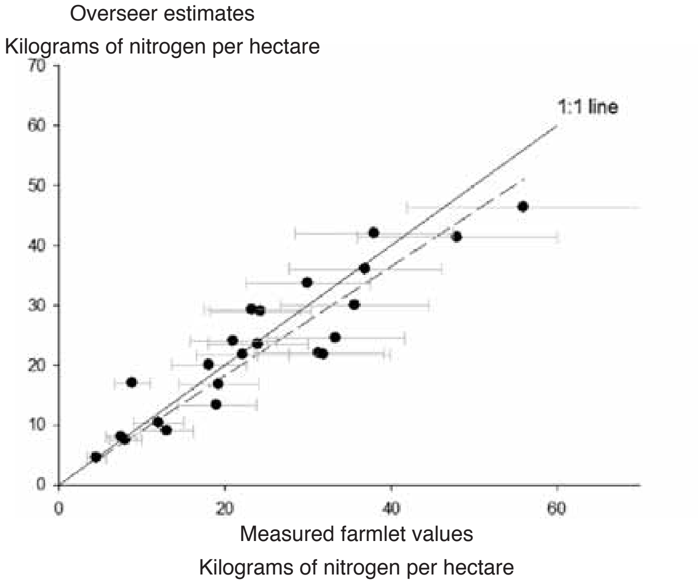
Where irrigation is used it increases the amount of water added to the soil and can result in more drainage. This is due to inefficiencies in the irrigation procedures and to the soil profile being wetter, especially on the shoulders of the drainage season. It is likely to result in higher nitrogen loss estimates than would occur in the same situation without irrigation.

If a specific irrigation amount is entered into Overseer, this should match the entered annual rainfall. A technical note which describes this problem and potential solutions is available on the Overseer website.

Model comparisons

Overseer is a mathematical representation of complex biophysical management systems and may not always accurately reflect what actually occurs. However, the outputs are the best currently available estimates because the model has considered nutrient movements over the whole farm and is constructed with the best available scientific information. There has been a series of regular updates to keep pace with evolving farm systems, user requirements and new science.

Overseer estimates of nitrogen leaching have been compared with measured nitrogen leaching data from dairy farmlet studies in the Waikato, Manawatu and Southland where annual rainfall has been less than 1400 mm, and less than 200 kilograms of nitrogen per hectare has been applied annually as fertiliser. At the lower end of the nitrogen loss range, less than 60 kilograms of nitrogen per hectare, the correlation between measured and Overseer nitrogen leaching estimates is very good for a biological model.



Measured nitrogen loss data for farmlets and Overseer modelled nitrogen loss estimates

Many of the individual model components have been independently reviewed. The ultimate challenge is the current inability to validate the end result for whole farm nitrogen leaching. Even with the farmlet trials, validation has been undertaken at the block level. It is currently impracticable to validate at a farm scale because it is not feasible to measure nutrient losses at the whole farm scale.

Cropping

Much of this article has focused on pastoral farms. Many of the points raised about use, interpretation and validation are equally applicable to the other enterprise models within Overseer, as testified by the recent Foundation for Arable Research review of the cropping model. The review concluded that the current model '… is the best tool currently available for estimating nitrogen leaching losses from the root zone across the diversity and complexity of farming systems in New Zealand', but found that there were areas that needed addressing to improve its utility for arable and vegetable system use.

The review also concluded that the simplifications used in the arable and vegetable models are consistent with the approach taken in modelling pastoral systems within Overseer, but contrast with those taken in other crop soil interaction models. It also found that Overseer needs further testing and validation under cropping systems and the user interface needs more development to deal with complex crop rotations.

Accuracy of a measurement is how close that measurement is to the true value, and error is the level of disagreement between a measured value and the true or value. This concept has limited applicability to the estimate of whole-farm nutrient loss where it is not practicable to measure this directly.

Uncertainty in the context of a model such as Overseer can be defined as the combination of uncertainty from the modelling process and uncertainty from incomplete knowledge. This concept is most applicable to its use given that the number of assumptions and errors in sub-models produce a level of uncertainty about the estimate of nutrient losses. It is not currently possible or appropriate to specify a generally applicable uncertainty for Overseer nutrient loss estimates.

Conclusion

Overseer is the best available method to construct an annual nutrient budget, using readily available information and the best available science to obtain the complex information from many New Zealand farm systems. It is based on a considerable body of publicly available scientific research and investigations.

Overseer is a robust method of testing different input and management strategies to provide information on the implications that these changes would have on nutrient cycling and nutrient losses. Appropriate application needs a thorough understanding of farm systems in general, as well as the individual farm system being modelled, training in its use, and the application of generally agreed practices for input variable choices.

>> **Economic assessment of reducing on-farm nutrient leaching** continued from page 5

University of Waikato has constructed these catchment scale models in the work which DairyNZ has been involved with in Canterbury and the Waikato. These allow the modeller to investigate different levels of reductions in catchment nitrogen load, and also different allocations of nitrogen discharge allowances.

One particular study showed that the allocation mechanism used in the initial distribution of nitrogen discharge allowances can have serious implications for dairy farm viability. The further the initial allocation moved from the status quo, the higher the initial social and economic disruption caused by the policy. This conclusion was reached even when allowing trading of nitrogen discharge allowances, without which the effect of the different allocation mechanisms would become much more pronounced.

This evidence provides an argument for recognition of the existing land use in the initial allowance. Policies that do not consider existing capital invested and land use, such as equal allocation or the land use capability mechanism, can have unintended consequences. These mechanisms effectively ignore the abatement curve concept. They consider the benefits of the policy of receiving a nitrogen discharge allowance without regard for the costs of making the required reductions in nitrogen leaching.

Conclusion

Catchment nutrient load limits will become common around New Zealand as councils work through changes to regional plans which address water quality problems. As a result, we will see increasing emphasis on managing agricultural nutrient losses, with reductions required in over-allocated catchments. This will require smart solutions on the farm as the options available are limited without substantial changes to the production system or large amounts of capital investment.

Some small reductions can be gained by focusing on improving on-farm efficiency, but to make larger gains it is probable that a farm will be required to adjust the system they are operating. However, in many cases, either the cost of doing this is too high or the loss in milk production will have significant consequences for the farm, the industry and the regional economy.

Each farm is unique and what may be viable for one farm may not be for another. Farm system models such as Farmax Dairy Pro and the Grazing Systems Limited, in combination with Overseer, can be used to determine what these on-farm effects might be. An abatement curve may aid the interpretation of expected effects and can feed into catchment level modelling.

Matthew Newman and Sam Howard are DairyNZ Economists based in Hamilton.

Peter Taylor

Nutrient management within Horizon's region

Nutrients on the farm can be contaminants in waterways off the farm. Nitrogen and phosphorus help grow grass, crops and vegetables on the land and algae in the water. This algae takes on various forms – black, brown, green, yellow, short and long – with some types benign and others toxic. When excessive growth blankets rivers and streambeds, a significant diversity of aquatic insect species is replaced, mainly with snails.

The respiratory nature of algae can trigger large fluctuations in levels of dissolved oxygen. This can be debilitating to fish life, but can also alter the pH of the water, causing ammonia toxicity resulting in sub-lethal and lethal effects on fish. For swimmers and fishers, excessive growths ruin the pleasure of those pursuits.

In general, nitrogen and phosphorus have different pathways from land to water. Nitrogen mainly travels through the soil profile and phosphorus across or with the soil. This means understanding the sources of nutrient dictates actions to prevent or minimise their access to water. For example, fencing streams to exclude stock with sufficient buffer of ungrazed pasture to trap sediment, and therefore phosphorus, will prevent phosphorus entering the water.

Applying farm dairy effluent at amounts less than the soil moisture deficit will prevent run-off, and all things being equal, allow the uptake of nitrogen by the pasture so it does not leach into groundwater and eventually to streams and rivers. Similarly, following the Code of Practice for Nutrient Management will minimise losses of valuable fertiliser applications of nitrogen and phosphorus. Managing or controlling these sources of nutrients is relatively simple – not so nitrogen deposited to land in cow urine.

Horizon's One Plan

Cow urine contains the equivalent of 800 to 1,000 kilograms of nitrogen per hectare and is the major source of nitrogen to a farm. In contrast, farmers usually apply only 50 to 200 kilograms a year of artificial nitrogen to a dairy farm to boost pasture growth. It is this challenge which has redirected the specific focus of regulation for dairy farms to whole farm nutrient cycling and nutrient loss to the water consent.

The rule, known as Rule 13-1, aims to control contaminant loss from the land. It applies to the intensive farming activities of dairying, commercial vegetable growing, cropping, sheep and beef when under irrigation. For intensive uses which already exist it involves nine target catchments out of 44 where water quality is degraded, and to conversions of any of those activities anywhere in the region.

The contaminants are nitrogen, phosphorus, sediment and faecal bacteria. There has understandably been greater attention given to nitrogen because the One Plan contains targets of numeric values of nitrogen leached per hectare per year. As noted, nitrogen leached via the urine spot is the most challenging and potentially the most costly to reduce and manage. It requires a significant change in farm management thinking and planning. Different farm practices contribute differing amounts of nitrogen leached at different times of the year.

For example –
- Using imported pasture silage will result in a higher nitrogen leaching than the equivalent energy contained in imported maize silage
- Winter applications of artificial nitrogen will leach more than summer applications
- Winter fodder cropping will leach more than summer fodder cropping.

Overseer for nutrient budgeting

Leaching is not measured on each farm but is modelled using the Overseer nutrient budgeting software. This takes into account all inputs for a farm and estimates various outputs, of which nitrogen leached to water is one. This model has been developed progressively over a number of years by the Ministry for Primary Industries, the NZ Fertiliser Manufacturers Association and AgResearch.

While Overseer estimates the amount of nitrogen and phosphorus leached or lost from a farm, it does not comment on whether the amount is environmentally acceptable or not. It will indicate whether phosphorus loss is low, medium or high and if nitrates in the drainage water risk breaching the World Health Organisation standard for nitrate in drinking water.

However, an environmentally acceptable loss of nitrogen from a farm is modelled separately and then monitored using Overseer. It includes several factors such as the nature of a catchment, its values, types of land use and their prevalence, and presence or absence of municipal waste water and industrial discharges. The river itself also has some bearing as its flow regime, background levels of nutrients and river substrate all factor in the assessment.

Natural capital

The modelling takes into account current estimated nitrogen loads and the desired concentrations in the river to safeguard identified values. Then there is the method for allocating an allowable nitrogen loss from the land and these can vary around New Zealand. The method chosen to be applied within the Horizons region is based on the natural capital potential of the land. This was defined by the Parliamentary Commissioner for the Environment in 2004 as 'The renewable and non-renewable stocks of natural resources that support life and enable all social and economic activities to take place. It includes rivers, lakes and aquifers, soil, minerals, biodiversity and the earth's atmosphere'.

The principle is then expanded to understanding that the soil with high natural capital requires fewer inputs and has less of a footprint. Therefore, for the same level of production, nitrogen leaching will be higher on soils with less natural capital.

Horizons has accepted a working interpretation of natural capital as the ability of the soil to sustain a legume-based pasture fixing nitrogen biologically under optimum management and before the introduction of additional technologies. This in turn is based on the understanding that legume-based pasture is a self-regulating biological system with an upper limit on the amount of nitrogen that can be fixed, retained, cycled and made available for plant growth. This understanding is further enhanced by acknowledging that it is the introduction of technologies, including irrigation, drainage, nitrogen fertiliser, wintering pads, off-farm grazing and imported feeds that have the potential to lift pasture and livestock production levels significantly above the inherent productive capacity of a basic legume-based pasture system.

Land Use Capability

Accepting the natural capital principle to allocate nitrogen leached, led to the adoption of the Land Use Capability system as the method to assess what each farm is allowed to leach. Land Use Capability, or LUC as it is usually known, is a ranking of the land from best at Class 1, to worst Class 8, in respect of its capability for long-term sustained agricultural production.

Progressively, from Class 1 to Class 8, the limitations to use increase, and the land's capability to support a range of arable production decreases. Four types of limitation, or hazards to use, are identified – erodibility, climate, the soil's rooting zone limitations, and excessive wetness. As the underlying productive capacity and ability of the soil to sustain a legume-based pasture system declines due to the increasing limitations, so does the potential for nitrogen to leach.

The strengths of the use of natural capital and land use capability as an allocation method against others is that the allocation is linked to the underlying land resources in the catchment, and is unrelated to current or future land use. This is an important point. The allocation method allows for

innovation by not constraining the future use of the land to its current use. For example, a sheep and beef farm can convert to dairy, and while it will need to meet a nitrogen leaching limit, it is not restricted to its current leaching.

In addition, it does not reward farms with existing high leaching as the grand-parenting method does. Grand-parenting is where a farm's nitrogen leaching allowance is capped on its immediate past, generally an average of three to five years.

To summarise, Horizon's natural capital and land use capability is the acknowledgement that a legume-based pasture system is self-regulated where the nitrogen leaching loss is reflective of the soil's inherent biophysical attributes and local climate. It acknowledges that introduced technologies such as imported feeds, off-farm grazing, irrigation and artificial nitrogen remove the soil and climate limitations, boosting farm productivity regardless of the soil's underlying productive capacity and ability to assimilate nutrients. Ultimately, in the face of continuing farm productivity gains, the environmental effect will also grow unless constraints are considered. That is, our success in developing production technologies to overcome production constraints has created an environmental problem.

River problem

The land use capability based nitrogen loss rates translate to a problem in the rivers. Several policy options for the allocation of nitrogen, proposed by submitters to the Environment Court, were modelled for the court by Horizons with respect to their effectiveness in achieving the desired result. The court accepted the land use capability based approach.

How it works in practice is that a farm's soils and land use capability composition is mapped, and a weighted average of nitrogen leached per hectare per year calculated. This calculation is based on One Plan's table 13.2, which assigns a certain amount of nitrogen leaching allowed to each land use capability class. These amounts reduce as the class progresses from Class 1 to Class 8 and over time.

For example, the nitrogen leaching allowance for land use capability Class 1 for year one is 30 kilograms of nitrogen per hectare per year, reducing to 25 kilograms of nitrogen per hectare per year at year 20. For land use capability Class 6, it is 15 kilograms per hectare per year at year one, reducing to 10 kilograms per hectare per year at year 20.

Nutrient management plan

This information is provided to Horizons Regional Council in a nutrient management plan, which in essence is a resource inventory of the farm. The plan contains a physical and operational description of the farm including maps showing farm paddock layout, farm features such as bores, sheds, ponds, wetlands, bush blocks, streams, soils, land use capability and nutrient management blocks as used in Overseer.

Effluent and sediment management is calculated, along with water use. Nitrogen leaching allowances are also calculated and where these can be achieved a long-term consent of 20 to 25 years is granted. A farm does not have to achieve the year 20 allowance at year one as it has 20 years to progress to that number. Where the nitrogen leaching allowances cannot be achieved, and a trajectory of reduction is agreed with the applicant, a medium-term consent of 15 to 20 years is granted.

Where a trajectory of reduction is possible, but not agreed to by the applicant, a short-term consent of three to five years is granted and it is expected that, upon re-application, a trajectory of reduction has been developed and agreed to. A trajectory of reduction is worked out using Overseer, testing which farm practices allow the best gain. However, a wider view of the farm and its performance might be the best approach for some farms.

Future options

There are potentially three broad aspects which can be contemplated for reducing nitrogen leaching –

- Exploring options within an existing farm system
- Considering farm system modification
- Options for land use change.

There is therefore the need to develop awareness for the farm of the options available. You should obtain good advice, and capitalise on the most useful ways to make the optimum decisions, aligning the farm's aims with its best economic and environmental performance.

Running an efficient effluent system on a dairy farm provides an example of where nutrient management could be mutually beneficial. Using the nutrients in the effluent for pasture and crop growth saves on fertiliser. Managed well it has the potential to almost eliminate nitrate and phosphate loss from the effluent to water. Other good management practices are also gaining recognition on the farm. Well-planned cultivation and paddock contouring practices on any farm reduce sediment getting to the water and importantly, keep that natural capital on the land where it does what it does best.

