Ravensdown

INSIGHT AND ACTION FOR AGRICULTURAL SUCCESS

ground EFFECT

SPRING 2015
EDITION 1

"Farming is in our DNA. It's what we do."

George Williams, Grassendale Genetics

Environmental Legislation

New rules, new challenges. Are you ready?

Soil fertility

Gambling on nutrient status a fool's game.

WELCOME TO THE FIRST EDITION OF GROUND EFFECT FROM RAVENSDOWN

We wanted to package up the kind of insights, actions and scientific collaboration that supports New Zealand's agricultural success.

As an aerodynamic term, Ground Effect is all about lift. And we see our co-operative's role as helping customers lift production, profitability and environmental performance for the benefit of the country as a whole.

Whether you are a Ravensdown customer or not, our ambition is that you find some value in the agronomic advice and expertise contained in this publication.

The scientific approach that is so important to us and to a progressive agri-sector, is all about making connections and questioning the status quo for innovative solutions. In this biannual magazine, we'll show you some examples.

Stories such as how the Analytical Research Laboratories team has established a long-term study to monitor whole-farm soil testing trends. Their early results show a huge spread in soil fertility on single properties, raising the possibility of saving money and mitigating potential environmental impact with more precise spreading. Read about their work on page six.

We know how strongly the environment factors into your farming decisions, because it plays a huge part in ours too. For an expert's view of the changing regulatory landscape, lawyer Mark Christensen from specialist resource management law firm Anderson Lloyd, gives us his take on page 33.

We're also delighted to have the Minister for Primary Industries Nathan Guy and University of Waikato Professor of Agribusiness Jacqueline Rowarth write guest commentaries for our first edition.

The MPI co-funds our Primary Growth Partnership as we work with our research partners Massey University and AgResearch to explore remote testing of hill country nutrient status and more accurate aerial spreading. Catch up on how it's tracking on page 12.

Despite the exciting innovation and research that is always on the boil here at Ravensdown, there is nothing we like more than seeing our shareholders succeed. George and Luce Williams are doing just that: forging new ground with their sheep genetics, while balancing family and life on farm. I know you're going to enjoy reading about their experiences as much as I did.

Science is all about experimentation and feedback. Ground Effect's packaging up of the good news agri-science stories is a new innovation for Ravensdown, so it would be great to hear from you about what you think. Just drop me a line at the email address below.

Best Regards
Greg Campbell
Ravensdown Chief Executive

CEO@RAVENSDOWN.CO.NZ

This edition

Thought leaders

Regular content

BEHIND THE SCENES

Ravensdown is collaborating for a sustainable future

Slug Damage Control

Ravensdown has teamed up with AgResearch to provide guidelines for farmers on monitoring and optimising molluscide use, based on a damage-forecasting tool.

agresearch

Overseer

We've been involved with Overseer for years and are currently improving the accuracy of the nutrient modelling tool. This year, we're working with The Foundation of Arable Research on Overseer for Cropping – determining the extent of nitrate leaching from cropping rotations, climates and soils.

OVERSEER®

Water Quality Monitoring

Ravensdown is working with Lincoln University to continually monitor water quality through sensors at Southland Demonstration Farm.

SOUTHLAND DEMONSTRATION FARM

Certification of Nutrient Management

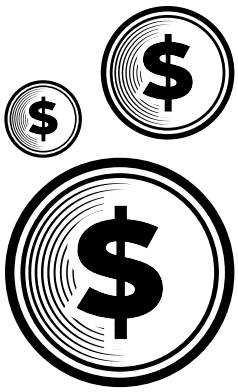
We celebrated a recent milestone as the first agricultural company to have more than 50 staff certified through the Nutrient Management Adviser Certification Programme. The NMACP was developed in 2012 to define a transparent set of industry standards for professionals to meet, to provide nationally consistent advice to farmers.

To become certified, Ravensdown Agri Managers complete the Intermediate and Advanced courses in Sustainable Nutrient Management in New Zealand Agriculture at Massey University, plus demonstrate their skills and knowledge through a competency assessment.

Nutrient Management Adviser Certification Programme Ltd

The future of the primary sector

By the numbers



$11.1 billion
potential economic benefits of the PGP programme

$25 million
allocated to the Irrigation Acceleration Fund

$120 million
allocated to Crown Irrigations Investment Limited

$7.5 million
invested to boost skills and systems across the primary sector

I'm proud to be the minister responsible for the primary sector, which is still the backbone of New Zealand's economy. The goal we've set as a Government is to double the value of our primary sector exports by 2025. My vision is that we'll be a world leader in producing premium, value-added products that are in huge demand around the world.

The regions will be booming and the primary industries will be a top career choice for our best and brightest young people.

Science will have helped us become a world leader in environmental sustainability, not just mitigating our footprint, but actually improving things for future generations.

Of course, to achieve all of this won't be easy – especially when commodity prices like dairy fluctuate a lot. We know there will be a lower payout for dairy farmers this year, but at the same time, beef exports are strong and horticulture is enjoying a record year.

We produce enough food to feed 40 million people and there is only limited scope to increase that volume. Therefore, we need to be targeting the wealthiest 40 million individuals across the globe.

This is why innovation is so important, and why the government is working together with the industry through the Primary Growth Partnership (PGP).

There are now 17 PGP programmes underway covering a broad range of industries, with a total of $720 million co-invested into cutting-edge programmes.

One great example is 'Pioneering to Precision', a $10 million project with Ravensdown (read more about this on page 12). The aim is to improve the use of fertiliser on hill country farms using remote sensing and GPS technology, delivering real economic and environmental benefits.

If successful, this could transform the way fertiliser is applied in farming in New Zealand. It will improve profitability and generate earnings of $120 million per year by 2030 from additional exports of meat and wool.

There are many other great examples of innovation the PGP is kickstarting, such as Precision Seafood Harvesting which is developing new nets to target fish by size and species.

A new technology for developing mozzarella cheese allows it to be produced in one day, instead of months. And new remote control robotic tree fellers are being exported as a much safer way of harvesting logs from dangerous slopes.

A report by the New Zealand Institute of Economic Research shows the potential benefit of PGP is around $6.4 billion by 2025 – with the possibility of up to $11.1 billion if the aspirational stretch of some of the programmes is realised.

We also have a strong focus on developing irrigation and water storage, the need for which is obvious given droughts in recent years all around New Zealand.

> **"We'll be a world leader in producing premium, value-added products that are in huge demand around the world."**

We don't have a shortage of water in New Zealand; it just tends to fall in the wrong places at the wrong times.

Providing a reliable water supply for farmers and growers has massive potential to boost growth, creating jobs and exports in provincial regions. I've seen for myself what a difference irrigation makes to rural communities, revitalising schools and entire towns, and creating jobs for locals.

NATHAN GUY IS MP FOR OTAKI AND THE MINISTER FOR PRIMARY INDUSTRIES AND RACING. BEFORE ENTERING PARLIAMENT HE WAS INVOLVED IN FARMING AND LOCAL GOVERNMENT, SERVING FOR EIGHT YEARS ON THE HOROWHENUA DISTRICT COUNCIL AND MANAGING THE FAMILY DAIRY FARM.

The Government has allocated $120 million to Crown Irrigations Investment Limited (CIIL) to support major projects, and we also have the Irrigation Acceleration Fund (IAF) to kickstart smaller projects at the planning stage. In Budget 2015, we allocated a further $25 million towards the IAF.

It's worth noting that irrigation projects often have environmental benefits, such as more consistent river flows which improve the habitats for fish and birdlife, while taking pressure off groundwater aquifers.

Other important policies to help boost our exports include more free trade deals, new roads and rural broadband.

We are also investing $7.5 million into boosting skills and systems across the primary sector. Some of this will go towards improving Overseer and working with the education system to encourage more young people into primary sector careers.

On that note, it's pleasing to see a 20% increase in funding for agriculture at tertiary level in Budget 2015. This is on top of $25 million over three years to develop three new privately-led Regional Research Institutes.

Of course we are never going to achieve the export double if we don't protect our growers and producers. This is why biosecurity has always been my number one priority as minister, and Budget 2015 backs this up. An extra $27 million will mean more dogs, more x-ray machines and improved auditing of systems in other countries.

There will also be a new levy on overseas travellers to help protect our border (around $22 per trip) which means that travellers will pay for customs and biosecurity services, rather than the taxpayer. This is a fairer, more transparent and flexible way to fund the system.

So there is a lot happening in the primary sector and the long term outlook is very strong.

As the Asian countries on our doorstep become increasingly wealthy, their demand for our protein and our products is only going to increase.