Similarly, well-timed pasture and crop irrigation with the right amounts can minimise drainage below the plant root zone, which is wasting expensive and precious water and removing nitrogen with it. Last but not least, stock exclusion from waterways, where very good progress has been made, has an immediate and significant effect on lessening sediment and faecal bacteria contamination of water.

Promising prognosis

The nutrient management provisions of the One Plan, particularly on nitrogen leaching, have attracted a reasonable amount of debate over the last few years. Often forgotten are other provisions in it to improve and maintain water quality throughout the region. The effort is not just on some farming activities in a few catchments. There is a major programme of sewage treatment plant upgrades and a continuing commitment to riparian fencing and native fish habitat protection. In combination, and with a shared responsibility, the prognosis is very promising.

Peter Taylor is Manager Rural Advice, Horizons Regional Council, based in Palmerston North.

Jacqueline Rowarth and Doug Edmeades

The value of models in agriculture

Data models have been used in agriculture for many years and have fulfilled various objectives and functions. The value of models can be high as long as the type of the model is appropriate for its subsequent use. John Thornley has identified nine different points of value for models. They can –

- Be used to provide a convenient data summary
- Make good use of quantitative data which is expensive to obtain
- Reduce the requirement for expensive experimentation
- Allow predictions
- Explore possible futures and results
- Enable integration of existing knowledge
- Enable understanding of factor interactions by allowing insight
- Help with identifying areas where information is lacking
- Enable assessment of priorities for research or action.

Achieving these points of value depends on the type of model used, such as those listed below.

Deterministic Used to make definite predictions, for example dry matter or animal intake without any probability distribution

Stochastic This includes random elements so that predictions have a distribution, and this type of model is difficult to construct and to test or falsify

Dynamic Predicts how quantities vary with time, common in agriculture

Static Prediction of a factor at a point in time, for example harvest or slaughter weight

Empirical Describes responses of a system at a single level, and these models are often constructed using mathematical equations without scientifically-generated data and are unconstrained by any scientific principles

Mechanistic Enables understanding or explanation of the phenomena being modelled and requires at least two levels of description, such as organ and plant. This means that there is a causal relationship between the quantities and mechanisms or processes at the lower level, and the phenomena predicted at the higher level, such as photosynthesis and plant growth. At higher levels the constraints impinging on the value below can be identified.

In a mechanistic model, the mathematical equations describing the lower order processes can be regarded as empirical. They might or might not have scientifically generated data. The concept behind this type of model is the way a system works, what the important elements are, and how they relate to each other.

The Hurley pasture model

The Hurley pasture model is a mechanistic model based on scientifically generated data. It is research-oriented and is allowing exploration of future scenarios such as the balance between food production, and nitrogen and carbon cycling. It also allows explanations of phenomena recorded. An example of this is Louis Schipper's University of Waikato, paper reporting 'unexpected and contrary changes of C and N in different pasture systems, suggesting the need for [more] data ….'.

His results can be explained using the Hurley pasture model. The observations he makes are from results of a survey of changes in soil carbon and nitrogen under different historic management over 17 to 30 years of significant decrease in soil carbon, and therefore organic matter, under dairying in contrast to drystock systems.

Tony Parsons has used the Hurley pasture model to explain that the increase in nitrogen inputs to pastures in areas of sustained dairy production or, where there has been a switch to dairy production, has not been sufficient to sustain soil carbon and soil nitrogen. The model also explains that the global requirement of increased food production and decreased loss of nitrogen will, by necessity, involve a reduction in soil carbon.

What the model does make clear however, is that at a given nitrogen input rate, the sustainable rate of nitrogen loss is lower in high food production, such as dairy, than in low food production, such as drystock, due to the offtake of nitrogen in food products. Process-based models can be used to find the optimum trade-off, and the best land-use management for grazed systems, for multiple aims. This allows consideration of how alternative agricultural systems compare with conventional intensive ones.

Overseer in development

Overseer is a mixed model incorporating aspects which are both mechanistic and empirical. It has been described as 'an on-farm decision support model to help users develop nutrient budgets for nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), magnesium (Mg), sodium (Na) and hydrogen (H – potential acidity) on a block and farm scale'.

In the 1980s the Ministry of Agriculture and Fisheries developed a maintenance fertiliser recommendation method. Ian Cornforth and Alan Sinclair were the scientists involved and the Computerised Fertiliser Advisory Scheme was a static model. This evolved into Outlook, an econometric approach, and some aspects were then used to create Overseer. Nitrogen aspects were new to Overseer, the farm nutrient budgeting model accounting for nutrient flows in crop and pastoral systems.

The pasture model is based on animal intake, not pasture growth or soil fertility. The model calculates the energy requirements of the livestock on the unit under consideration based on milk production, stock numbers, stock classes and management provided by the user. This information, in addition to an energy calculation for supplements, is used to estimate the amount of pasture dry matter, taking into account pasture quality which must have been consumed, and then grown after pasture use is entered.

The model relies very much for accuracy and usefulness on the data entered. When data for a specific farm is not available, default figures are used. Long-term averages are also employed so that variation between years in nutrient flows and losses as affected by climate variability, for example, are involved. A considerable number of papers involving David Wheeler, Ants Roberts, Stuart Ledgard and Mark Shepherd explain its workings, and have recently been summarised by Diane Selbie as lead author for a paper at the New Zealand Grassland Association conference.

Latest version

Overseer Version 6 released last year includes effects of drainage and soil type on nitrogen leaching, as well as the use of DCD. The model has also been split into urine and non-urine sub-models. The urine model is new and is based on monthly deposition of urine, a monthly calculation step, and a modelled nitrogen load per urine patch of 700 kilograms of nitrogen per hectare. The background model integrates fertiliser, effluent and other non-urine sources of nitrogen.

Some consequences for the revised model are already apparent, in particular that in shallow soils and high rainfall, losses appear to have increased. In addition, because there is now a background and a urine model for leaching losses, late season applications of effluent are compounding losses from urine patches in the new model. Losses from effluent blocks can be larger than with previous versions and the effects of winter-applied nitrogen are larger than with these versions.

This has been highlighted by an exercise to look at the sensitivity of the Overseer nutrient model to input data for the Lincoln University dairy farm. The potential variation between versions of the model was found to be 55 kilograms of nitrogen per hectare per year. However, it is important to understand that the new version of Overseer does not mean that nitrogen losses are increasing, but just that the predictions have changed and might now be more accurate.

Overseer in operation

Overseer can be used to demonstrate the effect of a change in management, inputs or mitigations on nitrogen loss from a farm or block. Its usefulness depends upon the quality and accuracy of data entered. Overseer is subject to type A and type B errors. Type A errors arise from using poor data which is inaccurate or incorrect, such as soil type, clover content or pasture development.

Errors also occur because not all the necessary information is known at the paddock and farm scale, and because the mathematical models within Overseer have not been tested in all possible situations across New Zealand. Type A errors can be summed up as rubbish in, rubbish out. This is an extremely important point and means that farmers will be required to keep accurate records of nutrient use, including supplementary feeding and stock grazed where for how long, as part of their nutrient management plan.

Type B errors arise from variability to do with seasonal and annual variation, such as the timing and intensity of rainfall and how this affects nitrogen leaching. Overseer works on long-term average nitrogen leached, based on the average rainfall for the average soil type and texture calls. Type B errors in soil nutrient measurements are plus or minus 20 to 25 per cent. This means that for the the Lincoln University dairy farm, a loss of 55 kilograms of nitrogen per hectare could be a loss of 41 to 69 kilograms of nitrogen per hectare. Total variability is the sum of type A and B errors. If type A errors are added, the magnitude of the potential range increases.

Helps understanding

Although Overseer has been used by regional councils to set limits on nitrogen loss, it is important to recognise that the model estimates nitrogen loss for the rooting zone, not what enters waterways. It is also important to recognise that the alternative could be restrictions on nitrogen inputs.

As part of the 2013 Sustainable Dairying: Water Accord dairy farmers are working on five main areas – riparian management, nutrient management, effluent management, water use management and conversions. The nutrient management involves a nationwide system of management and support, which translates to increased use of Overseer.

Overseer is important and useful, and understanding how it works helps in using it sensibly. Its best use is in calculating the effect of different mitigation options with the farmer being free to choose the farm management options which best suit the farming system under consideration. This is part of the nutrient management plan which is being advocated in the accord, the principles of which are likely to be applied to be applied to sheep and beef farms in the future.

To help with adoption, regional councils need water quality data as a benchmark and to be able to show farmers how extra nitrogen, for example, could have an effect. Development of a nutrient management plan could then evolve cooperatively using independent experts who have expertise in nutrient management.

Sustainability

Overseer might be one of the methods used to examine the effect of changing stocking rate, reducing fertiliser inputs or using a feed pad. This would allow a focus on a qualitative reduction of nitrogen loss rather than on a quantitative reduction. In this way the type B errors inherent in field measurements, and therefore inherent in Overseer, are not compounded in the nutrient management plan developed.

Once best options are identified for nitrogen loss, a cost-benefit analysis can be used to identify the economic effect and which options are affordable. In this way some attempt at meeting the five components of sustainability agreed upon by the soil science community can be met –

- Maintain and enhance productivity
- Decrease risks to production
- Protect the potential of natural resources and prevent degradation of soil and water quality
- Be economically viable
- Be socially acceptable.

The next step would be for the chosen nutrient management plan to be accepted by the regional council. As a contract it could be audited, and the region would be assessed on the basis of the water quality benchmark.

It is generally known that part of the problems for the regional councils are the consented nutrient discharges from sources such as city sewerage plants and factories. Farmers assist in making the case for least input and loss per unit of milk and meat production. This concept was put forward at the Fertiliser and Lime conference at Massey University in 2008 by Russ Tillman, but has yet to gain traction.

Measuring and recording allows management and justification. In a reasonable world this provides time for change to be negotiated, but the main point is accurate measurement. This has been at least partly successful in the Horizons region, but a considerable amount of emotion was involved before some decisions were made. Part of the emotion reflected uncertainty because of a lack of a clear decision-making process.

John Monaghan, talking at the South Island Dairy Event, suggested that the Horizons' approach in the Waikato would result in milk production being cut by between 10 and 30 per cent, along with closure of milk plants. Collaborative decision-making is very important and measurement means understanding, always remembering that Overseer is a better method than the alternative of input restriction because it gives farmers choice in manipulating their farming systems.

Models in the future

To increase confidence in any model, the levels at which it was developed and the purpose for which it was constructed should be remembered. Experimental validation is important, but constructing a model based on data and then using a subset of the data for validation is of limited use, particularly when predictions of effects are being made.

For biological models involving the soil, increased understanding is needed of the underlying processes which cause problems such as nitrification and leaching. To study these processes and gain insights, data must be collected in situations where factors such as temperature can be controlled. This research cannot be done at field scale because of imperfect control and expense. Significant replication would be needed to cover the variation that a controlled study can reduce cheaply.

Information gathered from a controlled experiment can be assembled into process-based models, which can then be used to identify critical field experiments for validation. Unfortunately, New Zealand has few facilities of the type required. Increased investment in scientific research of facilities and people is required to ensure that critical research can be carried out. The alternative could be inappropriate regulation being imposed, with implications for economic viability on-farm and unintended restrictions for New Zealand's economic development.

Whatever future is envisaged for agriculture it is clear that more accountability, involving more measurements and reporting, will be part of it. Collaboration and agreement earlier, rather than legislation later, must be the aim. The role of the independent professional is therefore likely to become increasingly important.

Jaqueline Rowarth is Professor of Agribusiness at the Waikato Management School, University of Waikato. Doug Edmeades is Managing Director of agKnowledge Ltd based in Hamilton.

Jaime Thomson

Encouraging students into the primary sector

New Zealand sits in an interesting position. It has a reputation as a world-leading, innovative food producer and has around 60 per cent of its export wealth coming from the primary sector. As such, you could be forgiven for assuming that a fairly typical secondary school student, when considering options for tertiary study, would be attuned to the scientific and commercial opportunities which fall out of the nation's largest industry.

However, New Zealand is also a highly urbanised society. According to the 2001 census, 86 per cent of the country's total population were living in urban centres and a large proportion of these in Auckland. When it comes to population distribution this country is therefore highly urbanised and top heavy.

We can put part of New Zealand's heavily skewed demographic shift from rural to urban down to the efficiencies and innovations which make our primary sector so competitive, features which have eased the demand for labour on the land. However, such a change need not imply that the current urban to rural ratio is conducive to ensuring that this sector is will be supplied by the annual pool of university graduates. Between them, Lincoln and Massey Universities may only be turning out about a third of the graduates in land-based science and commerce programmes required by the primary industry.

Disconnection with agriculture

Lincoln's student liaison team travels the country promoting the academic and vocational programmes at career expos and school career evenings. They can provide anecdotal evidence which suggests a growing unfamiliarity with the primary sector disconnected from the word agriculture. This can be partially attributed to New Zealand's more urbanised population.

It is not uncommon at career events in Auckland for a parent to ask the student liaison officer if they had 'come all the way from Wellington for this'. Alternatively a parent may scarcely even have heard of Lincoln University enough to locate it, such is the dominating presence of the large Auckland universities or technical institutes in the minds of local students and parents.

That is just farming

It is also not uncommon at career events for students or parents to pass by the Lincoln University stand and be heard to exclaim among themselves – 'that's just farming'. It is concerning that a tertiary institution, which has for more than 130 years provided programmes clearly aligned to the main commercial interests of this country, should suffer from such dismissive or uninformed comments. If this is indicative of the wider urban student market, then it has the very real possibility of being commercially detrimental, and is of concern for the primary sector's success in the future. New Zealand's competitive advantage relies on a healthy pool of the best and brightest choosing a land-based tertiary qualification.

The 'that's just farming' comment can be interpreted two ways, with each alluding to a worrying ignorance that has possibly developed within the general urban population. One interpretation, that Lincoln University only teaches farming, is obviously false. Yet perhaps underlying such a comment is either a mainly forgivable unawareness on the part of the individual about the full range of programmes on offer at Lincoln, or a more serious lack of awareness of the broader reach of what constitutes the primary sector. The primary industry is not just farming. It incorporates the vital fields of commercially relevant research such as plant science, animal science, soil science, food science, bioprotection and biosecurity, supply chain management, economics, finance and environmental management.

The other interpretation of 'that's just farming' may simply imply a lack of awareness of what managing a 21st century farm actually entails and what it takes to be a successful farmer. A farm is a multi-faceted complex business requiring the farmer to have a broad range of skills and knowledge in business and applied science, as well as the astuteness to bring these together in a commercially viable way.

The reality of farming speaks of a more complex business management than that of a florist or small cafe. Under this interpretation, just farming misses the point entirely and implies a more urban conceptualisation of what a business actually looks like.

Untapped student number potential

The lack of awareness in the urban sector to just what the primary sector entails, and the educational and career opportunities it can offer, could be viewed positively. It implies there is still plenty of untapped potential to service the graduate demands of the primary industry. However, the low numbers of students choosing land-based educational programmes relative to the industry's size, instead of qualifications which are deemed more fashionable or of higher status, has reached a point that should no longer be dismissed as an interesting quirk of the education market.

With New Zealand's primary production expertise required on a global scale more than ever, the lack of interest in land-based educational programmes in science and commerce is now a matter for serious consideration. To put this in perspective, last year less than one per cent of all university graduates across all eight universities were trained in an agricultural or horticultural-based qualification. Not only is this New Zealand's number one industry, it is the industry which complements the country's sizeable service sector.

Dr Andrew West, Vice-Chancellor of Lincoln University, suggested during his presentation at the NZIPIM conference this year, that it is an industry with tremendous reach and enormous potential for making an even greater contribution to the nation's commercial standing, even with a modest increase in investment in skills, research and development. Unless New Zealand starts drilling for oil, he suggested that no other industry can or will come close to the kind of growth that the primary sector can offer, no matter how much others may speak of new knowledge economy start-up ventures. When it comes to investment required relative to the gains to be had, primary industry is undoubtedly this country's most attractive proposition for global influence and commercial success, especially as its foundation is already firmly established.

Global value of land-based education

If the primary sector is to attract the desired quantity of high calibre candidates which it needs across all facets of the industry, then it may need to take a more comprehensive and persuasive approach than just stating the career opportunities available. Rather than merely pointing to a qualification and declaring that this could lead to job, we may need to consider using language about real causes that the primary sector can make some claim to.

This includes explicitly stating the tangible and meaningful effects that students with a land-based education can make to the challenges of a world under pressure from a global population which is growing exponentially. In so doing, it is hoped that a greater portion of the urban student market and their influencers, such as career advisors, teachers and parents, can become aware of the the global value and relevance of a land-based education.

Encouraging urban students

In case this begins to seem like an urban beat-up, some students from the larger towns and cities do have a very good understanding of the relevance and scope of the primary sector. Even in these cases, however, many are reluctant to enter into, perhaps a bachelor of commerce agriculture or a bachelor of agricultural science degreee, thinking that their urban upbringing has denied them the experience or foundational understanding they assume they need to succeed in these programmes.

These students worry that they would be on the academic back foot from the start. This is another hurdle that institutions promoting primary sector education need to overcome if the industry is to attract the much-needed student numbers. Lincoln does get students from larger cities enrolling in land-based programmes such as the bachelor of agricultural science or diploma in agriculture. But they often have a family member, perhaps an uncle and aunt, with a farm who they would visit during the school holidays. The disconnection with the word agriculture has therefore already been bridged. Such students feel less alienated from the rural world, as some of their urban contemporaries do, and they have also gained an insight into its possibilities.

University catchment

Of the 42 schools around the country from which Lincoln University has averaged 15 new students or more every year for the past four years, 34 are South Island based. This is not necessarily surprising as a university's main catchment area for new students will usually be its own. However, a notable proportion of these schools are in small towns which service the rural sector. In addition, a large number of the Christchurch schools from where Lincoln may gain new students are boarding schools, suggesting an even greater proportion of new students coming from rural or semi-rural locations. This would reinforce the fact that tertiary programmes orientated toward the primary sector are not the main choice for highly urbanised students.

As the burden of our commercial viability rests most heavily on the primary sector, and when we consider that over the past seven years, only five per cent of Lincoln University's students have come from the city which has more than 30 per cent of our population, we can begin to see the problem more clearly. The problem looks starker when we also consider that the figure for Bay of Plenty is 4.9 per cent and 3.4 per cent for Wellington. This means that over the past seven years, just 13.3 per cent of Lincoln's tertiary students came from regions making up 44 per cent of New Zealand's total population base.

These figures might not seem all that troubling. If not, then it should be noted that the figure of 13.3 per cent applies to all programmes offered at Lincoln – undergraduate and postgraduate degrees, diplomas and certificates – across all subject fields. If we were to look at total students nationwide enrolling purely in the bachelor of commerce (agriculture), the bachelor of agriculture, or the bachelor of agricultural science relative to total undergraduate enrolments, in 2013 as an example it is about 41 percent of Lincoln's undergraduates.

Anecdotal evidence

Is stating the kind of roles open to students were they to embark on a land-based qualification enough? An anecdotal example from the travels of a student liaison officer may help. He was given, along with representatives from other universities, 15 minutes to overview the science offerings available at Lincoln to an assembly of 300 Year 13 students in one of the North Island's largest city schools.

'Who here is interested in science and is seriously considering studying a science-based programme at university next year?' he asked. Approximately 200 students raising their hand in answer. Of those who did this he went on to ask, 'Who would like to have some sort of career working in a science field?' In response to this question, practically all the same individuals raised their hand.

Sensing he had captured the attention of up to 200 students anxious for information on making a sound decision about their choice of university programme, he went on to outline how they could apply their interest in chemistry or biology or both to programmes aligned to the main commercial interests of the country. He also mentioned that because these are the country's main commercial interests, and with the added bonus of an industry skills shortage, the opportunity for securing a science-based role from a four year bachelor of agricultural science degree is good.

As well as overviewing this degree, the liaison officer went on to outline some of the roles available such as bioprotection and biosecurity, animal science, plant science and viticulture. He then noted that because of industry shortages, starting salaries can be higher than that of the average graduate.

He also said that should they wish to be employed in many other science fields, they may be required to study to PhD level only to find themselves entering a highly competitive job market which could mean lower starting salaries and fewer opportunities. He was therefore suggesting to them to apply a core interest in biology or chemistry to fields that come with a higher probability of employment and progression.

It may come as no surprise that of the 200 or so budding scientists at this school, not one came to see him afterwards to discuss the possibility of enrolling in a degree programme in a land-based science field. What does this tell us? Perhaps these students are influenced by what sounds cool, what their friends will be studying and where, or what their brother or sister did at university.

Role of career advisors, teachers and parents

If the primary industry is to attract the graduates it needs it should perhaps be asking parents, career advisors and teachers to take a more paternalistic approach to guiding our secondary students into tertiary programmes. For this to be successful with regard to the primary industry, it also requires a sound and unbiased understanding of the industry on the part of these influencers.

I believe there is a sometimes tepid attitude held by those in the career advisory profession towards recommending training for a career in the land-based industries. Part of the problem is that some career advisors may still have the misconception that agriculture is the domain of the less academically gifted. If this is the case, then as a university we need to do more work with career advisors to educate them on the full scope of the activities and opportunities of the primary sector.

Returning to the students themselves and what encourages them to take on a land-based education, such an approach has been underwritten in Lincoln's marketing campaigns of the last two to three years. It is reflected in the principles guiding our recent qualification reforms 'Feed the World, Protect the Future, Live Well'. These aim to further align our programmes to the expectations of New Zealand industry and very real global demands.

A government problem

The responsibility for making a land-based education and the careers stemming from it a more attractive proposition for even the most urban of students does not fall just on tertiary providers. It is a broader industry problem, which also makes it a government problem.

With shared responsibility, effective collaboration from mechanisms such as industry scholarships and sponsorship, and an industry-focused public relations campaign, a bridge can be built to the urban student market, sufficient to provide the primary sector with the quantity and calibre of new entrants required to optimise the potential of this country's most important industry. What is needed is recognition of the problem, a collective will to rectify it, and a well-implemented strategic vision.

Jaime Thomson is the Student Liaison Manager at Lincoln University.

Donovan Wearing

What standard of agricultural student are we creating?

School liaison officers at the Taratahi Agricultural Training Centre continue to struggle to open some secondary school doors. On occasion we are still denied the chance to spread the word about agriculture and to have the opportunity to update schools on the breadth of career pathways that exist and are being created. There are many interesting and cutting edge careers within the industry and it is very frustrating to be denied the chance to show these opportunities to students.

In our training centres around New Zealand we educate young people who can take the agricultural industry from the 21st century into the next century and beyond. They will have a positive financial effect on the state of New Zealand's economy. What is to say they will not also be helping the world to feed itself in the future?

The reluctance we sometimes face is the misguided perception some people have of the agricultural industry. To be blunt, this perception is that the industry is the natural dumping ground for students who struggle with literacy or numeracy, have behavioural problems or are unmotivated. I am frustrated that this perception exists. We therefore need advocates around us to encourage schools and parents to see that agriculture is the industry to be in.

Student profile and accommodation

The statistics below show a more accurate picture about agricultural students.

- Currently the full-time student intakes are an equal split from urban and rural backgrounds
- Students have a variety of experience, those who are not in education, training programmes or employment and those from families with generations of farming experience
- The average age range is 16 to 21 years
- Approximately 80 per cent of full-time students are school leavers, and the remaining 20 per cent are either career changers or have discovered an interest in agriculture and would like to give it a go
- Around 75 per cent of our students learn by being practical, which is why wherever we can, a theory component is turned into a practical activity to reinforce the main points
- First year students who complete the year-long programmes tend to stay in agriculture, and approximately 50 per cent of first year students will progress to second year study
- A high percentage of second year students will remain within the agricultural industry and are very motivated.

There is often a dawning realisation in students during their course of study that having a qualification really does open doors. If they want to get ahead and change the direction of their life then they need one.

At our residential campus in the Wairarapa we have accommodation which has been designed to create a flatting environment for students. They have their own bedroom with shared kitchen, laundry and living spaces. First year students are well catered for and have three cooked meals a day, but second year students are responsible for shopping and cooking for themselves.

As well as gaining critical theoretical and practical skills on the farm they are also learning basic life skills. Many campuses around New Zealand also provide budgeting and cooking classes. Some students come straight from living with their parents and have no idea how to cook an economical and nutritious meal for themselves.

Programmes and placements

Taratahi has been training students for agricultural careers since 1919 and offers full-time courses, extramural study, short courses and STAR/Gateway programmes as well as the Primary Industries Trades Academy. The programmes range from training in schools, introductory pre-employment, work ready and diplomas in agriculture.

A student can start at Year 11 and end up as a graduate of Lincoln or Massey University. Second year students spend six months of their study on farm placements which is a critical point in their education. All of the practical, theory and life skills they have learned are put into practice when they are working and living on the farm and being part of a farm team.

We spend considerable time ensuring that we place the right student with the right farm manager or owner. If we have a student who lacks confidence then we will try to find a farm placement where the farm manager or owner will be able to provide the support and guidance necessary. The farm liaison officer will help the student and farm to ensure that the placement is working well and the student is thriving.

Learning problems

As with every educational establishment the world over, each class will contain students with a mix of attitudes. We can have a group of students which is unmotivated and difficult to involve but the next group may be passionate, interested and soak up information and the acquisition of new skills.

For some students we need to manage numeracy and literacy problems. Students can range from needing total support to needing no support at all. Our staff provide significant resources to students who need help. We offer up to four night classes a week, taken by tutors in their own time. We do everything we can to give them the best chance to succeed in their chosen programme. Although they may struggle in a theoretical environment, more often than not they are very practical and will shine on the farm.

The three most common challenges to learning problems that we manage are autism, Aspergers and attention deficit hyperactivity disorder. The formula of only seven students to one tutor helps those dealing with these problems to cope better. This is in contrast to being in a classroom of 30 where there is less personal attention and ability to monitor how well a student is absorbing information. We also liaise with local medical and counselling services to ensure these are available to students should they need them.

It is essential that we work with these students to make sure that those who struggle, but are still interested and gifted in other ways, have every chance to be as successful as those who do not have any literacy or numeracy problems. We also have students who compete in young farmers competitons, receive scholarships and move quickly up the managerial ladder.

Students as potential employees

Our programmes are designed to create a skilled and well-rounded future employee and a person who is able to look after themselves. These life skills are critical as some students may find themselves working on remote stations where it is essential that they are self-sufficient. Just as some secondary schools do not understand how this industry could provide a positive direction for their students, at times we also struggle with expectations of students from our communities.

We are acutely aware that we must provide students with as many training experiences as we can. The best way to do this is to train them in a variety of different environments, whether it is on a dairy farm in Masterton or on a remote sheep and beef station in Hawke's Bay. Students could end up working anywhere in New Zealand. If they have experience in many different environments they are more employable, which is why we continue to look for new training environments.

Employer support

We also want students to be exposed to the many different pathways the agricultural industry offers. This could include engineering, research and information technology, which is why we are involved with the research programmes on many of our properties. It is our responsibility to give students the chance to get involved so that they can make an informed decision about which pathway is right for them.

I am often heard saying that every student is different, has different skills, a different personality and different ways of learning and absorbing new information. Future employers of any students need to be realistic. Think back about your first job, and your first employer, and remember the feeling of being overwhelmed and realising how much you still had to learn.

Some of our most successful students who are already in managerial roles on the farm say the same thing – they could not do it without the support of their employers. To be encouraged to keep on training, to take responsibility, to make decisions and to have a mentor with many more years of experience makes a big difference to their performance and the contribution they will make to the agricultural industry.

When we are denied the opportunity to demonstrate all of these points at secondary schools we find it disappointing. The programmes, pastoral care and farming opportunities we can provide to young people is extensive and it is unfortunate that we are not always able to explain this to schools. How

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Mike Styles

Low literacy and numeracy levels in the primary sector

Low literacy and numeracy skill levels are a significant problem for the primary sector. As a nation, 40 per cent of our workforce do not have the literacy and numeracy skills to do their job effectively. For the primary sector this figure jumps to 55 per cent. These figures are the result of international surveys and are on par with countries such as Australia, Canada, the United States and the United Kingdom. Canadian figures indicate that a one per cent reduction in adults with a literacy and numeracy deficit would contribute billions of dollars in increased productivity. The effect would be similar in New Zealand.

Most of us will have anecdotal stories where we have experienced employers, employees, new recruits and industry trainees with literacy and numeracy problems. However, it is not limited to people at entry level positions or positions with low levels or responsibility. There are many stories of successful farmers and others in the primary sector who have succeeded in spite of this barrier.

What are schools doing?

The most common question asked by many people in the industry is – Why do they not learn literacy and numeracy at school? This is closely followed by the comment that it is not my job to do what should have been done at school.

Schools should take some of the blame, but there are a number of other reasons why people leave there without the most basic skills in this area including –

- Truancy and other factors mean that a significant number of children are absent from school for long periods of the year
- Transient children often do not settle in any one school and therefore make little progress
- A significant number of young people were educated in another country before they came to New Zealand
- Progress in schools is a result of input from home as well as school and a large number of children get no support from their parents.

Keep in mind that 80 per cent of those who will be in the workforce in 10 years' time are already working. We have a problem on our hands right now that we must work.

Higher incidence of dyslexia

There is shame and embarrassment attached to literacy and numeracy problems and people go to inordinate lengths to hide them. An associated factor is the condition of dyslexia, which affects approximately 10 per cent of the population. Because people with dyslexia migrate to jobs where they believe they can hide the problem, it is probable that the percentage of dyslexics in the primary sector is higher than in others. This is a condition where people of normal ability struggle with reading and writing because of an inability to decode groups of letters into words. There are well-known examples of very successful dyslexics in New Zealand including Richard Taylor,

Results after assessment of 6,600 primary sector trainees

Step score	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Percentage	1 per cent	4 per cent	13 per cent	24 per cent	32 per cent	26 per cent

John Britten and Peter Leitch the Mad Butcher. These people are exceptions as most dyslexics struggle with literacy and numeracy problems. The way that the government, employers and training providers are dealing with this problem is an interesting case study of how to manage the way through a major problem which is a significant barrier affecting primary sector productivity.

Government initiatives

The government has taken three significant actions to help with adult literacy and numeracy deficits.

Literacy and numeracy progression

The government started the ball rolling a decade ago carrying out research because it was important to know what other countries were doing and how successful these attempts were. It was vital to define precisely what adult literacy and numeracy looked like as they both evolve relatively quickly.

The literacy and numeracy demands of the workplace have escalated enormously over the last generation and each workplace has its own jargon, terminology and acronyms. A generation ago it was possible to secure a good job with minimal literacy and numeracy, but those days are gone and even foundation level jobs require good literacy skills.

A publication was produced out of this research – *The Literacy and Numeracy Progressions.* It divides literacy and numeracy into their component parts, and describes a number of skill levels and set pathways showing how people could progress from low literacy and numeracy levels to higher ones.

There are six skill levels. Step 1 is very low and equivalent to a reading and numeracy age of five or six years. Step 6 is the highest level and indicates a sound level of literacy and numeracy. A worker scoring at Step 6 is very capable of progress in the workplace. *The Literacy and Numeracy Progressions* is an important benchmark which enables the government and professionals in the sector to measure progress.

Adult literacy and numeracy assessment

The second major contribution the government has made has been to invest in the development of a computer-based adult literacy and numeracy assessment method. It provides an objective assessment of each adult's reading or numeracy skills. Results are compared to *The Literacy and Numeracy Progressions*.