Some forecasts predict global food demand may increase by 40-45 percent in the next 10 years, driven by a rising global population and the emerging middle classes of Asia.

The future looks bright, and it's an exciting time to be involved in our industry.

FERTILISERS' ECONOMIC BENEFITS GROUNDED ON TARGETED APPLICATION

Analytical Research Laboratories has offered whole-farm testing since 2012, to improve the reporting and understanding of soil fertility which often varies significantly across a single property. More than 300 farms have so far participated in whole-farm testing and have adjusted fertiliser applications based on the results. ARL has established a long-term study of whole-farm testing results to track changes in soil fertility as precision application increases.

General practice

On many dairy farms the cost of fertiliser is the third highest input, making efficient nutrient management critical to achieving maximum return on investment, while minimising nutrient loss to the environment. Traditionally, soil testing has been used as a management tool where monitor paddocks, representative of larger, generally uniform blocks with the same soil type, were sampled and the trends monitored.

New demands

As farming has become more intensive the need for more accurate information has increased. Grid soil sampling for precision farming has revealed globally that soil fertility can vary significantly within a single paddock. But variable rate fertiliser and lime applications, based on accurate soil sampling, resulted in a general decrease in fertiliser use. Economic benefits are grounded on spreading additional amounts on low fertility areas and reducing fertiliser on high fertility areas, an approach that increases production and reduces expenditure. These benefits are not only limited to extensive agricultural enterprises, but are within reach of smaller land area enterprises such as dairy farms in New Zealand. Intensive sampling of every paddock on farm will reveal differences between paddocks not possible with traditional monitor-paddock soil testing. Since no expensive capital outlay on precision farming equipment is required, the opportunities to share in the benefits that precision farming bring to farm resource management are open to all.

"Grid soil sampling for precision farming has revealed globally that soil fertility can vary significantly within a single paddock."

ARL Study

ARL established a long-term study of whole-farm soil testing, after offering the service for the first time in 2012. Since then, more than 300 farms, predominantly dairy, have completed whole-farm testing.

Analysis of ARL 2014 soil testing data for dairy paddocks on volcanic ash (1,500 samples), pumice (1,700 samples) and sedimentary soils (16,000 samples) show considerable variation from the scientifically-derived optimum values for pasture production for pH, phosphorus (P), potassium (K), magnesium (Mg) and sulphate sulphur (SO_4-S).

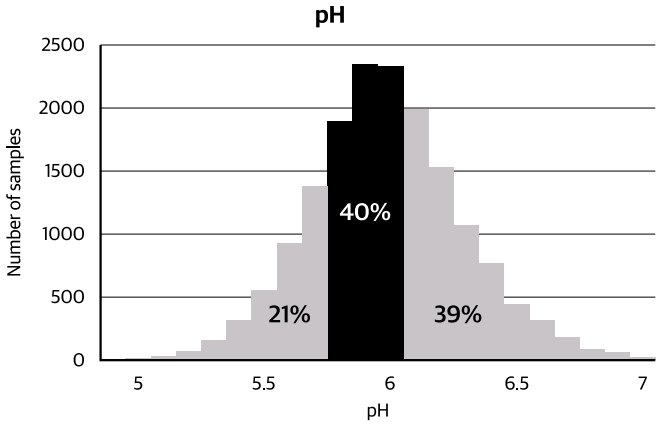
Extremely high and low results were recorded for all three of the soil types, with nine per cent of the sedimentary soil samples recording MAF QT K values above 15 - well above the optimum range.

Soil test parameters for these, presumably, effluent paddock samples, were mostly well above optimum levels, although it was conspicuous that there were also below optimum soil test levels for nutrients other than K. An old concept coined as the law of the minimum by Justus von Liebig (1803 - 1873) which states that the growth of plants is limited to the extent that an essential nutrient is lacking, may be old but still true.

Knowing your nutrient status can lead to cost saving

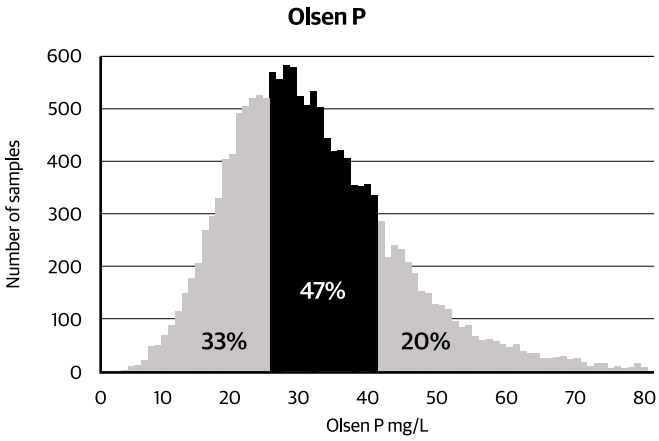
pH

Recommended soil pH range for New Zealand dairy farms is 5.8 – 6.0, which has sound science to back it up. At pH 5.8 and above, there is no detrimental effect from aluminum toxicity. pH 6 is beneficial to clover growth. Above pH 6 the solubility, and therefore plant availability, of trace elements steadily decreases with deficiencies expected at pH 6.5 and above. Sedimentary soil data for 2014 shows 39% of the paddocks had pH values above 6 and 21% were below 5.8. Getting pH right is one of the cornerstones for pasture production but the data is showing the opposite, with too many paddocks under or over the optimum. This is an opportunity lost on either production loss on 21% of the paddocks, or no return on investment for excess lime applied on 39% of the paddocks.



Olsen P

A commendable 47% of paddocks recorded Olsen P values within the dairy optimum range of 25 – 40 mg/L. However, yield losses can be expected on 33% of the paddocks that had Olsen P values below the optimum range.

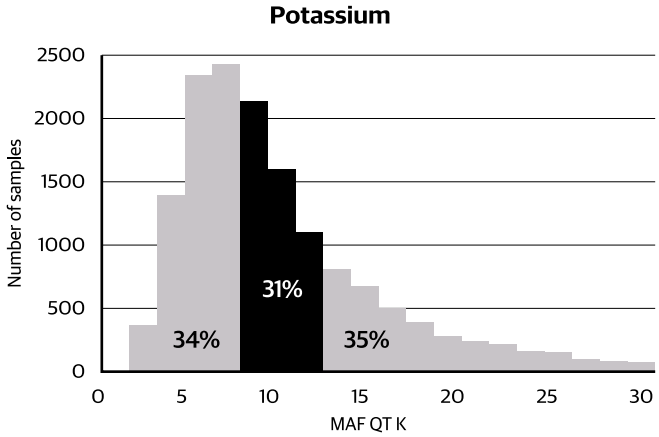


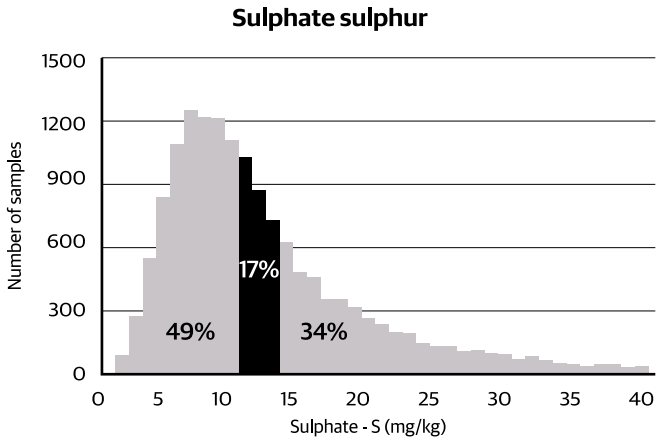
K and SO_4-S

Only 31% of samples had MAF QT K levels within the optimum range with an even split between the rest, being either below or above the recommended range. What is not known is how long these paddocks have been at sub-optimum levels, because, over time, this would have resulted in decreasing yields and lost production opportunities.

Fertiliser K, once applied to the soil, is exposed to potential leaching, it would be economical and environmentally beneficial to reduce the amount of fertiliser K on the 35% of paddocks above the optimum range.

Nearly half of the samples analysed showed sulphate sulphur (SO_4-S) concentrations below the optimum range, which may be ascribed to application practices not keeping up with leaching and other losses.





The pH Scale

THE RECOMMENDED SOIL pH FOR NEW ZEALAND DAIRY FARMS IS 5.8 TO 6.0

Benefits of whole-farm soil testing

Considering the low cost of whole-farm testing, compared to the potential benefits of targeted fertiliser applications, there is a financial benefit to be had, either through improved returns on fertiliser expenditure where yield increases can be expected on paddocks with low nutrient levels, or through savings on inputs on high fertility paddocks.