Trainees can take the assessment online or as a paper-based assessment and we now have a measure for each participant taking this. Collectively this provides a database of valuable information about the literacy and numeracy levels of trainees and also an indication of particular problem areas.

Government funding

The third contribution the government has made is to invest a significant amount of funding to help with adult literacy and numeracy problems. This has gone into improving industry training organisations, polytechnics and private training establishment management staff. Most tertiary tutors would justifiably assume that trainees or students at tertiary level would have foundation skills and that student literacy and numeracy were not their problem. Funding has also gone into a range of community providers to improve people's skills before they join the workforce. The money is not sufficient, but it is a start.

Initiatives

The Primary Industry Training Organisation has adopted a number of good management practices to change the literacy and numeracy skills of our trainees. We only deal with people in work and do not reach all primary sector employees because not all employees seek training.

It was important that Primary ITO itself had good systems to understand and help the literacy and numeracy skills of its own staff. Literacy and numeracy deficits appear everywhere, and surprisingly affect people in moderately high positions. Staff had to be persuaded that literacy and numeracy was our problem to solve and not one that could be blamed on schools and then ignored. From top management down, everyone had to be involved and accept that we can do something about it.

All staff took the adult literacy and numeracy assessment as we felt that we could not expect trainees to do what we would not do ourselves. Many people had a poor experience at school and the thought of doing such an assessment was daunting. There was considerable resistance from field staff, training providers and employers to the idea of measuring their literacy and numeracy skills. There was a need to sell them the idea that the industry should involve itself in helping with a problem that should have been sorted at school.

Administering an assessment to many thousands of trainees poses its own problems, mostly logistical. We administer the assessment at off-job training days and it has now become business as usual.

What next?

Assessing trainees gives us some valuable data. However, the assessment is just the diagnosis of the problem. The real challenge is what do we do with the results? How does

Primary ITO improve literacy and numeracy skill levels in trainees when the law prevents us from training them directly?

Primary ITO has adopted a multi-pronged approach. For people who have not managed to acquire sufficient literacy and numeracy skills in their 10 to 13 years of education, there will not be a simple solution. A range of initiatives have been put in place, some of which are outlined below.

- The mentoring programme where trainees with moderate needs are matched with a volunteer mentor to help them with literacy and numeracy and with course completion
- High needs intervention where trainees with very serious deficits are helped by paid literacy and numeracy professionals
- All Primary ITO training resource material has been, or is being re-written to make it easier to read because it is internationally recognised that this helps with literacy development
- Improving the skills of training providers to give better technical training, including literacy and numeracy improvement
- The NCEA project where trainees are awarded their qualifications based on the industry training they have completed with Primary ITO. The benefit of this is that it changes the understanding of trainees about their ability to learn as most trainees are much more capable than their school results would indicate.
- Primary ITO now uses screening to assess trainees thought to have dyslexia, and training sessions are being run for our training providers to help them help dyslexic trainees
- For modern apprentices there is a contractual arrangement with Literacy Aotearoa to provide literacy and numeracy help to those trainees who are modern apprentices.

The mentoring programme

Most young people who leave school to work on a farm are hands-on practical people. Many have done poorly at school because school learning was not their thing. Most are good at the hands-on learning which they do on the farm, but they struggle to complete their theory learning. Primary ITO has pioneered a learning mentor programme which is being rolled out around the country to help trainees complete their training.

Volunteers are recruited who are prepared to give some time to help trainees complete their training. There are many people in rural New Zealand who are keen to give something back to their community. These volunteers do a one-day induction and training session to learn how to become a mentor. Mentors come from all works of life and backgrounds. Many are retired farmers but others include a retired vicar and his wife, a fertiliser representative, rural bankers, a local librarian and a bed and breakfast operator.

Once trained the mentors are linked up with trainees who are struggling with their literacy and numeracy skills and to complete their assessments with us. In mentoring, a small investment of time makes a big difference. Mentors give up about an hour a week and the difference they make is remarkable. They offer empathy, confidence, organisation, regularity and consistency. The scheme is relatively new, but we are already experiencing significant successes. Trainees who had given up completely on finishing their training with us have now completed their qualifications.

Conclusion

Literacy and numeracy deficits are problems that are not going away soon. We will never achieve 100 per cent literacy and numeracy in the workplace but we have already made significant progress. There is an opportunity to make a substantial difference to individual employees and the productivity of the primary sector, and Primary ITO has started to face the challenge.

Mike Styles is a literacy and numeracy advisor at Primary ITO based in Wellington. This is a new industry training organisation helping with industry training in the agriculture, horticulture, equine, water and sports turf sectors.

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many young people do they have who would benefit from our philosophy of real training on real farms? How many young people are missing out on an exciting career path?

We do have a number of employers and careers advisors who support us and we cannot thank them enough for their help. I hope that in five years' time we are not still struggling with misguided perceptions about some students. I also trust that the primary industry will continue to invest in young people and champion the industry.

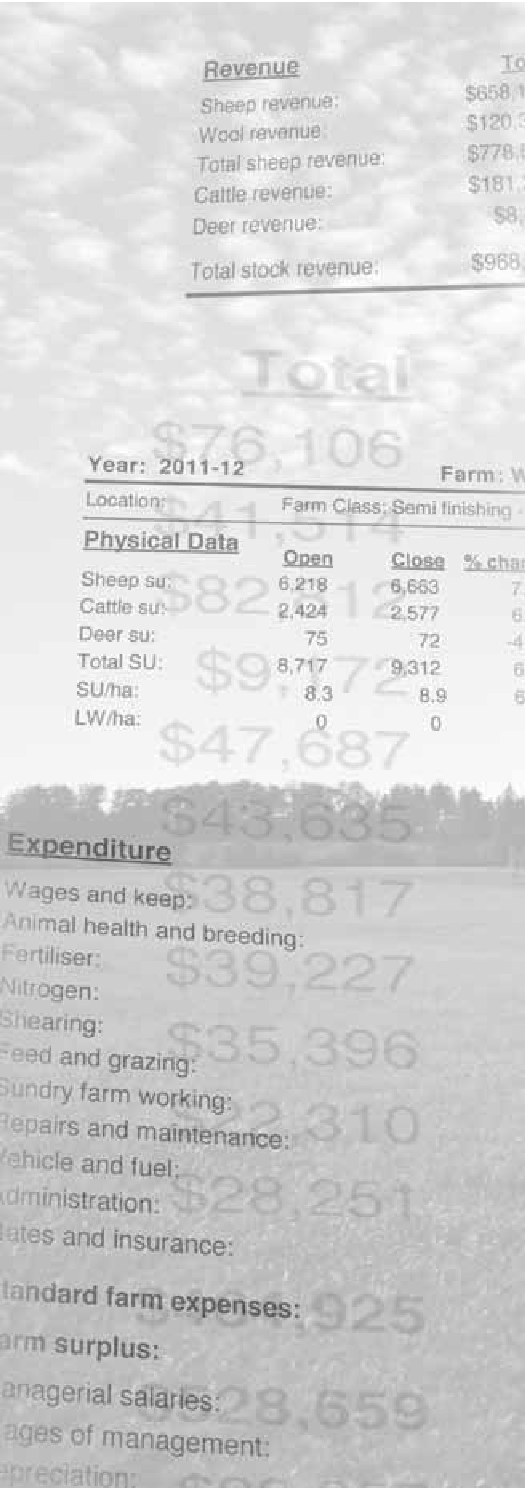
Taratahi Agricultural Training Centre has grown significantly in the last five years. We lease, manage or own a number of farms around New Zealand. On occasion I have been involved in robust debates and have been asked whether Taratahi is growing too fast and losing sight of our core mission of training in the agricultural industry.

I enjoy all these debates. This is because I find it encouraging that people care about what we are doing and the industry and because our core mission of real training on real farms for all New Zealanders is what drives us every day.

Donovan Wearing is Chief Executive Officer of the Taratahi Agricultural Training Centre. The main campus is based near Masterton in the Wairarapa, with non-residential campuses in the Manawatu, Taranaki, Waikato, Hawkes Bay and Northland.

David Baker

Common terminology in measuring productivity consistently



For most farm owners the cash surplus, in total but best measured per hectare, is their prime objective. Cash profit is king. However this does not indicate what can or should be achieved from a farm property's management input and resources, the latter being land, labour and capital available.

The real question should be – How well is the property actually performing and what are the best measures to determine this? Any figure calculated is only of use if it can be compared with other similar properties for the same year. This is what benchmarking is all about. The benchmarking process requires a standardisation adjustment of income and expenditure so that the true and sustainable surplus can be assessed.

There have been many attempts to standardise an agreed measurement approach over the years, but to date there has been a reluctance by professionals to adopt one agreed standard. This may be partly due to the different purposes for which the final results are required. For example, there is a difference between a financier's requirements when looking at an individual property compared with a farm operator who is wanting to use analysis figures to formulate or modify management policies.

Nevertheless there are many common terminology measures which should be agreed on. First, the purpose for which analysed figures are to be used needs to be clearly defined and understood. This article is about defining the more important key performance indices and benchmark measures so that some industry consistency can be achieved. I have also provided an example of the measures that are produced and used at Baker & Associates.

Benchmarking analysis

We have developed our benchmarking analysis to help us advise our sheep and beef farming clients, and annually publish Farm Analysis Bureau data results. Properties in this survey are classified by farm class for group comparative purposes. The final main index is the economic farm surplus, but this is assessed along with a number of other key performance index measures. Both economic farm surplus and key performance indices are assessed for the average of each property class and also for the top 10 per cent.

Properties are ranked from highest to lowest and then the key performance index – the economic farm surplus and key performance indices – are published in a benchmark table. This allows the final economic farm surplus and associated key physical and financial achievements to be studied. In most cases the relationship between the key performance index and the final result will show results which correlate reasonably well. It is important to note that –

- High lambing percentages with low deaths in ewe and ewe hogget capital stock is a feature of a high economic farm surplus
- Stocking rate per hectare is not as important as return per stock unit
- The level of return per stock unit is a function of good physical performance and good stock prices
- Expenditure as a percentage of income is more important than expenditure per stock unit or per hectare.

Summary of the key performance index measures for the average property in each class

	Class 2 Semi-dry	Class 3 Semi-wet	Class 4 Finishing	Average all farms
Total in category	63 (57)	32 (26)	9 (9)	104 (92)
Average size effective hectares	1049	789	684	934
Average labour units	2.4	2.4	2.4	2.4
Total stock units opening	8717	7635	8250	8321
Stock units per hectare	8.3	9.7	12.1	8.9
Per cent stock unit changes	+6.8	+4.5	-7.3	+4.9
Per cent stock units as sheep	71	61	70	68
Lambing per cent ewes	128.9	136.2	130.4	131.0
Hogget lambing per cent	53.8	52.3	74.6	55.9
Calving per cent survival to sale	85.7	85.8	81.7	85.6
Wool per sheep stock units	4.9	5.1	3.6	4.9
Wool per sheep hectare	41	49	43	43
Sheep deaths and missing per cent	7.0	7.1	4.0	6.7
Cattle deaths and missing per cent	2.3	2.1	1.5	2.6
Fertiliser/lime dollars per stock unit excluding nitrogen	11.12	15.72	11.67	12.56
Nitrogen dollars per stock unit	1.05	.93	3.64	1.23
Average lamb price dollars per head	110.53	115.60	110.30	111.84
Average sheep price dollars per head	126.48	129.36	111.34	124.72
Average weaner price	601	564	532	579
Average other cattle dollars per head	1052	1043	971	1041
Average wool price dollars per kilogram	3.91	3.69	4.14	3.86
Sheep return dollars per stock unit	105.85	113.62	111.92	108.48
Wool return dollars per stock unit	19.36	18.69	14.74	18.78
Total sheep and wool dollars per stock unit	125.21	132.31	126.66	127.26
Cattle return dollars per stock unit	74.76	76.19	97.01	76.97
Return dollars per hectare	947	1115	1521	1028
Standard expenses dollars per hectare	443	514	678	476
Economic farm surplus dollars per hectare	422	490	708	459
Return dollars per stock unit	113.98	115.24	126.08	115.42
Expenses dollars per stock unit	53.34	53.14	56.25	53.46
Economic farm surplus dollars per stock unit	50.81	50.63	58.67	51.51
Expenses per cent of income	47	46	45	46
Average debt servicing per stock unit	20.41	16.24	23.95	19.46
Average debt servicing per cent of income	18	14	19	17
Return on capital per cent	6.4	5.9	6.7	6.3
Gross return/ land value ratio	5.7	6.1	5.9	5.9

Comparing an individual property result with key performance index measures for both the class average and that of the top 10 per cent should identify the areas which require review. Interpretation for the client is helped by the consultant's knowledge of the characteristics of properties within the database compared with the subject property.

It might be reasonable to have high income per hectare but the expense of achieving this may well make it uneconomic. This can particularly apply to nitrogen use, feed and grazing costs.

Year: 2011-12 **Farm: Weighted Average - Class 2**

Location: Farm Class: Semi finishing - summer dry Effective area (ha): 1,049 Total labour units: 2.4

Physical Data

	Open	Close	% change				
Sheep su:	6,218	6,663	7.2%	Lambing %:	128.9%	Total SU's/labour unit:	3,611
Cattle su:	2,424	2,577	6.3%	Hogget lambing	53.8%	Sheep SU's at open:	71%
Deer su:	75	72	-4.0%	Calving %:	85.7%	Sheep SU's at close:	72%
Total SU:	8,717	9,312	6.8%	Sheep D&M%:	7.0%	Wool prod(kg greasy)	30,724
SU/ha:	8.3	8.9	6.8%	Cattle D&M%:	2.3%	Wool prod/SSU:	4.9
LW/ha:	0	0		GFI/Lab unit	$411,574	Wool prod/sheep ha:	41

Revenue

	Total	per su	per kg		Total
Sheep revenue:	$658,173	$105.85	$16.90	Net crop revenue:	$5,139
Wool revenue:	$120,385	$19.36	$3.92	Grazing revenue:	$8,346
Total sheep revenue:	$778,557	$125.21		Other farm revenue:	$11,899
Cattle revenue:	$181,224	$74.76	$10.90	**Gross farm revenue:**	**$993,584**
Deer revenue:	$8,418	$112.24	$19.53	**GFR/ha:**	**$947**
Total stock revenue:	$968,200	$111.07		**GFR/su:**	**$113.98**

Expenditure

	Total	per ha	per su	% GFR
Wages and keep:	$76,106	$73	$8.73	8%
Animal health and breeding:	$41,514	$40	$4.76	4%
Fertiliser:	$82,812	$79	$9.50	8%
Nitrogen:	$9,172	$9	$1.05	1%
Shearing:	$47,687	$45	$7.67	5%
Feed and grazing:	$43,635	$42	$5.01	4%
Sundry farm working:	$38,817	$37	$4.45	4%
Repairs and maintenance:	$39,227	$37	$4.50	4%
Vehicle and fuel:	$35,396	$34	$4.06	4%
Administration:	$22,310	$21	$2.56	2%
Rates and insurance:	$28,251	$27	$3.24	3%
Standard farm expenses:	**$464,925**	**$443**	**$53.34**	**47%**
Farm surplus:	**$528,659**	**$504**	**$60.65**	**53%**
Managerial salaries:	$20,057	$19	$2.30	2%
Wages of management:	$42,119	$40	$4.83	4%
Depreciation:	$23,609	$23	$2.71	2%
Economic farm surplus:	**$442,874**	**$422**	**$50.81**	**45%**
Capital fertiliser:	$2,125	$2	$0.24	0%
Lime:	$12,043	$11	$1.38	1%
Capital R&M:	$9,996	$10	$1.15	1%
Development expenditure:	$832	$1	$0.10	0%
Interest and rent:	$177,874	$170	$20.41	18%

Capital		per ha	per su	**Ratios**		**Cash Analysis**	per ha
Land and building value:	$5,668,901	$5,404	$650	Return on Capital	6.4%	Farm cash revenue:	855
Plant and vehicles:	$106,506			Gross Revenue/ Land Value Ratio:	5.71	Farm cash expenditure:	657
Total value stock:	$1,339,417		$154			Farm cash surplus:	198
CV as Going Concern:	$7,114,825	$6,782	$816				

An economic analysis report based on a Farm Analysis Bureau survey

The tables and graphs from the 2011/12 Farm Analysis Bureau survey demonstrate the type of information gathered to assess productivity key performance indices for a property.

Standardisation

Benchmarking requires a standardisation process which involves a minor tweaking adjustment of income and expenditure so that the real and sustainable surplus can be assessed. Our analysis is completed using the effective hectares being farmed. Financial returns are analysed and expressed as economic farm surplus and a return on total capital involved, before any debt servicing, is also calculated.

For clients who use Farm-Max, which is feed budgeting, it is possible to assess results with gross income, expenditure and the economic farm surplus calculated kilograms of dry matter pasture consumed. The main areas to watch when benchmarking are outlined below.

The effective area must be correctly assessed and many do not do this. This area should include farm buildings and facilities. It should only exclude fenced-off areas of trees, bush and scrub, but include any area of leased land involved in other than short-term grazing. If not carried out accurately, the results will provide incorrect information to the client involved. It is best to start with the total title area and be very hard on the deduction made for the non-effective area.

Year: 2011-12		Farm: Example			
Farm class: 2	**Semi finishing - summer dry**				
FAB Average	**Description**	**Your figures**	**Class Avg**	**Class Index**	**Best 10%**
Physical Data					
934	Effective area (hectares)	850	1,049	81	815
8,321	Total stock units at open	6,594	8,717	76	7,572
8.9	Stock units per hectare at open	7.8	8.3	93	9.3
68%	% sheep stock units at open	74%	71%	104	79%
2.4	Labour units	2.3	2.4	95	2.1
3,453	Total stock units/Labour unit	2,867	3,611	79	3,549
131.0%	Lambing %	135.9%	128.9%	105	143.0%
85.6%	Calving %	0.0%	85.7%	0	94.5%
6.7%	Sheep deaths and missing %	6.4%	7.0%	92	7.4%
2.6%	Cattle deaths and missing %	0.3%	2.3%	13	1.6%
4.9	Wool per sheep su	4.9	4.9	99	5.7
43	Wool per sheep ha	38	41	93	53
Revenue per su					
127.26	Revenue per sheep su	156.11	125.21	125	146.01
76.97	Revenue per cattle su	101.20	74.76	135	93.79
115.42	Gross Farm Revenue	142.53	113.98	125	136.49
57.93	Actual farm expenditure	82.61	56.11	147	57.88
51.51	Economic Farm Surplus	57.44	50.81	113	75.09
Expenditure per su					
8.53	Wages	9.61	8.73	110	8.21
4.81	Animal health	7.51	4.76	158	4.35
12.55	Fertiliser and Lime	20.91	11.13	188	17.27
7.59	Shearing (per sheep su)	8.88	7.67	116	8.10
1.15	Freight	1.42	1.10	128	0.36
6.64	Feed and fodder crops	12.85	6.06	212	5.31
1.38	Weed and pests	2.67	1.54	173	0.76
1.88	Farm Working	4.09	1.81	225	1.80
5.92	Repairs and maintenance	4.31	5.65	76	4.47
3.98	Vehicles	5.00	4.06	123	3.11
2.54	Administration	5.20	2.56	203	2.32
3.37	Rates and insurance	2.46	3.24	76	3.51
19.46	Debt servicing	26.87	20.41	132	17.76
50%	Actual expenses as a % of GFR	58%	49%	118	42%
Revenue per ha					
1,028	Gross Farm Revenue	1,106	947	117	1,268
516	Actual farm expenses	641	466	137	538
459	Economic Farm Surplus	446	422	106	698
Sundry					
6.3%	Return on Capital	5.7%	6.4%	89	10.1%
5.9	Ratio of GFR : Land value	5.9	5.7	103	4.4
4.0%	Return on Equity	3.1%	4.0%	79	7.5%

An example of a comparative report

Value assessment for change in stock numbers is required where the number of stock on hand at the end of the year is more or less than at the start. The opening stock numbers are used as the base and you should value any change based on the closing market values for the category of stock that is different. Using the National Average Market Price or tax standard values can distort a calculation because they apply to all stock.

Physical stock performance

Lambing percentage This should be calculated as survival to sale, which is the lamb numbers sold during the year along with the hoggets wintered at year end minus any lambs purchased divided by the number of ewes wintered. This tally and subsequent calculation will vary from the number of lambs docked and other figures from clients. The survival to sale calculation is the non-cheat benchmark adopted.

Wool per sheep stock unit This is the wool sold, added to any shorn weight of wool on hand unsold, as well any weight held over from the previous year divided by the opening sheep stock unit.

Calving percentage The tally of any mated or in-calf rising two-year heifers and the mixed age cows at commencement are included. The calf tally is the number of calves sold or on hand as rising one-year cattle at the end, minus any calves purchased.

Class 2 2011-12
Semi finishing - summer dry

Farm	Class Av	Top 10%	4706x	2721	2829	1025x	2542	9807	2854	2830	8216
Location			BM	BM	BM	BM	BM		BM	BM	BM
Effective Hectares	1049	815	450	762	1277	650	545	325	780	1200	1065
Summary Key Results											
Adj EFS per Hectare	$422	$698	$866	$758	$744	$679	$678	$664	$663	$651	$643
Return on Capital	6.4%	10.1%	9.1%	10.8%	10.9%	8.9%	8.4%	8.8%	9.3%	10.8%	9.2%
Gross Farm Income per Ha	$947	$1,268	$1,706	$1,358	$1,286	$1,384	$1,418	$1,391	$1,245	$1,107	$1,261
Farm Expenses per Ha	$443	$466	$667	$473	$472	$584	$598	$507	$465	$384	$516
EFS per SU	$50.8	$75.1	$79.3	$83.7	$79.7	$74.6	$63.5	$67.2	$69.9	$76.4	$71.2
Gross Farm Income per SU	$114.0	$136.5	$156.2	$150.0	$137.7	$152.2	$132.9	$140.6	$131.4	$129.9	$139.6
Standard Farm Expenses per SU	$53.3	$50.1	$61.0	$52.3	$50.6	$64.2	$56.1	$51.2	$49.0	$45.1	$57.1
Sheep Income per SSU	$125.2	$146.0	$156.3	$172.3	$147.1	$136.2	$147.4	$147.9	$128.7	$140.8	$158.4
Cattle Income per CSU	$74.8	$93.8	$154.3	$93.1	$87.9	$206.8	$83.7	$84.9	$138.5	$76.5	$62.1
Deer Income per DSU	$112.2	$0.0	$59.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Other Income per Hectare	$11.3	$6.9	$11.4	$7.9	$3.5	$22.3	$6.9	$31.6	$0.0	$7.7	$7.1
Physical Performance											
Total SU (Open)	8717	7572	4915	6897	11926	5912	5814	3214	7395	10225	9618
SU per Hectare (Open)	8.3	9.3	10.9	9.1	9.3	9.1	10.7	9.9	9.5	8.5	9.0
% Sheep SU's	71%	79%	55%	69%	83%	81%	76%	76%	81%	82%	79%
Lambing %	129%	143%	142%	162%	147%	143%	139%	141%	129%	141%	134%
Hogget Lambing %	54%	66%	78%	81%	56%	0%	87%	0%	50%	0%	82%
Calving %	86%	94%	91%	96%	97%	0%	95%	92%	0%	85%	81%
Wool per Sheep SU	4.9	5.7	5.9	4.6	5.8	2.4	5.6	7.1	5.3	6.0	5.7
Sheep Deaths	7.0%	7.4%	5.9%	7.7%	8.0%	3.1%	5.8%	5.1%	6.1%	9.0%	4.3%
Cattle Deaths	2.3%	1.6%	1.2%	1.0%	1.8%	5.5%	1.5%	0.0%	4.9%	3.0%	5.9%
Key Expenditure Ratios											
Wages & Management % GFI	14%	12%	10%	12%	11%	13%	14%	14%	9%	13%	11%
Exp (excl. wages/mgmt) % GFI	42%	36%	37%	29%	36%	42%	44%	40%	31%	40%	36%
Animal Health and Breeding / SU	$4.76	$4.35	$6.32	$4.36	$4.57	$5.83	$4.79	$4.43	$4.18	$3.93	$7.40
Fertiliser (actual excl. N) / Ha	$81	$122	$95	$99	$112	$157	$165	$185	$70	$145	$87
Nitrogen / Ha	$9	$15	$37	$0	$6	$0	$54	$10	$45	$0	$10
Shearing per SSU	$7.67	$8.10	$6.63	$6.41	$8.90	$7.91	$9.28	$7.87	$9.40	$6.59	$8.36
Feeds & grazing / Ha	$15	$17	$26	$35	$18	$46	$25	$30	$16	$0	$12
Cropping and Regrassing / Ha	$26	$16	$56	$5	$15	$0	$23	$23	$13	$23	$9
Repairs & Maintenance / Ha	$47	$42	$70	$27	$33	$47	$104	$40	$27	$41	$59
Vehicle Expenses / Ha	$34	$29	$39	$45	$22	$32	$32	$54	$23	$21	$50
Administration / Ha	$21	$22	$81	$24	$22	$31	$22	$35	$21	$16	$22
Rates & Insurance / Ha	$27	$33	$57	$31	$29	$30	$49	$51	$32	$26	$36
Capital Fert/R&M adjustment / Ha	$12	$34	$12	$0	$15	$77	$120	$87	-$36	$66	$19
Phosphate kgs / Ha	20	14	29	14	16	0	31	0	23	0	13
Nitrogen kgs / Ha	7	6	19	0	3	0	27	5	23	0	5

Part of a benchmark table for all class two properties

Stock unit conversion figures These are shown in the Farm Analysis Bureau survey. In simple terms one stock unit equates to one ewe or in-lamb hogget and all other sheep are assessed at 0.8. Beef cows and in-calf heifers are equal to six stock units, dry two-year cattle to five stock units, and rising one-year cattle to four stock units.

Comment on use of stock units

The analysis is still done on a per stock unit basis but considerable care is required with stock unit analysis. The conventional stock unit assessment was based on a ewe which produced 100 per cent lambs and consumed 550 kilograms of dry matter per year. Most ewes today eat a lot more than this. For example, in the 2011/12 Farm Analysis Bureau survey, average all class lambing survival to sale was 131 per cent which equates to over 700 kilograms of dry matter per year. Those who try to readjust stock unit assessments, by assessing their ewes at perhaps 1.2 stock units, are simply playing with figures.

We still calculate and show results on a per stock unit basis, but it is far more accurate to work on performance measured per hectare. Examples of other physical measures that are useful are –

- The calculation of the liveweight of lambs weaned per hectare
- Measuring carcass weight of meat or weight of wool sold, which will enable physical production per kilograms of dry matter consumed.

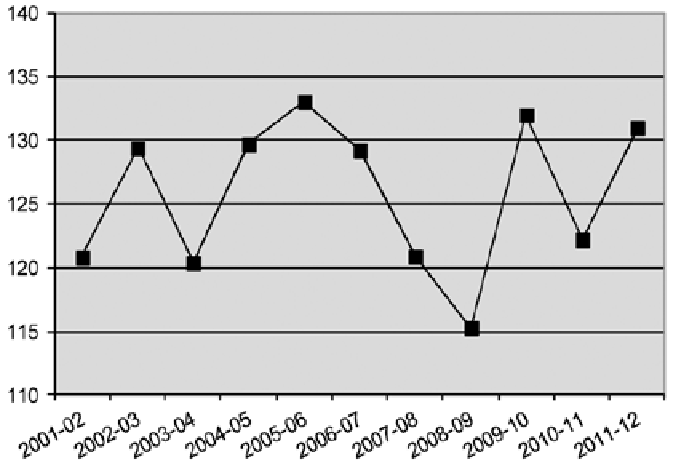
It has become clear that the assessments based on kilograms of dry matter consumed will be the better figure to adopt. The process requires recording monthly stock weights and the tallies and the change in stock live weight will allow calculation of the feed required. The change in pasture cover levels is then assessed, and from this it is possible to assess the derived pasture dry matter which has been consumed.

Income and expenditure

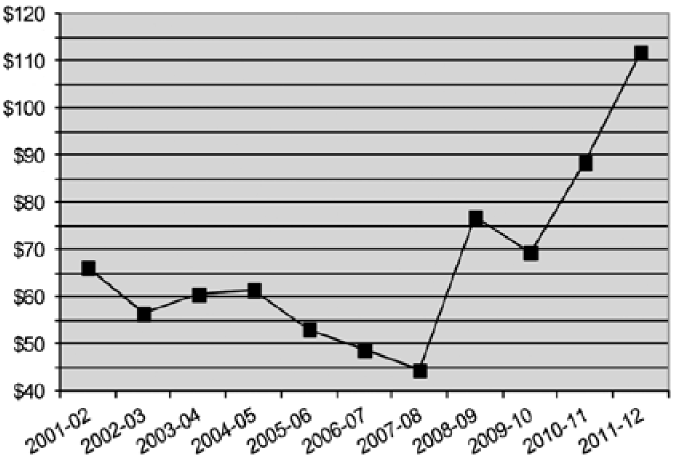
Financial returns are expressed as dollars earned and economic farm surplus calculated per hectare or per stock unit, as well as pasture consumed per kilogram of dry matter. Expenditure standardisation involves –

- Adopting a standard figure for maintenance fertiliser which is close to the average actual expenditure and represents the cost of applying approximately 1.8 units of phosphate per stock unit. For 2011/12, $9.50 per stock unit was used and then debited or credited the difference. The amount of fertiliser applied is recorded, and where this contains nitrogen, the total units are calculated and the applied cost of the nitrogen to feed cost is allocated.
- Making an allowance for value of management labour input. Where an owner-operator is involved wages of management is used to reflect the market value of the labour. A variable figure is used based on stock carrying which starts at $55,000 and stops at $94,500. For the class two average this is calculated out at around $63,000 for 2011/12. These adjustments may not be precise, but they attempt to adjust for the non-maintenance of the

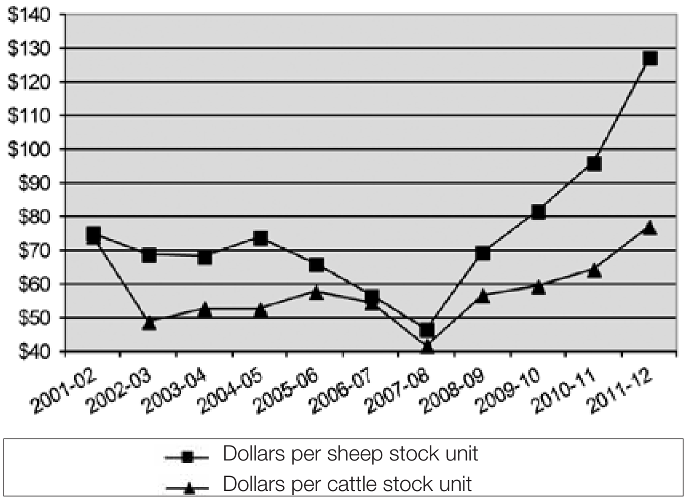
Lambing percentage



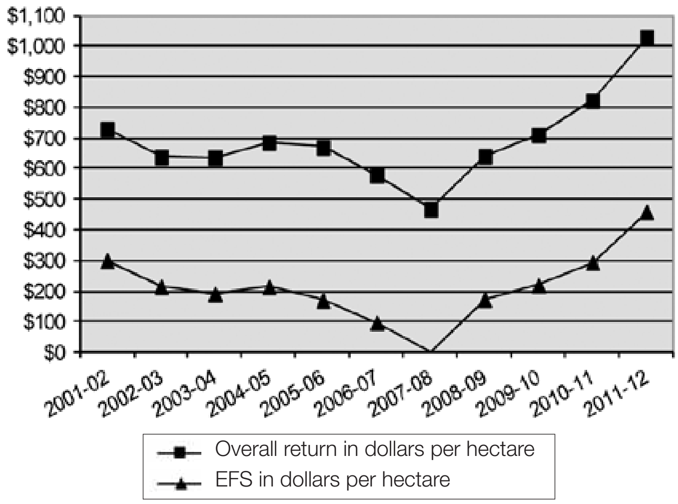
Average lamb price



Returns of sheep versus cattle



Gross farm income versus EFS



productive capacity of the property or provides a credit where there has been capital or development spending.