Milk production is driven by pasture and crop production, which depends on optimum soil nutrient management practices. Based on appropriate soil sampling programmes, returns on multimillion dollar farming enterprises could be optimised further.

Whole-farm testing is an opportunity to ensure that farmers are not wasting money applying lime or fertiliser where it is not required; ensuring they are not limiting pasture production and quality through low soil fertility and ensuring that all essential major nutrients are in optimum supply.

Why so many off target?

Typical spatial and temporal variation in soil test results do contribute to the spread in the data. But the size of the dataset used, reveals the big-picture situation on New Zealand dairy farms. This shows a spread in soil fertility with significant numbers above and below the optimum ranges.

In the past, it was sufficient to group and manage soils as either ash, sedimentary, peat or pumice, but within each of these broad groups are a continuum of physical and chemically differing soils. It is, therefore, understandable that over time the subtle differences in soils from each subgroup is likely to be reflected in differing nutrient concentrations for paddocks not regularly sampled, but managed similarly regarding fertiliser applications.

Intensive whole-farm soil testing, together with paddock specific fertiliser recommendations, is one way for future soil test results to converge on the optimum soil nutrient concentrations over time.

NAPIER-BASED ARL IS A STATE-OF-THE-ART LABORATORY THAT PROVIDES TESTING AND ANALYSIS FOR SOILS AND PLANTS. THE TEAM TESTS THOUSANDS OF SOIL SAMPLES EACH YEAR FROM ACROSS THE COUNTRY.

Perspective: Ants Roberts

Snowed under by a proverbial avalanche of revolutionary product claims?

Bombarded daily with all sorts of information about products you should buy, claiming they will transform your farm business? Soil fertility and nutrient management products are not immune from this, especially given the increased scrutiny and regulation regarding the non-point source loss of nitrogen and phosphorus from farm systems. Here are some proverbial things you should consider:

1. **If it ain't broke, don't fix it:** Farmers who have been using the same proven fertiliser and lime products for many years are sometimes persuaded to try a new product, thinking that pasture production and/or animal health isn't as good as it used to be, even though there may be no reliable measurement of any decline. There are many reasons, other than soil fertility, why pasture production may be compromised, including loss of pasture plants due to drought, insects, disease and (dare I say it!) poor grazing management. Additionally, soil compaction, caused by grazing soils in wet conditions, is the silent thief of pasture production.

2. **Don't put the cart before the horse:** There are 16 essential nutrients, apart from carbon, hydrogen and oxygen, required to produce healthy and productive plants and animals. In most places in New Zealand it is not necessary to apply all of these as fertiliser nutrients, as the soil itself supplies many- especially some of the essential trace elements such as iron and manganese. Test your soils, pastures and even animals to determine what nutrients your farm system requires and correct these major and trace element deficiencies and soil pH as necessary and in the most appropriate way. In some cases, required trace elements may be more cost-effective if directly supplemented to stock.

3. **Even a broken clock tells the right time twice a day:** Some of the magic mixes that unqualified fertiliser advisers recommend are usually light on the major essential nutrients but contain a plethora of small amounts of trace elements. It is possible that by taking this shotgun approach to nutrient management that the mix inadvertently overcomes a hitherto undiagnosed trace element deficiency. However, any visual response to these brews is usually because of the nitrogen added (most of them have this) or even perhaps a plant growth regulator.

4. **Familiarity breeds contempt:** Once you have identified the essential nutrients you need for the production of quality pastures that will confer health, production and wellbeing to your farm animals and have ensured that they are all at the appropriate levels determined by well-researched science, the work has not finished! All agriculture exploits nutrients which get transferred to non-productive areas of the farm, are lost to the atmosphere, lost below the plant rooting depth, or are sold as product leaving the farm gate. There is a continual requirement to maintain the supply of required nutrients to match their removal. When your farm is in a stable maintenance state with respect to nutrients (inputs matching outputs), do not expect to see responses to applied nutrients in either pastures or animals. If your nutrient management programme is correct for your operation, any variation in farm productivity will be due to other factors.

5. **There's no such thing as a free lunch:** Looking at some claims in the agricultural media, it seems to me that there are a multitude of products that promise to deliver a whole heap of benefits - both productive and environmental - when in fact the nutrient content is minor (relative to scientifically understood requirement). The other additives, be they biological agents or plant growth regulators, are either unproven in the former or have short-term benefit in the latter.

> **"seek information and opinions from people who you find credible and trustworthy"**

6. **All that glistens is not gold:** If product claims appear too good to be true, well they probably are not true. You should require at least a minimum amount of conventional credible scientific evidence, as opposed to just anecdotal information, to help you make a good, informed business decision to use a product on the farm. This does not mean you have to be a scientist, but you do need to seek information and opinions from people who you find credible and trustworthy.

DR ANTS ROBERTS, ALSO KNOWN AS 'DR DIRT', IS RAVENSDOWN'S CHIEF SCIENTIFIC OFFICER. A SELF-PROCLAIMED "CRUSTY AND GRIZZLED SCIENTIST", HE HOLDS A PhD IN SOIL SCIENCE FROM MASSEY UNIVERSITY AND A BACHELOR OF AGRICULTURAL SCIENCE GAINED WITH 1ST CLASS HONOURS.

"If your nutrient management programme is correct for your operation, any variation in farm productivity will be due to other factors."

TAKING THE VARIABILITY OUT OF VARIABLE FERTILISER APPLICATIONS

Less than a century ago, farmers were applying fertiliser to hill country farms by hand. It was only in the 1940s that aerial topdressing was introduced to New Zealand. This was a transformational improvement, but fertiliser has been aerially spread in a similar manner ever since. Essentially, this involves a pilot operating a lever to spread a largely uniform rate of fertiliser over the hills, irrespective of the nutrient status of the land or its potential for pasture growth. This can result in over-fertilising some areas and under-fertilising others, leading to waste and poor growth.

MEN POUR FERTILISER INTO A TIGER MOTH TOPDRESSING PLANE AT IHUMATAO, MANGERE, AUCKLAND, IN 1949. SOURCE: ALEXANDER TURNBULL LIBRARY.

Applications of superphosphate have been demonstrated to increase both quantity and quality of herbage. At the Ballantrae Research Station in southern Hawke's Bay, application of 125kg superphosphate/ha/year achieved a 30 per cent increase in dry matter (compared to no application of superphosphate) while 375kg superphosphate/ha/year has resulted in a 70 per cent increase since the early 1970s to today. Ryegrass and clover content also improved with rate of application.

This increase in productivity is due to the nutrients that superphosphate delivers - phosphorus (P) and sulphur (S) - nutrients that are essential for good legume (clover) growth, which in turn, fixes nitrogen. The opportunity to maximise the return from fertilisers containing P and S is to target areas where legumes grow, such as easy slopes and shady aspects where adequate soil moisture is held for longer.

New Zealand hill country pastures are chronically nitrogen (N) deficient. Increased dry matter production can generally be achieved from fertiliser N whenever moisture and/or low temperatures are not strongly limiting growth. In some situations, such as sunny, steep slopes, the response to applied N is greater in spring and autumn than superphosphate. So the opportunity to maximise the return from fertilisers is to target these areas for N application.

What's next?

Variable fertiliser applications continued

Ravensdown has already begun to develop better methods of fertilising hill country with Geographic Information System Smart Maps, which provides a platform for managing data and maps spatially on both flat and rolling land. Proof of placement maps of aerial fertiliser applications can be stored in this software.

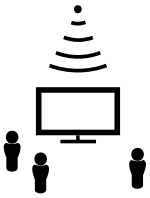
Ravensdown has just completed the second year of its Primary Growth Partnership Programme with the Ministry for Primary Industries - Pioneering to Precision - which aims to develop a more comprehensive method of assessing soil nutrient status on hill country farms. Assessing soil fertility is very challenging on hill country farms which have variable topography, soil types and stock movements. Manual soil sampling to a high degree of detail is impractical and certainly not cost effective. But recent advances in remote sensing and imaging mean that there is potential to measure soil nutrients either directly or via pasture, although this requires considerable research and development.

Alongside this programme, Ravensdown has continued to develop its capability to improve the delivery of fertiliser from the air. Through Ravensdown Aeroworks, fertiliser can be applied with a prescription map which details the boundaries of the farm and areas where fertiliser should and shouldn't be applied and at what rate. The differential system links the aircraft's GPS with a computer-controlled hydraulic gate box. This means the gate box will automatically adjust with changes in speed and also between prescribed fertiliser rates, depending on the differential fertiliser map loaded in the GPS system.