- For repairs and maintenance in 2011/12, adopt $4.50 per stock unit.

Sundry measures

The return on capital calculation is based on the market value of livestock and for the land and building, with both based on values at the start of the financial year. The value for plant and vehicles is the book value at commencement. The ratio between gross income and the value of the land and building provides a useful figure which is possibly more relevant than per stock unit.

Last year this ratio was 6.1 for our class two properties. This means the value of the land and buildings was 6.1 times the gross income. Income was $947 per hectare times 6.1, which equated to $5,404 per hectare or $650 per stock unit.

The main points of measuring productivity accurately are –

- A measure must be relevant to the purpose for which it is being used
- A key performance index needs to be calculated based on an accepted and clearly defined industry standard
- Benchmarking measures require data which is accurate and factual or the results will be worthless.

Productivity measurements are an important way for clients of any consultant or agribusiness practice. Benchmarking measurement standards need industry-wide agreement and adoption. The NZIPIM should be the body which coordinates an agreement on measurement standards. I have demonstrated how Farm Analysis Bureau survey data is compiled which could help this, and also identified some areas where further debate to get an agreement might be required.

David Baker worked as a farm advisor in the Wairarapa between 1969 and 1985 and then established the agribusiness consultancy and valuation firm of B&A (Baker & Associates (Wairarapa) Ltd) in 1986. He is now semi-retired and a Life Member of the NZIPIM. A copy of the Farm Analysis Bureau 2011/12 survey is available to NZIPIM members for $126 including GST. Please email: sheryn@bakerag.co.nz

Suzi Kerr and Zack Dorner

New Zealand's role in agricultural greenhouse gas mitigation

Small countries have an important role to play in climate change mitigation and achieving green growth – being policy innovators and leaders. New Zealand is a small country of just over four million people and our comparative advantage in climate policy is in agriculture. This is an important role for us because excluding agricultural greenhouse gases from global mitigation efforts would substantially increase the cost of meeting a given target.

Almost half of New Zealand's greenhouse gas emissions are from agriculture, by far the highest proportion among developed countries. Many countries may put a lower priority on agricultural mitigation in favour of easier options, but we do not have this luxury if we are to reduce our share of global greenhouse gases. If New Zealand does this in isolation, however, little will be achieved in mitigating global climate change.

As a small country we can be more agile and innovative in the policies we develop and we are disproportionately visible internationally relative to our population. This provides an opportunity to show leadership and help other countries tackle the difficult problem of agricultural greenhouse gas mitigation.

Most efficient in the world

In New Zealand, agricultural methane accounts for 30 per cent of national emissions while nitrous oxide is responsible for 18 per cent. These emissions reflect the importance of agriculture to the New Zealand economy, rather than significant inefficiencies in the agricultural sector. In fact our pastoral dairy, sheep and beef farms are among the most efficient in the world in terms of production per unit of greenhouse gases. In 2008 the New Zealand government legislated to include agriculture in its Emissions Trading Scheme (ETS) from 2013.

The entry of agricultural emissions into the ETS has since been pushed back, and now its entry date will not be reviewed until 2015. This reflects the contentious and difficult nature of bringing agricultural emissions into the ETS, along with the power of farmer lobby groups.

Agricultural greenhouse gas mitigation actions are challenging to decide on, undertake and monitor as they must be at the farm scale and each farm represents a complex biological system. This contrasts with fossil fuel emissions, where many mitigation actions can be embedded in technology adoption or large infrastructure.

Farmer capability and involvement is therefore critical for policy effectiveness and tackling agricultural emissions cannot be viewed only as a technical exercise. Because emissions come from a large number of small sources, and can be accurately monitored only at the point of emission, regulation of agricultural greenhouse gases is difficult.

The AgDialogue process

Motu Economic and Public Policy Research has undertaken significant research on agricultural emissions policy. This article summarises the findings of the AgDialogue group, which consisted of New Zealand farmers along with participants from iwi, industry, non-governmental organisations and the relevant local and central government agencies. By creating a politically acceptable and sustainable policy which is effective at reducing greenhouse gas emissions, we hope that this country's experience can help lead to better agricultural emissions policy globally.

To help communicate the thinking of this group, Motu produced a short film and developed a presentation to be used in conjunction with it as a teaching resource. The audience includes secondary and tertiary students, farmers, industry groups and government. From the understanding we gained our three main messages are –

- Be explicit about wider objectives, not just local emission reductions
- Involve a wide range of participants as this is not just a problem for government
- Build concern, capability and contracting incentives simultaneously, with more emphasis on concern and capability while New Zealand's response evolves.

If we can get these things right, we can provide a way of tackling emissions that other countries will want to emulate. This is our small country advantage.

Policy and aims

We must first define the objectives we are trying to achieve. It is important for New Zealand to contribute our fair share to the global climate change mitigation effort. This country can contribute by direct reductions in our own agricultural emissions, and from our ability to provide leadership in mitigation. For us to be an example for tackling these emissions, and for our own policy aims, we need to ensure they are mitigated –

- Efficiently, achieving a mitigation target at least cost
- Equitably, with an approach which is acceptable to our citizens including avoiding large costs falling on any one particular sector, such as the rural community
- Visibly, with our efforts documented, evaluated and promoted abroad.

Achieving agricultural mitigation in these three ways would create politically and environmentally sustainable and effective policy in New Zealand and elsewhere. Important to this country are two objectives. The first is maintaining a positive perception. The idea of New Zealand as clean and green is important for our international reputation and branding as well as our identity. To maintain this reputation we need to be seen to credibly perform well in all environmental areas. The second is realising there are potential co-benefits of greenhouse gas mitigation in agriculture such as improvements in water quality.

Mitigation options

Efficiency

In terms of efficiency of production, some techniques and technologies are already available, and others are undergoing research and development. New Zealand has a role to play in developing mitigation technologies and is a leader in the global research effort. Methods currently under development are a long way off being able to be applied, given the time required to develop those that work in the lab and then on the farm. Global collaboration is important so that information, discoveries and ideas can be shared and improved.

New Zealand farmers, especially the best, are efficient compared with the rest of the world. However, our farms vary significantly in terms of production efficiency per unit of greenhouse gases even when their characteristics are taken into account. This means there is already scope for valuable information sharing within New Zealand and across other countries.

Various characteristics have been identified which can make a farmer more likely to adopt new practices and technologies including larger farm size, younger farmers, better access to capital and information, and a higher level of environmental concern. The participants in AgDialogue emphasised that farms are a long-term investment and that New Zealand farms are heavily indebted, so may be constrained by capital. Even with strong leadership from our best farmers, change will be slow so it needs to be supported and started now.

Land use change

Changing what we produce is a more challenging prospect than increasing our efficiency. Internalising the cost of greenhouse gases in livestock products will make them less attractive. However, increasing global demand for food, especially protein, will increase livestock prices.

Internalisation of greenhouse gas implications in other countries will allow New Zealand farmers to pass some of the greenhouse gas costs on to consumers.

It is hard to know if we should be producing more or less livestock in the long term. We do not want to make massive, costly and difficult to reverse land use changes until we are more confident that these are globally valuable. By appropriately pricing environmental costs into global food production, and continuing to improve the efficiency of this production, we will find our way forward in answering this question.

Thinking of answers

Agricultural climate policy presents particular challenges. It is important to remember that global climate change is everyone's problem to solve and we all have a part in the solution. We need to avoid falling into the trap of assuming that agricultural emissions are a problem only for the government to regulate. We need to recognise this is about multiple types of action coordinating to meet shared aims. A framework we have developed could help find a way forward.

First, we identify that everyone has some role in the agricultural sector in New Zealand and globally because everyone is a consumer of food. We then divide up the roles into four different levels –

- National with central government and industry groups, NGOs and banks with an interest in how the agricultural sector operates have influence
- Regional level with regional governments and organisations such as Federated Farmers and iwi
- Community level with groups such as Rural Women NZ
- Individually are consumers, farmers and the people who work within organisations.

We divide possible actions into those which affect concern, changing attitudes and encouraging action, capability and contracting. These categories follow a logical progression. Concern must be built and those involved must be convinced of the need for change. They then need the capabilities to create change and there needs to be some sort of enforceable agreement to ensure change happens.

These three steps need to be thought of as a progression and as areas which have to be tackled simultaneously. Progression will be by concern and capability at different speeds and many actions will cover more than one of the areas at the same time.

Combining these, we developed the matrix shown below. This allows users with a specific initiative to classify the purposes of their initiative, to be clear about their target audience, and to reflect on how it fits within a wider set of initiatives. The matrix is relevant to everyone, ideas can be developed for particular targets and gaps can be identified.

Matrix of potential actions

	Concern	Capabilities	Contracting regulation
National		Global research alliance	Emissions Trading Scheme
Regional			
Community			
Individual			

Public debate in New Zealand tends to focus narrowly around the actions of central government and the ETS is usually identified as the climate change policy in this country. However, looking at the matrix, we can identify that the ETS occupies the top right-hand box only. The matrix demonstrates that it should be seen as the final piece of a much wider picture rather than as a starting place and complete policy.

Helping agricultural emissions

There is plenty of scope for increased ability to produce the intended result in New Zealand's potential role as a leader in global agricultural emissions policy. If humanity is to combat the worst effects of climate change, we should start from the assumption that we will succeed and act as though we will solve the problems in the long term. We are not predicting the future, it is an aspiration. By having a strong vision for New Zealand agriculture, we can work towards it in a way which will seem politically and economically attractive to others who might follow.

We could deal with emissions from an intrinsic motivation to tackle climate change concern. This would lead us to place emphasis on actions that can make New Zealand a credible leader in policy and science innovation

in agricultural emissions. If we want people to follow us we must make the path attractive. This requires us to try to control and mitigate adverse consequences in terms of global food security and effects on farmers and rural communities.

We want to avoid sudden effects on the agricultural sector and the New Zealand economy, high costs to taxpayers, and leakage of production. We need to be involved with and learn from countries on similar paths to our own, as well as those who face similar issues but are already dealing with them.

Stability needed

In the long term we envisage an international policy environment with a complete and stable international agreement and that New Zealand policies and mitigation practices are understood and used where appropriate. In addition we have to develop them with integrity and demonstrate their effectiveness and application where appropriate.

New Zealand and other countries have stable regulation, and in all nations the appropriate level of concern and capability is firmly established. If other countries do not price their emissions, they will have other forms of equally stringent regulation in place. We will therefore not protect production within this country.

The long-term vision within New Zealand is that the full climate cost would be imposed on marginal emissions, giving farmers efficient incentives. Fair compensation would be agreed for changes in land values, or to the extent that this was not possible, historical grievances accepted. Communities and workers would adjust to the changed patterns of production and shifts in employment. Farmers would become knowledgeable of existing mitigation options and would apply them with confidence. Research and dissemination of ideas and other important environmental resources would be well managed. For New Zealand, this would probably involve a farm-scale ETS.

Complex problem

In the short term the problem is much more complex so the vision focuses more on process than specific results. We do not know exactly where international agreements, technology or society are going or at what speed. There are costs and risks associated with acting early, but there are also benefits. With this in mind we suggest that we do not delay taking action but temper our pace to avoid irreversible change with long-lasting negative consequences. We must keep the future in mind, look for and maintain options, and focus on long-term efficiency.

As we move ahead we need to focus on devising fair decision-making processes which encourage participation and cooperation. There is a role for encouraging experimentation and learning and rewarding those who take risks. We have to act with integrity and always demand the highest quality information and science. We also need to promote and coordinate a broad set of actions by those at all levels while tackling concern, capabilities and regulation. By thinking about the world we want to live in we can develop ideas on how to get there.

Future-proofing New Zealand farming

The following are some prototype actions developed. These are not intended to be comprehensive, nor a replacement of those currently being undertaken. They are intended to provoke discussion about what New Zealand could do in mitigating agricultural greenhouse gases and these ideas together represent a mutually reinforcing package.

Regulation

There are two main options for regulation to mitigate agricultural emissions – command and control along with some type of pricing mechanism. The first approach would set requirements for farms to undertake certain mitigation options, but while it may be used elsewhere, New Zealanders tend to be resistant to this. Livestock farms vary greatly in their characteristics as we have a very diverse range of landscapes and climates for a small country.

A pricing mechanism allows farmers to choose the optimal mitigation actions on their farm, given an efficient price signal. With the superior knowledge of their farm, farmers can undertake the optimal level of mitigation. The unsubsidised nature of the New Zealand agricultural sector might mean it is more suited. A mixture of both options could be used, an example of this is minimum regulated standards of farm practices along with a price incentive to encourage action above the minimum.

Currently, agricultural emissions are set to enter the ETS at the processor level because a small number of participants in the ETS makes administration costs lower and operation easier. A major problem in the current proposed ETS for agricultural emissions is that the price incentive is based on a national average emissions factor, which determines a processor's emissions liability. This means that Fonterra, for example, would consider this emissions cost when deciding the price farmers get for their milk. However, this does not take into account the large variation in farm efficiencies in New Zealand, nor does it encourage mitigation action on individual farms.

The processor-level system could be modified to acknowledge the use of some mitigation techniques on the farm. Recognised mitigation techniques could earn that farmer a subsidy, set at a level to offset the emission charges on the greenhouse gas emissions they reduce. There are limits to how accurate this approach is in terms of accounting for emissions mitigated on each farm and the number of mitigation actions it can apply to.

Ideally the ETS would operate at farm level, so that farmers directly face the full costs and benefits of their decisions and mitigation actions. A farm-level ETS will require the modelling of emissions of all farms in New Zealand, an administratively difficult task. Whether the ETS ends up being at the farm level remains to be seen. However, the recent review of the ETS recommended farmers as the participants in the ETS, not their processors, as did the government's Agricultural Technical Advisory Group in 2009.

Bringing farmers into the ETS does not mean they have to bear the full cost of their emissions. Public debates about the ETS often fail to separate the issues of fairness and efficiency. Farmers could be compensated for their costs while still facing the price of their emissions at the margins. This would give farmers an efficient price signal for their emissions, but not reduce their income or the equity in their farms. What is fair is a more contentious problem than what is efficient and a more difficult problem to resolve.

Fairness

The question of what is fair is not a technical one. We have identified three principles for sharing costs. The first is a child's view, which is commonly shown in behavioural economic experiments. Most people believe in the general principles that everyone should have their turn, with tasks and rewards equally shared. Application of these ideas however begs the question of what is shared and among whom.

A second is polluter pays. This also has appeal but begs the question of who the polluter is. Is the farmer or the consumer responsible for agricultural emissions? If the polluter must be responsible for their actions, they must understand that they are causing damage and have the ability to do something about it.

The third principle is that those who are more able to bear costs should bear higher costs. We live in a very unequal world and need to take all opportunities to reduce those inequalities or at least avoid making them worse. We also need to be clear about who will bear the costs. This depends on whether costs can be passed on to consumers as well as on the abilities of farmers to mitigate them.

Equitable sharing of costs is only one motivation behind free allocation of units to farmers in New Zealand. Others are dealing with potential leakage of production outside this country, smoothing the transition into a new economy with low emissions and encouraging participation and compliance in a situation where change requires action by more than 40,000 farmers. These last three motivations are important in the short to medium term. In the long term, free allocation should be all about perceptions of equity as these adjustment challenges should be dealt with by then.

Incentives and contracting

Develop a set of graduated qualitative greenhouse gas focused standards for management practices on the farm. Farmers can display these in their communities and may be able to improve the value of their products. For example, Taupo Beef provides a marketing niche product on the basis of the regulation of Taupo water quality. As New Zealand farmers improve their greenhouse gas efficiency, AgDialogue participants saw it as important to have a credible national brand to promote the environmental performance of food producers.

Consider alternative financing mechanisms. The ETS revenue could fund some initiatives and other options such as a capital gains tax on agricultural land could be explored.

Conclusion

The climate challenge is perhaps most difficult in agriculture, and for such problems such as this there is a clear leadership role for small countries such as New Zealand. There are the conflicting objectives of feeding a growing global population and simultaneously recognising the important role agriculture must play in climate change mitigation.

By recognising the need for coordination, and by thinking about concern, capability and regulation, New Zealand could develop a package of effective national actions on agricultural emissions which could be adapted for use in other countries. The agility of a small country allows more rapid and innovative policy development than could occur in a larger jurisdiction.

Tackling agricultural emissions needs to be collaborative at both a national level and international level. New Zealand's example in this area could encourage other countries to act. If green growth is to be achieved, if the world's population is to be fed, and if the worst effects of climate change are to be avoided we need to take agricultural emissions seriously. That requires vision, innovation, collaboration and a lot of hard work.

Suzi Kerr is a Senior Fellow at Motu Economic and Public Policy Research based in Wellington. Zack Dorner is a former Research Analyst at Motu Economic and Public Policy Research, currently completing an honours degree in economics.

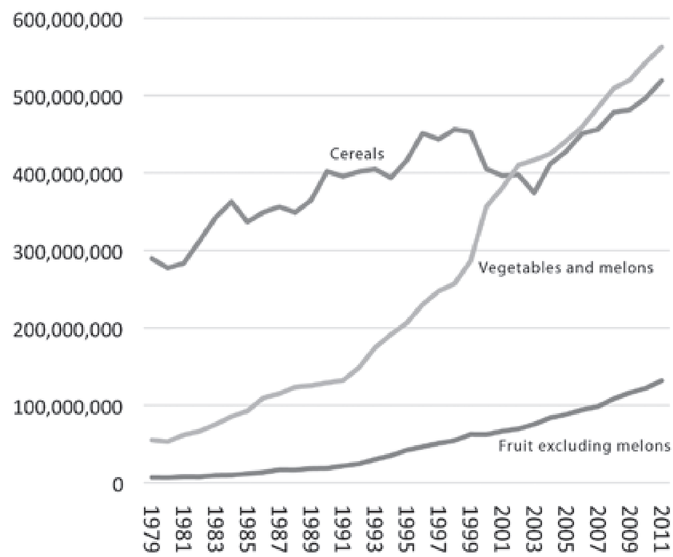
Xiaomeng (Sharon) Lucock and Keith Woodford

New Zealand's horticultural opportunities in China

Walk into either the Olé or BLT supermarkets, both high-end supermarkets in the World Trade Centre in Beijing, and the first products at the entrance in September 2013 include New Zealand Zespri green and sungold kiwifruit. Four-fruit convenience packs were selling for CNY 106.3, which is a little over five New Zealand dollars for each fruit.

In contrast, at a Carrefour supermarket in downtown Shanghai in the same month, imported New Zealand Zespri kiwifruit were selling for less than a fifth of this price at CNY 4.58 each, slightly less than a New Zealand dollar for each fruit. At the same Shanghai supermarket, locally produced green kiwifruit were selling for less than a fifth of this again, at CNY 6.56 a kilogram, which is about $1.25.

This begs the question of why such differences? How is value being perceived? Who is getting the apparent profits? It is not that China is short of fruit and vegetables. In the 32-year period from 1979 to 2011, Chinese vegetable production increased 10-fold and fruit production 18-fold. In contrast, the production of cereals during this period did not quite double.



Vegetable, fruit and cereal production in China 1979 to 2011

Kiwifruit is clearly the standout New Zealand horticultural product in Chinese supermarkets, but there are other examples. For example, we have seen a 20-minute Chinese television infomercial about New Zealand grown Pink Lady apples, an Australian-owned brand. Apparently a full container of these apples was then sold online within a 30 minutes of the infomercial at $1.40 per apple. The notion that television watchers could even be enticed to watch a lady and her cheer team extolling the virtues of Pink Lady for 20 minutes non-stop, let alone rushing online to purchase the apples, demonstrates how things are done rather differently in China.

New Zealand's horticultural products do have a presence in China, but are there more opportunities? What are the things that need to be thought through before entering this enormous market?

Local production

Chinese horticultural production systems are sophisticated. Large glass-house systems are to be found all over China. In some cases individual farmers lease part of a facility, in others it is industrial horticulture undertaken by large companies. At a technological level, the Chinese know how to produce the staple crops at a low cost of production. Root crops usually sell for well under one New Zealand dollar a kilogram and other local vegetables at well under two dollars.

Local and imported product prices in Xi'an supermarket November 2012

	Price per kilogram in New Zealand dollars equivalent $1 = CNY 5
Local	
Potatoes	0.63
Kumara	0.35
Cabbage	0.20
Tomatoes	1.20
Beans	1.40
Chillies	1.60
Imported	
USA plums	8.00
USA lemons	8.00
USA oranges	5.50
USA red grapes	12.00

The Chinese also understand technologies such as hydroponics and they have been using these for decades. In relation to both large-scale and precision horticulture, it is therefore probable that we have more to learn from them than they from us. Of course not all Chinese horticulture systems are industrialised, but this is the way of the future, particularly as labour costs increase.

It means big glasshouse units, big kiwifruit orchards and big vineyards. China may well have many challenges producing the feed for the growing herds of dairy cows and pigs, but it has no difficulty in producing the volume of fruit and vegetables needed for human consumption. Therefore if foreigners try and compete with local Chinese production at the commodity level they will fail. There is no chance of success.

Local supply chains

Supply chains for local produce are in a state of transition. With an increasingly urban population, the logistical demands of getting produce from the farms to the cities are increasing. Most fruit and vegetables are probably still sold through wet markets, although supermarkets are rapidly building their market share. The attraction of the wet markets is supposed freshness and cheapness, but with no guarantees of provenance.

However, not all produce sold in wet markets is necessarily of local origin. Even imported produce, particularly from other Asian countries, makes its way from large wholesalers to street-side sellers. Cool store facilities are limited and therefore shelf-life is usually short. Moving products throughout China is becoming increasingly straightforward via the super highways which criss-cross the nation.

Once outside the cities, travel is rapid, with highways of at least six lanes, but in general there are no centralised distribution systems to the supermarkets. This applies for all products, not just horticulture, and this is a major inefficiency in the system. Some large horticulture producers run their own fleet of chilled trucks while others rely on logistics companies.

Imported products, food safety and healthy living

Imported products from Taiwan, South Africa, the Philippines, the United States and New Zealand now reach the supermarkets of even the most distant cities of China, thousands of kilometres from the ports. Prices are generally at least twice those of local origin and in many cases much more. This price positioning relies on two intangibles. The first and most important is the perceived food safety. The second relates to the status associated with being able to eat new products and offer foreign fruit to your guests.

Beijing upmarket store prices September 2013

Product	Source	Price per kg in NZ dollars equivalent
Green grapes	Chile	20.00
Black grapes	Chile	28.00
Black grapes	Shanghai	2.80
Black grapes	Xinjiang, western China	6.40
Green apples	Chile	10.00
Red apples	Chile	6.00
Pears	South Africa	12.80
Grapefruit	South Africa	5.60
Pomelo	Taiwan	12.00
Green kiwifruit	New Zealand	14.80
Kiwi sungold new variety	New Zealand	37.20

Food safety concerns are everywhere in China. Nobody trusts the local systems. The most prominent food safety scandals in recent years have been melamine in milk and rat meat sold as lamb. There have also been a myriad of other examples including aflatoxins, cadmium and mercury in food of plant origin. Within horticulture there is no consumer confidence in relation to chemical residues from pest control. Consumers are also wary of chemicals sprayed on to improve the appearance. We know of Chinese who prefer to buy unwashed carrots with soil still attached, indicating they had not been sprayed and more likely to have been recently harvested.

Chinese concerns for healthy living and longevity are rooted in Taoism, also known as Daoism, a philosophy which goes back more than 2,000 years. Taoism emphasises the seeking of eternal life from both spiritual and physical meditation. A big part of the physical meditation is by eating the right kind of foods. There is a complex theory about what foods are hot, warm, cool, cold, rich, nourishing or harmful and is so complex that even an average Chinese person would not totally understand.

Any food intake is either to nourish or harm the body, although the degree of such nourishing and harming may vary greatly depending on the specific food. For example, peaches are regarded as warm and nourishing whereas apricots are hot and harmful. Even worse are plums, which are believed to be cool and lethal if consumed too much. There is an old saying, 'Peaches nourish the body, apricots harm the body, and under the plum tree lies the buried body.' The fact that such notions may lack a scientific basis is irrelevant. The main concern is that food and culture are closely intertwined.

The Chinese want food that is natural because they perceive it as more likely to be safe. Organic farms on city outskirts where people can either buy their own produce, or have the it delivered to their apartments, are increasingly popular among the wealthy and privileged classes. Similarly, food from the grasslands is perceived to be more likely to be free of artificial chemicals.

With regard to New Zealand, the perception of a distant and remote island country which is genuinely clean, green and unspoiled is very powerful. In contrast, we have seen no evidence that the Chinese are prepared to pay more for green food for any altruistic reasons, such as to save the planet. It is simply that they associate such food with safety.

Current trading relationships

In 2012, New Zealand exported horticultural products to China worth $105 million with the major ones being kiwifruit making up $94 million, frozen peas $4 million and apples $2 million. Apart from kiwifruit, for which a tariff of 8.9 per cent was applied in 2012, reducing to zero by 2017, nearly all other horticultural products are already tariff-free under the free trade agreement. This compares to other World Trade Organisation countries which pay 10 to 25 per cent.

Chinese kiwifruit at the same price as Zespri green in Shanghai

Vegetable seedling production in a controlled environment

Variety of fresh produce in a Shanghai supermarket

Hydroponic vegetable production in a controlled environment

However there are phytosanitary barriers which require government-to-government negotiations. From a New Zealand industry perspective these have been proceeding inordinately slowly. In some cases, New Zealand has put forward the relevant submission to China, but other crops such as capsicums and tomatoes have apparently yet to get on to the list for consideration.

Opportunities for fruit and vegetables

The Chinese are very open to new foods. In the past, many crops such as carrots, peppercorn and dates were introduced via Central Asia and the Silk Road. For example, the Chinese name for the carrot, which is widely eaten in China, translates back to English as foreign radish. More recently, lemon and avocado juices are being found on restaurant menus among other traditional fruit juices. Similarly, although Chinese apples are traditionally sweet rather than tart, a niche has been found for the tart Pink Lady.

Blueberry, avocado and feijoa have all been suggested to us as fruit with currently unrealised potential for China. Another opportunity is with vacuum-packed dried fruit and vegetables. These, such as dates or apple slices, can retain good colours of the original fruit and are often offered as snacks on airlines in China. There are also opportunities for branded fruit juices which appeal to the demand for safe food.

The flower industry

In recent years there has been spectacular growth in the Chinese flower industry, particularly in provinces such as Yunnan where there are regions with an all-year sub-tropical climate, as well as throughout China using controlled environments. However, 2013 has been a watershed year with demand plummeting. This downturn is mainly due to a government crackdown on official extravagance, led by the new President Xi Jinping.

No longer are fresh flowers used for lavish banquet decorations. It is not just the decorations that have gone, the banquets themselves are no longer being held among the nation's 26 million officials. This has reduced the demand for flowers by at least 20 per cent. Only time will tell if this is a short or long-term change.

Investments in Chinese horticulture

The two best known examples of New Zealand investments are Global Horticulture in Shaanxi Province, in what the Chinese call north west China although geographically in the centre, and Biovittoria in Guangxi, in south China and bordering Vietnam. Both are wholly-owned foreign companies. Global Horticulture has been an ambitious investment in kiwifruit orchards, pollen production, new varieties, cool stores and a juice factory. Currently this company is going through a restructure having seriously over-reached itself financially. The evidence would suggest that the Chinese kept their side of the bargain in terms of the business environment they offered, but the New Zealanders fell short.

Biovittoria is the brain child of Dr Garth Smith who discovered that a particular mogroside within the local luo han fruit could be used as a natural zero calorie sugar replacer. Biovittoria processes the extract to a powder form. This company continues to chart a development trajectory and has 'generally regarded as safe' status from the US Food and Drug Administration allowing the product to be used commercially.

The processing occurs in China, but the company is headquartered and managed from New Zealand. Dr Smith, although still resident in China and the founding director, no longer has an operational role. The last public announcement from the company was in August 2012 with the launch of zero calorie Nectresse in association with a Johnson and Johnson subsidiary McNeil Nutritionals. The company has the protection of processing patents, but its long-term future will depend on getting a good supply of quality fruit from contract Chinese growers.

The third notable New Zealand horticultural endeavour in China has been that of expatriate Lew Dagger. He is based in Yunnan, but with horticultural interests across many provinces. He originally went to China to commercialise the international marketing of the red pear, developed with input from Plant and Food. Although still involved with the red pear industry, Lew, to use his own words, 'failed to internationalise the product'. The reason was that local prices were too good for any of it to be exported. He has subsequently found a niche in the licensing of foreign plant varieties to Chinese companies, despite the challenges of intellectual property protection, and he consults widely across China on horticultural development and marketing.

Conclusion

There are opportunities for New Zealand within China's horticulture sector, but this will not be in the commodity sector where the local cost of production is much lower than in New Zealand. The Chinese horticulture advantage comes from relatively low labour costs combined with modern technologies. This creates a different situation from dairy and meat where New Zealand's competitive advantage does extend into commodity products and markets.

In contrast, a competitive advantage for New Zealand's horticultural products in China requires a branding focus aimed at top-end markets, with an associated clean green story which translates as meaning safe food. Phytosanitary challenges for some crops still need to be sorted out at a government level. As well as fresh produce, the opportunities can include fruit juices and dried fruit. There may also be opportunities, under strict licensing and quality control, of patented and trade-marked New Zealand-bred varieties.

Xiaomeng (Sharon) Lucock is a Lecturer in Agribusiness Management at Lincoln University. Keith Woodford is Professor of Farm Management and Agribusiness at Lincoln University and has been visiting China periodically since 1973.

Profile

Lucy Cruickshank

Lucy Cruickshank grew up in Invercargill on her parent's sheep and beef hobby farm. Her parents, Liz and Peter Cruickshank, were both heavily involved with rural broadcasting with her father reporting for *Country Calendar* and *The South Tonight,* and her mother on local and national radio. Her grandfather, Reg Cruickshank, was an exporter of primary produce from the 1920s to mid-1970s which included wool, hides, seal skins, possums, rabbits, calf skins, deer and even the last export of seal skins from New Zealand. He established a sawmill, a canning factory and forestry and was in his day, the tenth largest exporter of wool from New Zealand. These roots of agriculture, the media and exporting lay the foundations for her career in the agricultural marketing of New Zealand's products.

At school her best subjects were agriculture and horticulture. Many of her peers thought it was an odd subject to take and regarded it as being one for the academically challenged. However she enjoyed the marketing focus and the opportunity to study some of Southland's best exporters such as Pyper's Produce, Van Eeden Tulips, Chard Farm, Molyneux Orchard and the local apiary. In her view the attitude has to change that agriculture and horticulture is for students struggling at school. We need the brightest producers to lead New Zealand from the grassroots up.