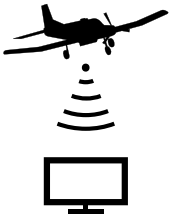
The coefficient of variation (CV) is often used as an indication of the evenness of fertiliser spread, which has significant flow-on effects for maximising pasture growth response from an application. Previous New Zealand research has found aerial applications achieve CVs between 63-78 per cent (Grafton, Yule and Watson, 2012). A comparative differential system currently installed in a Ravensdown Aerowork Cresco plane showed significant improvements in achieving a CV of 43 per cent and 44 per cent for single superphosphate applied at 250 and 750kg/ha respectively.

1 Remote sensing

2 Integration of remote sensing data into Decision Support Package



3 Upload computer file to plane



4 Precision application

5 Greater production/profitability and less nutrient wastage

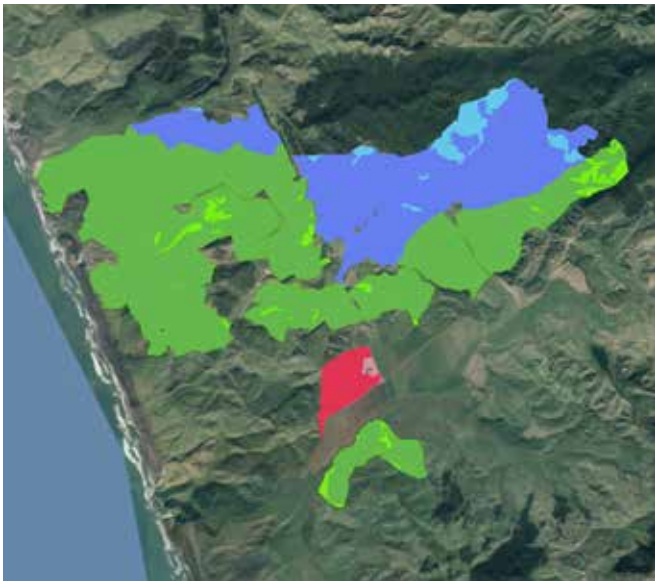
FARMERS GATHER FOR A DEMONSTRATION AT TE KUITI, KING COUNTRY.

Testing differential systems

Earlier this year Ravensdown ran its differential spreading system through its paces at Limestone Downs, a 2,500ha sheep and beef property near Port Waikato, which has flat, rolling and steep terrain.

Approximately half the farm had received double its maintenance P and S fertiliser requirements in 2014, so these areas were omitted from fertiliser application in 2015. The remaining areas were split into three categories based on soil test results which identified:

- Blocks that were at optimum soil fertility based on current production had maintenance P and S applied in the form of superphosphate at 250kg/ha.
- Two further blocks were identified as above optimum soil Olsen P levels and were prescribed an application of sulphur superphosphate 30 at a rate of 100kg/ha, which applied sub maintenance P requirements to enable some soil mining of P but supplied the annual requirements for S.
- A further block required a small amount of capital fertiliser, in addition to maintenance superphosphate at 300kg/ha.
- We'll report ongoing results in future editions of Ground Effect.



BLOCKS AT LIMESTONE DOWNS WERE SPLIT INTO THREE CATEGORIES BASED ON SOIL TEST RESULTS - EACH RECEIVING A DIFFERENT RATE OF FERTILISER. THIS MAP SHOWS WHAT WAS SPREAD.

Sulphur Super - 100kg/ha - Request

Super - 250kg/ha - Request

Super - 300kg/ha - Request

MIKE MANNING, BAgSc, RAVENSDOWN GENERAL MANAGER INNOVATION AND STRATEGY, HAS BEEN INSTRUMENTAL GETTING THE PGP OFF THE GROUND

RAVENSDOWN TECHNICAL DEVELOPMENT MANAGER MIKE WHITE, MHortSc, IS DRIVING THE PGP PROGRAMME

Limestone Downs case study

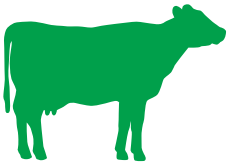
Variable fertiliser applications continued

Aerial application evolving


ALF HARWOOD, MANAGER, LIMESTONE DOWNS

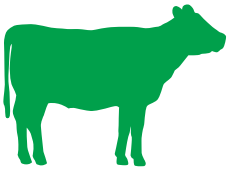
Limestone Downs

3,200ha total 2,500ha effective



800
dairy cows

8,000
ewes lambed each year



900
cattle

Aerial topdressing has come a long way from the days when farmers used their hands to fill Tiger Moth planes with fertiliser.

Limestone Downs Manager Alf Harwood remembers his father filling up a Tiger Moth plane with superphosphate. "We used to pour it in by hand, about three or four bags," he says. "Sometimes we'd ride in the plane too, but I'm not sure that was really allowed!"

Ravensdown is developing its Primary Growth Partnership (PGP) technology at Limestone Downs, a 3,200 hectare dairy, sheep and beef farm near Port Waikato, owned by the Charles Alma Baker charitable trust.

Out of the property's 3,200 hectares, 2,500ha are effective. The dairy unit occupies 500ha, milking about 800 cows, which also graze on the hill country at various times throughout the year.

The remaining 2,000ha are used for sheep and beef, with the farm lambing about 8,000 ewes each year and running between 2,000 and 2,500 hoggets. Around 900 to 1,000 beef cattle graze the hills. Five staff take care of the sheep and beef operation, with four on the dairy unit.

The seven-year PGP programme, a partnership between Ravensdown and the Ministry for Primary Industries, with research carried out by Massey University and AgResearch, aims to improve hill country sheep and beef farming productivity, while preserving the environment through more efficient application and use of fertiliser.

Alf has followed the development of aerial spreading throughout his career – as Cresco planes that could carry tonnes of fertiliser replaced Tiger Moths and GPS technology replaced pilots peering out of the cockpit window.

When Alf started farming after leaving school, GPS data and precision soil testing did not exist. Instead, pilots set out to spread a standard rate over the entire farm. "Some of it was probably lost on steep faces," Alf says. "Now, with sophisticated soil testing and GPS-controlled hopper doors, we can put it where it is needed.

"When GPS first came in, people said that pilots wouldn't use it, that the pilots would be too busy flying to look at it, but it actually has made their job easier," Alf says. "They can concentrate on flying the plane because GPS tells them where to go. It's made the aerial spreading process more efficient."

Now, with the advancement of GPS technology, online management tools such as Smart Maps and remote sensing, farmers and pilots know what has been spread, the application rate and where it was applied.

The goal of the PGP Programme is an auditable map that shows where fertiliser landed, rather than only a record of when the hopper door opened. After all, proof of placement will always be more important than proof of release.

Proteor kale: Quality and Quantity

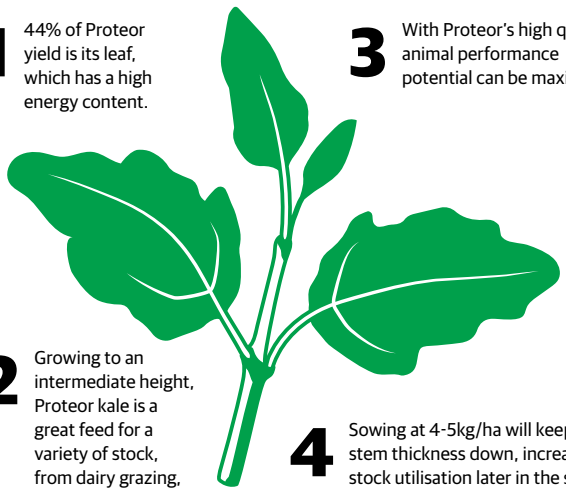
Reliable and proven time and time again in trials, Proteor Kale delivers a high-quality, high-quantity feed.

1 44% of Proteor yield is its leaf, which has a high energy content.

2 Growing to an intermediate height, Proteor kale is a great feed for a variety of stock, from dairy grazing, to deer, through to pregnant ewes.

3 With Proteor's high quality, animal performance potential can be maximised.

4 Sowing at 4-5kg/ha will keep the stem thickness down, increasing stock utilisation later in the season.



Agronomic Traits of Proteor Kale

Leaf:Stem Ratio	Stem Height	Palatability	Sowing Rate (kg/ha)	Sowing Depth (mm)	Sowing Date
Very High	Intermediate	Very High	4-5	10-20	Oct-Jan

Yield Results Canterbury Kale Trials, 2011-14

Variety	Average Yield (kg DM/ha)	Leaf:Stem Ratio
Proteor	13, 800 ab	44%
Sovereign	12, 600 bc	43%
Regal	14, 300 a	42%
Kestrel	11, 500 c	41%
Trial Mean (kg DM/ha)	13,000	
Significance	**	
CV%	16.6	
LSD (5% level)	1,540	

Internal Cropmark study

BLAIR COTCHING, PRODUCT MANAGER SEED

IT'S ELEMENTAL

Major Nutrients

It's recommended to supplement cows with magnesium four to six weeks before calving and for four months afterwards.

ELEMENT	PLANT	ANIMAL
Nitrogen **N**	Synthesis of all proteins, enzymes and cell membranes. Also required to make chlorophyll	Synthesis of all proteins, enzymes and cell membranes
Phosphorus **P**	Key ingredient in adenosine triphosphate (ATP) – used in all activities requiring energy transfers. Also for cell nuclei and membranes in cell division, photosynthesis and respiration	Like plants, all energy transfers in animals require ATP. P is also essential for bones, teeth, cell membranes, nerve fibres and muscle function
Potassium **K**	Carbohydrate (sugar) and N metabolism, protein synthesis, enzyme activity, opening and closing stomata (little holes in the leaf surface that regulate water use). Maintains cell turgor – keeps plants standing up! Balances electric charges during uptake of anions (negatively charged ions like P and S)	Essential for muscle contraction, nerve impulse transmission, kidney function, electrolyte and water balance
Sulphur **S**	Required to produce S-containing amino acids – for proteolytic enzymes, in some vitamins and oil production	Synthesis of all proteins, including wool. Also used in heparin (which prevents blood clotting), B Vitamins & involved with enzymes that metabolise carbohydrates
Calcium **Ca**	Used in cell membranes for enzyme activity, protein synthesis and ion uptake	Used in bone and teeth formation, along with P for nerve function, muscle contraction, blood clotting and enzyme activity
Magnesium **Mg**	Used in chlorophyll formation, protein synthesis and all energy transformations	Important in the metabolism of carbohydrates, lipids (fats) and protein. Also used for nerve activity and muscle contraction
Sodium **Na**	There is no known function for Na in plants, despite being readily taken up	Key role in transmitting nerve impulses – which is why Na helps relieve cramps after vigorous exercise

All life on Earth, plant and animal, is built from the same elements: carbon, hydrogen and oxygen, along with smaller amounts of 25 minerals. These minerals are readily provided by the diet – eaten by animals and taken up from the soil by plants.

Most minerals perform more than one function to keep life ticking along, from providing cellular structure to powering the immune system. Some are required in larger quantities. These are the macro or major nutrients. Others are required in tiny, yet still essential amounts. These are the micro or trace elements.

Trace Elements

Eighteen trace elements are essential for life, in very small amounts. In New Zealand pasture-based systems, watch out for deficiencies in cobalt, copper, iodine, selenium and zinc.

ELEMENT	PLANT	ANIMAL
Boron **B**	Used for carbohydrate metabolism and transport throughout the plant, nucleic acid metabolism and inhibition of starch formation	B has no known function in animals
Chlorine **Cl**	Important for photosynthesis and electrolyte balance	Aids Na transport in the kidneys and Na, Mg and Ca transport through the rumen wall
Copper **Cu**	Integral part of proteins and used in photosynthesis, respiration and N fixation	Integral to proteins
Cobalt **Co**	No known function in pasture plants or crops.	Critically important for rumen bacteria to produce vitamin B12
Iron **Fe**	Part of chlorophyll production and required by enzymes involved in photosynthesis and respiration	Integral part of haemoglobin and myoglobin (blood) and required for respiration and enzyme function
Manganese **Mn**	Used in enzyme activity for carbohydrate metabolism, making fatty acids and in energy transfers during photosynthesis	Required for synthesis of bones and teeth, hormones and glucose synthesis and utilisation
Molybdenum **Mo**	Essential for rhizobia in clover nodules to fix N and to assist N use inside plant	Used in some enzyme activity and for Fe storage in tissue
Selenium **Se**	No known function, even though plants uptake it readily	Used in enzymes that protect tissues from oxidation damage – antioxidant – and for general cellular activity
Zinc **Zn**	Required by enzyme activity associated with carbohydrate metabolism	Required by enzyme activity associated with carbohydrate metabolism and for protein synthesis

Innovation calls for funding

Innovation is everywhere. Harnessing it to create dollars, however, is challenging. The transition that New Zealand needs is from number 8 wire to some kiwi food-equivalent of the iPod; revolutionising people's lives and bringing wealth to the inventor and the country.

Or perhaps producing food more sustainably than any other country can manage is the key. This is about protecting resources, including human and animal welfare, whilst maintaining and increasing yields, decreasing risks to production, achieving social acceptability and economic viability.

Innovation starts with an idea. Whether on farm, in industry or in a research organisation, somebody has to ask the question: "Is this possible?"

It shouldn't be a pipe dream, but it is increasingly clear that we don't have the innovation system to enable what is required.

Statistics New Zealand data on product innovation in companies employing more than five employees, indicates only 17 per cent of New Zealand companies are actively innovating. Denmark, Finland and Ireland are all small countries with relatively small populations, but they are reporting more innovation than New Zealand (see table below).

Innovation starts with an idea. Whether on farm, in industry or in a research organisation, somebody has to ask the question: "Is this possible?" Turning the possible into the probable requires considerable research. Turning probable into practical on-farm results requires even more and is expensive. Without it, however, the value of New Zealand's primary production will decrease.

The problem is that research funding from the government is not increasing as fast as inflation. Funding for the Crown Research Institute Core Funding has remained at $201.7 million in the latest budget. This is the funding to 'create and maintain capability that is required for their core purpose and strategy'. Biological Industries Research funding was reduced in the budget from $94.92 million to $92.15. This is the funding needed to meet the government's goal of doubling the export income from the primary sector. In addition, the funding for research to protect ecosystems and land and freshwater resources, about which all New Zealanders feel strongly, has also been reduced from $32.45 million to $31.54 million.

country	Innovation activity					Latest data available (year)	Collection period (years)	Minimum employee-size surveyed
	Implemented innovation type (1)				Total innovation rate (2) %			
	Goods or service (product) %	Operational process %	Organisational or managerial process %	Marketing method %				
Australia	20	19	23	20	41	2012	2	0
Finland	31	29	30	27	51(3)	2010	2	10
Ireland	28	33	36	30	60	2010	3	10
Denmark	23	21	28	27	46(3)	2012	1	2
New Zealand (4)	17	17	20	23	46	2013	2	6

1. Innovation-type results are only for implemented innovations, so do not include abandoned, or ongoing activity.
2. Innovation rate results include implemented as well as ongoing or abandoned activity, unless otherwise stated.
3. Innovation rates for Finland and Denmark only include implemented innovations, so do not include abandoned or ongoing activity.
4. Results for New Zealand differ from those already published, as they only include implmented innovations.

Source: Statistics New Zealand

JACQUELINE ROWARTH IS PROFESSOR OF AGRIBUSINESS AT THE UNIVERSITY OF WAIKATO. HER PhD IS IN SOIL SCIENCE AND INVOLVED EXAMINING THE MOVEMENT OF SUPERPHOSPHATE IN GRAZED, HILL COUNTRY PASTURE.

Scientists who are stressed about bidding and reporting are unlikely to be innovative. This is a problem for us all. Companies can do their own research, but it is not independent. Examples of this abound in the soil supplement area. An additional concern is that very few companies employ real scientists – those with doctoral qualifications in the right area for the company's business. This lack of expertise can result in incorrect or limited interpretations of research results. Another common strategy is to avoid the research step altogether, relying on advertorials and farmer testimonials instead. Again, examples of this are easy to find. The challenge for farmers is to evaluate likely effect against cost of implementation. The very simple response to any advertising is to ask about the science underpinning the claims.

Science involves a rigorous approach to eliminating variables in order to hone in on cause and effect. How many times out of how many has the product or approach worked? And on what type of system? Products and approaches must stand up to claims by presenting data and statistical interpretation. In addition, the soil type, nutrient status, climate and production intensity and where the research was done should be known before product claims can be applied to home farms.

And label claims along the lines of 'natural, biological, organic, eco and green' are not a substitute for rigorous research, however appealing the approach.

This 'green-halo' effect has been examined in the psychological journals and reveals that people are far more likely to feel good about purchases if the product has the 'green-halo'. As an extreme example, water with a 'halo' tastes better than one without. And food that is labelled as organic is assessed by taste panel consumers as having fewer calories, lower fat and better taste than conventionally-grown food – even when it is the same organic food. Everybody would do well to remember this when faced with purchase decisions. Another point to remember is that 'alternative' becomes mainstream when it has been proven by results from scientific research.