At the end of secondary school she accepted a scholarship from the Alliance Group to study marketing at Otago University. She graduated with a Bachelor of Commerce and a Bachelor of Physical Education in 2002.

Various jobs

One of Lucy's defining characteristics is taking the road which is less travelled in terms of subjects and careers. This was the case when she graduated and took up a job as the first marketing and sales executive role for Tohu Wines. It was then owned by Wi Pere Trust, Ngati Rarua Atiawa Iwi and Wakatu Inc.

Her peers questioned why she would want to represent a Maori wine company when she was not Maori, but she has always felt that New Zealand needs to be more involved in its Maori roots. This job opportunity allowed her to combine her interest in indigenous cuisine, culture and singing waiata with talking to buyers from around the world. A year into the position she presented a paper to the board of Wakatu on implementing a family branding strategy across their horticulture, seafood and viticultural assets. Soon after this she became brand manager for family brand Kono meaning 'food basket'.

Wakatu then moved her to the United Kingdom to manage sales of wine and seafood. It was a good opportunity to practise international marketing and sales and see some of the northern hemisphere. After six years working with Wakatu and their indigenous brands, Lucy was offered a role with fast growing honey company, Watson & Son. She made the move from London to Masterton to learn this industry.

As global sales manager she met with some of the world's biggest buyers of manuka and health-related products and got to explore New Zealand's potential of selling unique high quality products underpinned by cutting edge science. Moving from a city of eight million to Masterton, one of just over 20,000 people, was a shock but she enjoys the outdoors and quickly made Wairarapa her home.

Leadership

Over the years Lucy has been offered various leadership opportunities in the community and agriculture sector. While working at Wakatu in 2006, she was invited to apply to be an inaugural participant on the Food and Agribusiness Market Experience. This is a unique professional development opportunity for people in the agriculture sector to see some of the world's best examples of agricultural and marketing ventures.

The programme is run in conjunction with the Universities of Otago, Lincoln and Massey. It aims to develop the next generation of sector leaders within New Zealand. Lucy received scholarships from Wakatu, Lincoln University and Agmardt to be part of the experience. It was an opportunity for her to hear about some of the important problems and opportunities for this country's products off-shore.

In 2010, Lucy joined a group of 40 New Zealand

agri-future leaders on the Jenysys exchange programme to Japan. The scholarship enabled her to see the culture and requirements of the Japanese market for New Zealand products. She now exports products directly to a client in Japan promoting food and beverages via an on-line marketing site.

Lucy has also served on various local committees and is currently on the Wairarapa Chamber of Commerce Board. She belongs to local agriculture leadership group and is also a member of 43 Below, a network aiming to provide opportunities for competent executives to remain in the Wairarapa.

Business ventures and home life

Lucy is a self-confessed incubator of ideas. She enjoys getting new businesses, brands and markets established and then handing them on to others to continue with the day-to-day operations. After leaving Watson & Son four years ago, she established her first company and brand – Pure Aotearoa. The business was designed to promote this country's honey, wine and seafood to off-shore clients. The brand was sold to a New Zealand trading company and the Pure Aotearoa food and beverages are now available in various off-shore markets.

The next initiative she established was Pure Wairarapa, an umbrella brand designed to market and sell local artisan foods to gourmet chefs and retailers nationally. The venture was not viable and the brand was recently sold. From this experience Lucy learned that the distribution side of business was not her strength.

Lucy is currently project managing a new initiative for the Poutama Trust called Indigenous NZ Cuisine. This is a group of 30 Maori food and beverage producers which targets joint marketing initiatives in New Zealand, Asia and Australasia. Over the past four years she has also worked with various national food, beverage and agricultural groups, consulting and coaching them in the marketing space through her consultancy business. Lucy values the importance of networking and believes that much can be learned from other company's networks, successes and failures. In her view cooperation helps companies to benefit from each other for the collective and individual good.

Lucy also has a busy out-of-work life. Her partner Simon Griffiths runs a local IT company, which services the region's businesses including agri-businesses. She is a keen triathlon participant and has completed three half-ironman events.

Her love of cooking helped her become a finalist in the 2012 season of Masterchef, and she is also part of a Wairarapa female vocal ensemble. Recently she was narrator in a local production of Joseph and the Technicolour Dreamcoat.

The future for the sector

Lucy sees a number of concerns as being important to the agricultural marketing sector in the future. It will be necessary to get closer to the consumer by becoming actively involved with social media and on-line channels to market. We need to manage brands so that they resonate with discerning customers globally, and this can be ensured by using focus groups and other market research with international markets.

She feels we need to make sure our products are unique and underpinned by credible science. The manuka honey industry is an example of how science has allowed this honey, which was once fed to animals and difficult to sell locally, to become one of the world's most expensive. It has also turned some unproductive native scrub land in New Zealand into sought-after property.

Another concern is the need for more women in leadership and she believes that women should play more active roles in the New Zealand agriculture sector. Women on boards can lead to enhanced company performance and culture, with examples including Mavis Mullins, Nicola Shadbolt, Lindy Nelson and Emily Crofoot.

Finally, as already noted, Lucy feels that there is a need to help more talented young people into studying agriculture. For her it is not acceptable for agriculture to be perceived as the subject for those who are not academically inclined. She sees that the way to change this is to get more role models telling their stories and showing what a lifetime commitment to agriculture can achieve for New Zealand.

Peter Burke

Ahuwhenua Award creates a new generation of Maori farmers

As the government aims to double primary exports by 2025, one of the sectors it is relying on to achieve this is the growth of Maori agribusiness, a point made many times by the Minister for Primary Industries Nathan Guy.

The current growth of Maori agribusiness is not widely known. Maori tend not to seek the limelight for their success, but as their businesses develop it is becoming increasingly hard for them to fly under the radar. The reality is that about 10 per cent of the milk produced in New Zealand and 15 per cent of sheep and beef production comes from Maori farms. For example, a Maori Incorporation Paraninihi ki Waitotara is Fonterra's largest supplier of milk in the Taranaki region, with close to three million kilograms of milk solids produced annually. Maori also account for 10 per cent of Fonterra shareholders.

Maori also have their own milk processing factory, Miraka, based near Taupo and this produces milk powder for export to Asia, the Middle East and South America. They have recently signed a joint venture agreement with the Chinese dairy company, Shanghai Pengxin. The latest statistics show that there are 129 Maori incorporations and 5,200 trusts in New Zealand administering about two-thirds of all Maori land. The top 10 Maori incorporations control over two billion dollars in assets, most of which are in the primary sector.

While the achievements to date are impressive there is still a lack of appreciation in the wider community, and even within the primary sector, about the contribution that Maori agribusiness makes to the New Zealand economy. This is not helped by the fact that the mainstream media generally ignore this area according to Kingi Smiler, Chairman of the management committee which runs the Ahuwhenua Trophy BNZ Maori Excellence in Farming Award.

Ahuwhenua Trophy history

One of the reasons for the renaissance of Maori agriculture has been the creation of an award – the Ahuwhenua (sons of the soil) Trophy – instigated 80 years ago by Maori politician, leader and visionary Sir Apirana Ngata. The trophy is competed for annually by individual Maori, trusts and incorporations and it rotates between sheep and beef and dairy farming. In 2014 it will be for dairy farming.

The origins of the trophy go back to the early settlement of New Zealand when land was bought and taken from Maori, and what they were left with was mostly poor quality and in remote areas. During this period Maori were excluded from access to capital to develop their land.

In 1931 Sir Apirana Ngata persuaded the Governor General at the time, Lord Bledisloe, to look at the state of Maori land. Concerned at what he saw he donated a trophy, and with Sir Apirana launched the Ahuwhenua competition. The strategy was to lift the performance of Maori farming by setting judging criteria which would provide a set of practical and achievable aspirational aims. The vision of Ngata and Bledisloe is still there today, which is their pursuit of science, of aggregating small-holdings into larger economic units, of nurturing the environment and of making a profit, cornerstones of the Ahuwhenua competition.

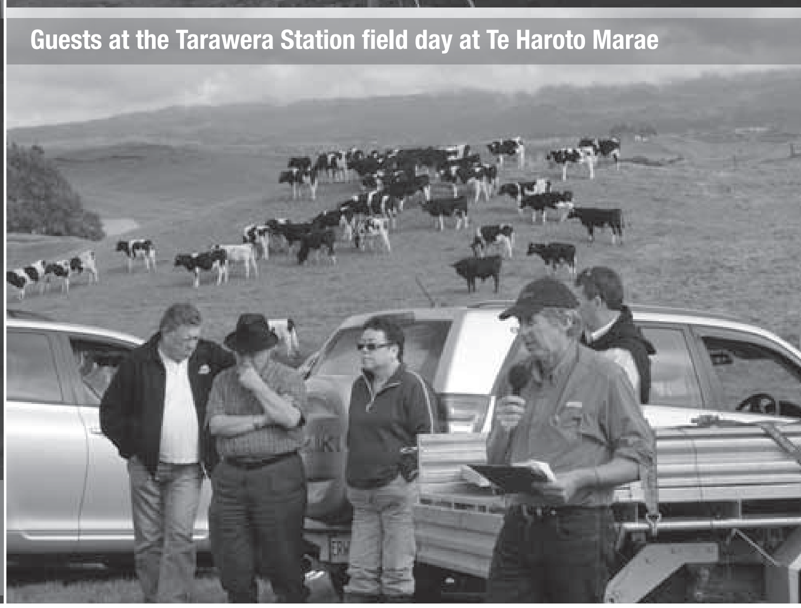
Winner of the 2013 Trophy for the best sheep and beef farm Tarawera Station Tamihana Nuku Chairman of the Te Awahononu Forest Trust with Hon Bill English and Hon Pita Sharples

Jordan Smith winner of the 2013 Young Maori Farmer of the year

Roku Mihinui, Chairman of the Kapenga M Trust the winner of the 2012 Award for the best dairy farm, with Sir Jerry Mataparae, Governor General

Kingi Smiler, Chairman Ahuwhenua Trust

Taruhara Moana Trust near Taupo were one of the finalists in the 2012 Trophy for the best dairy operation



Guests at the Tarawera Station field day at Te Haroto Marae

Maori resilience

In the early days Maori farmers and their families worked hard to clear the land and improve the performance of their stock to produce high quality milk. They looked at ways to further process their milk and built their own dairy factories and exported their produce. In those days there were scrub cows with quite basic milking sheds. Today high-yielding cows, stainless steel and farms which benchmark against the best in the country are the order of the day.

The history of the Ahuwhenua Trophy has been recorded in a recent book, *Ahuwhenua: Celebrating 80 years of Maori Farming*, to commemorate this important achievement. It is a story which goes beyond most of the writing about the Treaty of Waitangi and shows the resilience of Maori to triumph in the face of extreme adversity and oppression. It explains the efforts of Sir Apirana Ngata who persuaded his own people and the government of the day to back his vision in tangible and practical ways.

It was Ngata who started the renaissance of Maori agriculture in the 1930s, which had flourished until the arrival of the first settlers. It was he who convinced his parliamentary colleagues to make legislative changes which helped change the course of history in terms of Maori Ahuwhenua.

Award winners

In the early days it was mainly single individual farmers who won the award, and today there are still some of these, such as the 2008 dairy winners Dean and Kristen Nikora of Hawkes Bay. The most recent winner of the dairy award was the Kapenga M Trust based 20 kilometres south of Rotorua. Their 330-hectare property runs a mixed Jersey and Friesian herd, which in 2009 was producing 241,441 kilograms of milk solids. The profitability of this farm is above the national average when benchmarked against all dairy farms in New Zealand. The Trust, which has 915 shareholders, also won the Ahuwhenua Trophy for the best sheep and beef farm in 2003.

Kingi Smiler says that one of the main differences between Maori and mainstream farming is that Maori are required to farm for sustainability and also to generate cash returns for owners. For him the land is never going to be sold and it is being held for future generations, the current generation therefore needs to benefit. For that to happen there have to be cash dividends, education and cultural support. This contrasts with mainstream farming which is about property development and capital gain.

He also says that Maori farms are between three and 10 times larger than most commercial farms and in all areas of performance they are well above the average. This shows that commercial farming can be done on a large scale, and with their leadership and governance Maori farms are becoming role models for the whole industry.

A good example of scale is the 2009 winner of the trophy for sheep and beef, Gisborne's Pakarae Whangara B 5 partnership. The 5,600 hectare property runs 30,000 Romney-based sheep and 5,000 Angus cross cattle. Since winning the award, the trust has continued to upgrade the infrastructure of the farm and recently spent over $1 million reticulating stock water to all parts of the property. They plan to be running 60,000 stock units in the next five years.

Primary Growth Partnership grants

Many of the past winners have both sheep and beef and dairy operations. One of these is Wairarapa Moana Incorporation which won the sheep and beef trophy in 2005 but is now significant in the dairy sector. It is a major shareholder in Miraka and was recently awarded a $1.75 million Ministry for Primary Industries Primary Growth Partnership grant, matched by equivalent industry funding to develop ways of extracting high value proteins from milk. Miraka and Wairarapa Moana were the first Maori agribusiness recipients of these grants.

This one is unusual in that it will take just three years to get it to commercialisation. Projects like this usually take about seven years from start-up to market. The products will be manufactured at the Miraka plant as a powder and used as an ingredient for nutritional and health benefits.

The Primary Growth Partnership programme expects to generate $8.6 million a year to the New Zealand economy by 2021. The venture will also enhance the experience and skill base of Maori agribusiness, investing in higher valued foods and differentiated products for Asian markets. Miraka will operate with in-market partners to ensure a strong consumer connection. This is a good example of the motivation that the Ahuwhenua Trophy has been to support Maori to improve the governance and management of their farms. It is now leading to them improving the returns to their owners and the economy.

Judging the awards

Entering the Ahuwhenua Trophy requires considerable effort on the part of entrants. They need to have a very high performing farm and to produce detailed data about this for the judges. The data is carefully analysed by expert consultants and given to the judges. It is not just the performance of the farm which is judged, there is strong emphasis on governance, the environment, sustainability, and social and tikanga Maori concerns. The way staff are treated is also a factor which is considered.

The judging itself is in two parts. All the entrants are visited by a panel of judges who select three finalists, then over to a completely separate panel to determine the winner. As part of the second round of judging, the three finalists are required to stage a field day on their property and to explain what they have done and why they should win the trophy. This includes a farm tour that can involve transporting upwards of 200 people around the farm and making presentations to highlight the unique features of their enterprise. It is a signifcant logistical exercise for the finalist.

With the field days over the awards dinner is a challenge for the Ahuwhenua organisers – up to 800 people attend including political party leaders, government officials, sponsors, consultants, media and the finalists and their whanau. In recent years a new category has been added to the awards – that of Young Maori Farmer of the Year. This is a statement that Maori are committed to intergenerational farming and developing new leaders and talent.

Wider benefits

The awards highlight the passion and enthusiasm of the whanau of the trusts and incorporations which attend the awards. All winners and participants see the real value of the competition in being assessed and benchmarked, not only with their Maori counterparts, but also with mainstream farmers. What is evident is that top Maori farms perform as well, if not better, than all other New Zealand farms. By virtue of their scale, location and structure they are complex businesses, but year after year the enthusiasm to participate in and hopefully win the Ahuwhenua Trophy never wanes.

Maori have done well, but naturally there are opportunities to develop the land. Politicians recognise the importance of encouraging Maori agribusiness and providing some tangible assistance. Maori have made quantum leaps in the area of governance, the way they structure and manage their multi-million dollar enterprises, and ensuring new leaders are being trained to take care of the future.

Entries for the 2014 Ahuwhenua Trophy BNZ Maori Excellence in Farming Awards for dairy farming are now open. For more information about the awards and Maori agribusiness visit www.ahuwhenuatrophy.maori.nz.

Peter Burke is an agricultural journalist who currently works for the farming magazine* Rural News*, and is also the public relations officer for the Ahuwhenua Awards. He has been a lifestyle farmer in the Horowhenua for more than 30 years.