"label claims along the lines of 'natural, biological, organic, eco and green' are not a substitute for rigorous research"

Research institutes are under stress, but good scientists are doing good work despite the funding system. Moving forward will require an emphasis on stable funding for science relevant to the regions, with scientists working with farmers and industry people.

Innovation is everywhere – and harnessing it to create dollars for New Zealand will require teamwork from paddock to plate, tractor to tongue and soil through to saliva. Facts, evidence and data will provide the platform for an innovation-fuelled future.

NITROGEN CYCLE & WORLD FOOD PRODUCTION

Eighty per cent of the air we breathe is nitrogen.

Traditional agriculture supplied limited amounts of the nutrient by recycling organic wastes and by planting leguminous crops. It was the Haber-Bosch synthesis of ammonia, first commercialised in 1913, that removed this key constraint on crop productivity and had significant, immediate benefits for world food production.

This high, and rising, dependence can exact an environmental price, as the system losses of nitrogen can lead to contamination of waters, eutrophication and excessive atmospheric deposition of greenhouse gases. Additionally, inefficient use of nitrogenous fertilisers is also an obvious economic loss.

There is no single measure that could substantially reduce these losses but they can be mitigated by careful management.

"without the use of nitrogen fertilisers we could not produce enough food for nearly 50 per cent of the world's population"

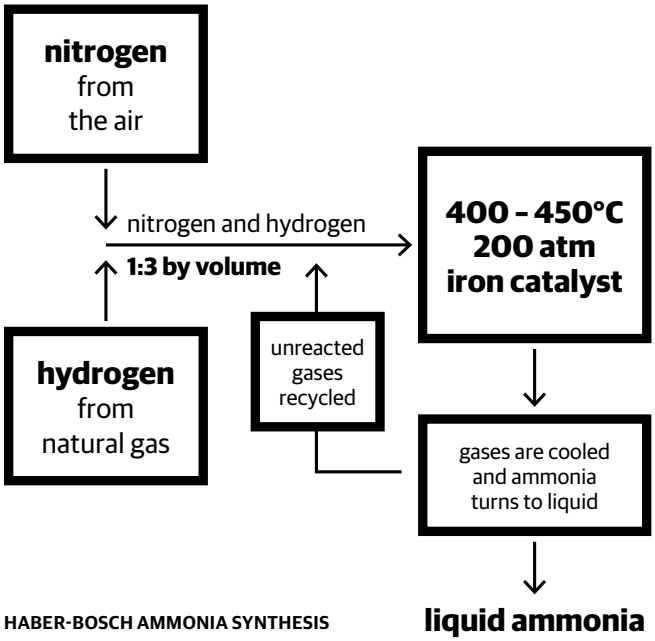
In the future more nitrogen will be needed to feed the additional 1.5–2 billion people that will be added to the global population before its growth is expected to level off later in this century.

Although grain crops can recover as much as 85–90 per cent N in small-scale experiments using 15N-labelled fertiliser, actual field recoveries are rarely above 50 per cent.

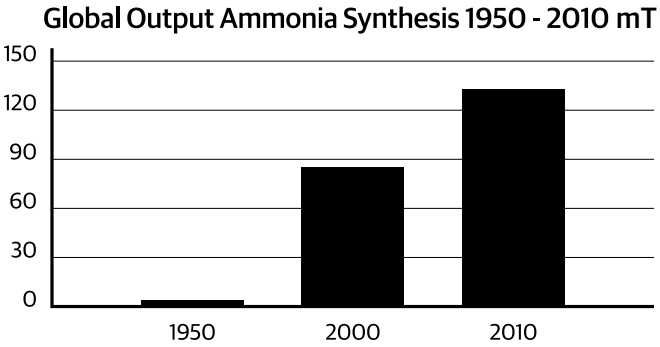
The global extent of N losses may increase because at least three billion people need substantially better diets and higher nitrogen applications are required to produce the necessary food.

This leaves us with the requirement for better management, a portfolio that includes multiple applications and balanced use of fertilisers, precision farming, optimised crop rotation, nitrification inhibited fertilisers, optimised animal feeding regimes and the use of controlled release compounds. A challenge not beyond us but it will need industry alignment and continuing research investments.

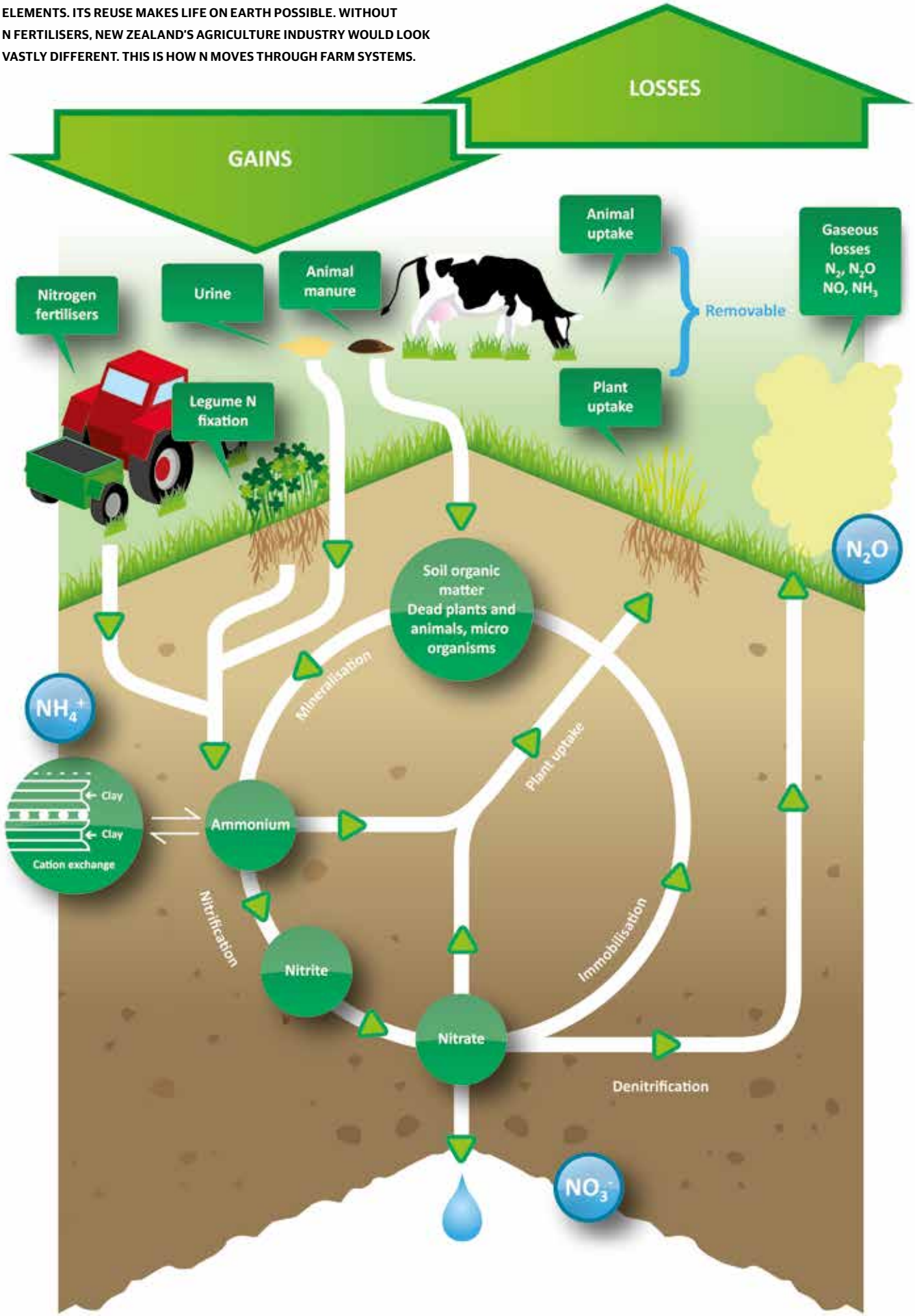
Global agriculture has become steadily more dependent on mineral nitrogen fertiliser. Without the use of nitrogen fertilisers we could not produce enough food for nearly 50 per cent of the world's population, roughly three billion people.



HABER-BOSCH AMMONIA SYNTHESIS



NITROGEN HAS THE MOST COMPLEX CYCLE OF ALL CIRCULATING ELEMENTS. ITS REUSE MAKES LIFE ON EARTH POSSIBLE. WITHOUT N FERTILISERS, NEW ZEALAND'S AGRICULTURE INDUSTRY WOULD LOOK VASTLY DIFFERENT. THIS IS HOW N MOVES THROUGH FARM SYSTEMS.



Keep your Ammo dry

Inherent nitrogen deficiency in your grass and clover pastures will always limit potential annual production.

But nitrogen (N) deficiency can be relieved by applying N fertilisers, which are best used as a strategic supplement to N fixed by clover plants. N fertiliser use should always be targeted so the extra grass satisfies a specific animal feed requirement and you must manage the extra response to ensure that you efficiently utilise it.

Used this way, N fertiliser has frequently been demonstrated as the cheapest way of providing additional feed, after your home-grown pasture.

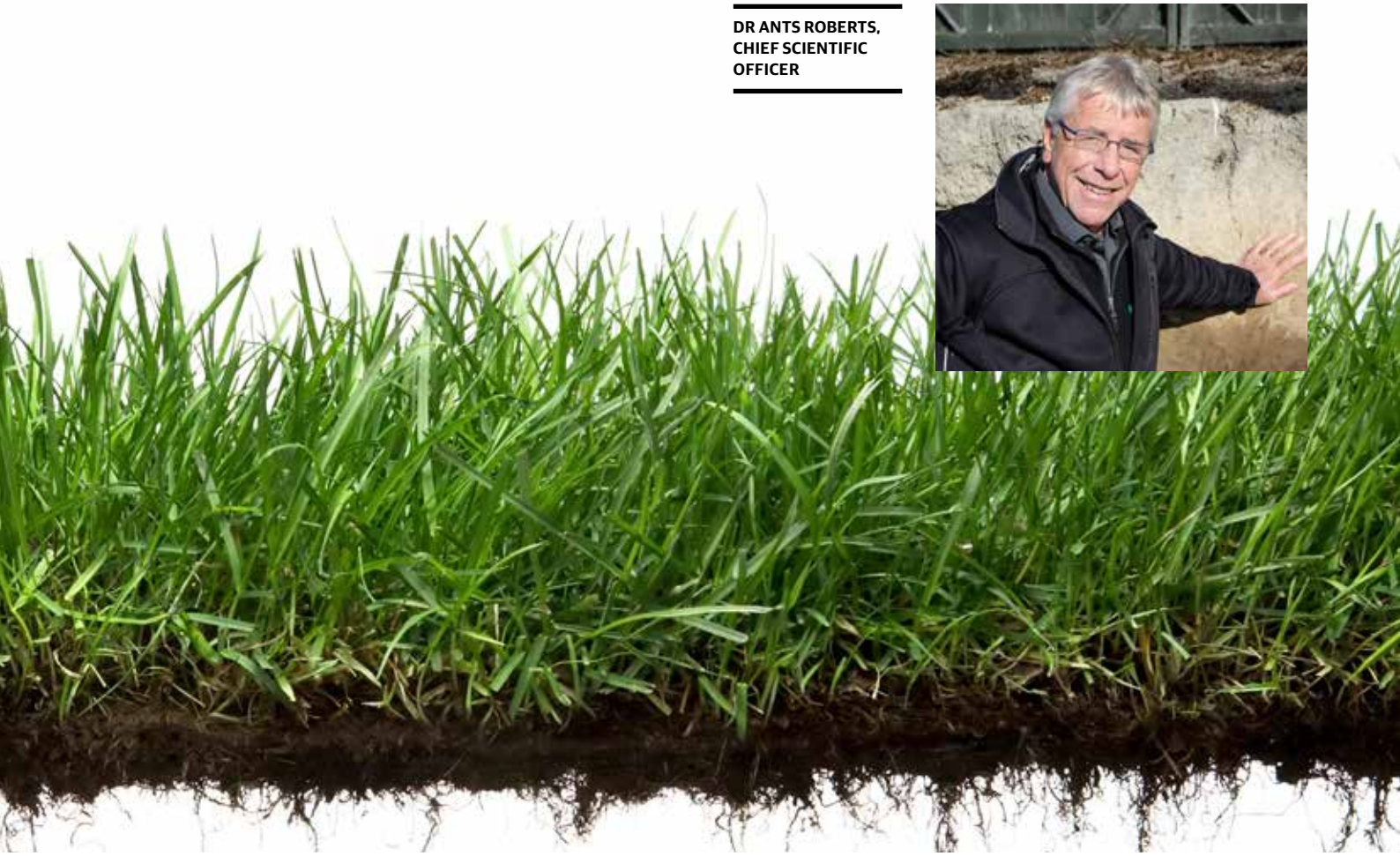
The availability of nutrients for the growth of grass and clover pastures depends on soil biological processes, controlled mainly by temperature and moisture. As environmental conditions change with the season, this means that the amount, and often quality, of pasture can be variable. N fertiliser can be used to reduce some of this variability in pasture growth.

What happens when N is applied to soil?

Under New Zealand conditions, plants take up nitrate (NO_3-) preferentially because it's usually the most prevalent form of plant-available N present in soil.

When we add urea to the soil, a naturally occurring enzyme called urease rapidly converts urea (NH_2CONH_2) into ammonium (NH_4+) ions. The converted ammonium ions are the same form of N as ammonium sulphate (and MAP, DAP, etc.) and can be taken up by pasture plants.

However, ammonium ions are held quite strongly by soil particles and soil-living bacteria convert them to nitrite and then nitrate ions, which the plant then takes up. The conversion of ammonium ions to nitrate generally takes longer than urea to ammonium ions and is affected by temperature and moisture. This conversion is slower in cooler temperatures of late winter and early spring.



DR ANTS ROBERTS, CHIEF SCIENTIFIC OFFICER

Does the form of N matter?

It's commonly believed that the N fertiliser you apply, e.g., urea vs ammonium sulphate, will affect the response you get to N.

Trial results suggest that you would not be able to observe any difference in the speed of response between urea and ammonium sulphate in cool or cold conditions, provided that there were no other limiting nutrients except N.

However, many farmers report that ammonium sulphate works better and for longer than urea. These observations may well be correct, but remember that urea contains no sulphur while ammonium sulphate does.

In late winter/early spring, after winter drainage events have leached much of the sulphate sulphur present from previous fertiliser applications, there may be a temporary lack of available sulphur (S) for the pasture as it starts to respond to increasing day length and temperatures.

Additionally, on sedimentary, pumice and peat soils, the soil bacteria that mineralise S from soil organic matter may not be fully active due to cold and wet conditions and sometimes there will be a short-term S deficiency which will limit the response to urea N. Ammonium sulphate, applied at the same rate of N, may give a bigger and longer response due to the added available sulphate.

The reason for the better response under these conditions is thought to be possibly due to two of the essential protein-forming amino acids, cysteine and methionine, which require sulphur as part of their structure. If pasture plants don't form these amino acids through lack of S, the physiological processes prompting increased growth may be compromised.

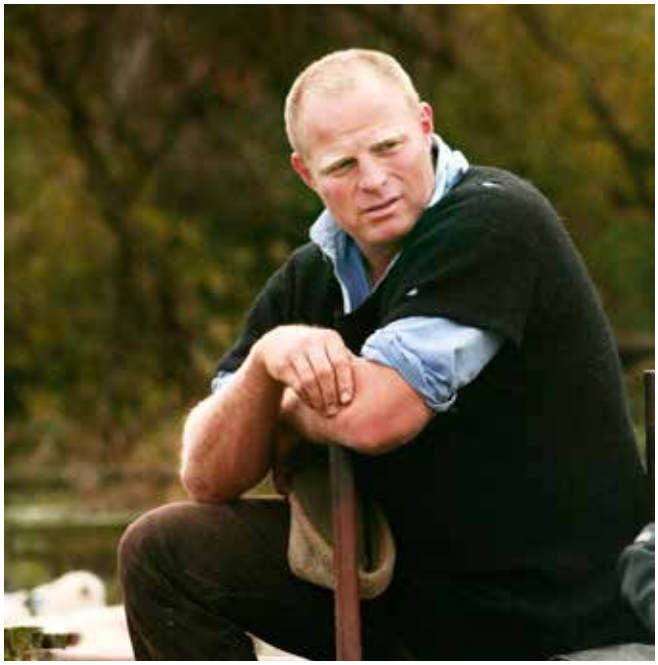
While there is no way of predicting where or when these limitations will occur, in cold, wet late winter/early spring conditions, a product like Ammo 31 or 36 is ideal as it combines both urea and ammonium sulphate and should be effective at eliminating this risk.

Why not use an N fertiliser containing nitrate?

If an N fertiliser contains some nitrate, such as calcium ammonium nitrate or ammonium sulphate nitrate, will this work better in cold conditions? Trials have shown that even at soil temperatures between 2 °C and 6°C for 3-4 weeks after application, the extra response is barely measurable and not large enough to justify the much higher cost per kilogram of N in these products when applied to pastures.

FORGING NEW GROUND AT GRASSENDALE

Balancing family life on the farm is just as important to Wairarapa farmers George and Luce Williams as delivering top-class genetics through their business, Grassendale Genetics.



GEORGE WILLIAMS

Having both grown up locally and worked and travelled overseas, the couple bought their first property, Longridge, in 2005 and then in 2009, bought the property next door - Luce's family farm Grassendale - from her parents John and Sue Dalziell.

The next milestone was buying the Valley Coopworth Stud, renamed Grassendale Coopworths. They have recently bought the Raho Ruru Romney stud as well and are now known as Grassendale Genetics.

George says, in hindsight, it has been a busy time building up a business alongside three young kids.

"We had bought two farms and to go into selling our own rams as well was a big step. It was a matter of backing ourselves really, which we did, and it has worked.

"A huge component to our business now was the realisation, back then, that we could do it on our own," Luce adds.

George and Luce are transparent with their business plan and have always written down short- and long-term goals – both personal and business. They're proud of ticking off two of the more landmark goals – farm ownership and starting a stud – but are adamant family still comes first.

"It's too easy to get caught up in what you're doing and forget why you're doing it."

"Business goals could range from fencing or re-grassing to debt levels," says George, "putting pegs in the ground and making sure they've been ticked off. The personal goals are a good way to keep on the right side of work/family balance. It's too easy to get caught up in what you're doing and forget why you're doing it. So we're spreading more of that time into the routine. We all have ideas in our heads of how things should be but something on a piece of paper cements it. You can't ignore it."

He says the business plan also means they don't sit idle and neither does the business.

"We want to have systems in place, built around our farming business, to minimise risk or adversity that might come our way. We also want to be trying new things. It keeps farmers farming. If it's new it is exciting, whether it works or not."

Grassendale in its current entity is 1,580 hectares - 1,050ha effective - including 315ha of native bush and 200ha of forestry.

It is summer-dry, steep hill country with a lot of wind, George says. In fact, the area was almost home to the country's largest wind farm.

"The farm is one of the highest farms around here so wherever you are you get wind, it's the nature of the game really."

Stocking policy has been built around mitigating drought.

"We know we live on the East Coast and have long, hot and dry summers and we've built our stock policy around that. By the start of December, we try to be at wintering stock numbers."

Grassendale carries 5,000 ewes including 1,000 recorded Coopworth, 500 recorded Romney and 500 recorded Romney Coopworths. Lambs are sold store in November with a target of 30 kilograms. Last year's total lamb crop was 8,500.

Grassendale Genetics has highly reproductive, easy converting, robust sheep, measured and selected on five traits – reproduction, growth, survival, meat and wool. That information is processed through the Sheep Improvement Ltd (SIL) database.

"When we get our ram selection list back we go through and make up the type and numbers to get a mix – we want to end up with sheep that look like we want them to look and with the numbers to match," George says.

He says reproduction has been major trait of the Coopworths on the SIL database.

The Williams are also passionate about wool.

"We still weigh all our hogget fleeces and have a wool classer come through and class all the rams. Once upon a time, everyone used to do that, but it's getting less and less. Wool is a fantastic product. It's renewable and ticks a lot of sustainable boxes. Wool is quite strong at the moment, compared to the lows where it has been, but we do need dual purpose sheep. We need to spread our source of income off them, not be purely reliant on meat."

Grassendale has a minimal animal health intervention policy apart from giving Toxoplasmosis and Campylobacter vaccinations to the hoggets.

LUCE WILLIAMS

FAMILY DOGS GUARD THE QUAD BIKE

"As far as the ewes go, which are the main driver of our business, the timing of shifts and good stockmanship has eliminated a lot of the animal health problems and we're feeding them properly," George says.

The farm has 90ha of plantain in its second year. There are no winter crops but all new grass goes through a summer cropping programme.

The beef side of the business exists mainly to groom pasture for the sheep. The property calves 220 Simmental and Angus cows with black cows going to red bulls and vice versa to utilise hybrid vigour.

"The Simmental is a high-growth-rate milking cow and the Angus has more constitution and suits our hill country farming. Speckle Park bulls have also been used in the past two years. The progeny are all sold store as weaners, or at 18 months, depending on the season.

"We have a complex sheep system so we need the easiest cattle system we can get and the cows on the hill country do a fantastic job."

As well as George on the farm and Luce in charge of accounts and administration, stock manager Richard Puddy has been working at Grassendale for 18 months, alongside fencer general Stacey Torwick, who has been there four months. George says they're not scared to ask for outside expertise and one of those closely involved with their business is their Ravensdown Senior Agri Manager Greig McLeod. Greig has worked with George and Luce for more than six years and before that, with Luce's father John Dalziell.

He says when the Williams took over the two properties, six new soil test transects were created to be used alongside some of the old ones to get a better understanding of the farm's fertility.

"We also completed herbage analysis to determine the metabolisable energy status of the pasture and did a visual assessment of the pasture," Greig says.

A nutrient budget was done using a number of scenarios to see both fertiliser impact on pasture growth and any environmental impacts.

"Econometric modelling was also completed to determine what financial impact capital phosphorus would have on the various blocks. After reviewing all this data, a maintenance and capital fertiliser programme was created based on sound science and the belief George and Luce had in the science and advice I gave them."

Soil test results are reviewed every two years. Smart Maps is used to identify under-performing areas in need of capital lime or fertiliser and also to help the planning process for new paddocks. The system can confirm the new hectare totals and measure new fence lines.

AN ACCOMPLISHED RIDER, LUCE WORKED AS AN EQUINE AND HUMAN PHYSIOTHERAPIST IN THE UK

GEORGE AND LUCE WORK HARD TO SHOWCASE THEIR GENETICS PROGRAMME, HERE PHOTOGRAPHING BREEDING RAMS

Greig visits George and Luce about six times throughout the year, with two sit-down meetings to discuss upcoming cropping programmes and the maintenance/capital fertiliser programmes for the year. "The other meetings are to discuss things such as Nitrogen use or to do farm walks to assess covers and crops, as well as to generate discussion regarding forward planning."

George and Luce are both valued members of their local community. Luce is on the Tinui School Board of Trustees, its parent fundraising committee and the Tinui Horse Sports committee. George is a steward at the Castlepoint Races and organises the Tinui School Trail bike ride. On the farming side, he is a member of the Tinui/Wainuioru Farm Discussion Group, the Waiknotz Business Focus Group and the Coopworth Society National Council.

George grew up on the Te Parae horse Stud in Wainuioru, near Masterton, and when he started shepherding at 16 found he had an instant passion for dogs and stock. He shepherded for two years at Wairere Romneys then headed to the South Island high country working on Molesworth, Argyle and Mt Nicholas stations, boasting more than 40,000 stock units each.

While on his OE he met Luce, who had grown up on Grassendale with three sisters.

"It will be an exciting industry for them. Who knows what will happen."

"If I wasn't on my horse I was on the farm with Dad," she says.

She finished a four-year physiotherapy degree in Auckland then studied veterinary physiotherapy in London where she went on to work across the UK as a human and horse physiotherapist.

"Farming is in our DNA profile. It's what we do," says George.

"Our kids are growing up on the farm and it's their farm. Ultimately, like any parents, we'd love to see one of them take it over and do things better than we've done. They will have more technology and more tools than we have to drive production. It will be an exciting industry for them. Who knows what will happen."

Luce adds their aim is to give the three children, Max, 7, Sofia, 6, and Harvey, 4; an equal opportunity at an early stage.

"It might not be farming. We were fortunate our parents were able to give us opportunities early enough in life to make something of it. That's what life's about really. As long as they love whatever they end up doing as much as we love what we do."

The Editorial Team thank George and Luce for sharing their story.

THE HILLS OF GRASSENDALE PROVE IDEAL FOR BREEDING QUALITY STOCK

Soil organic matter & nutrient density under a century-old spotlight

I like history. It gives me a sense of belonging and big picture perspective. The Soils Science department at my university shared a building with the School for City and Regional Planning. On their notice board was written: "A town without old buildings is like a man without a memory," and that's stuck with me now for 40 years.

Maybe in this day and age, with the accusations made against the green revolution and mineral fertiliser being responsible for dragging humanity into a period of abundant food, resulting in the apparent demise of the world eco system, that it's time to take a long-sighted look at the bigger picture. Has soil organic matter (SOM) and nutrient density in foods really changed? Do the old buildings stand taller and stronger than their modern-day counterparts?

"Consumer preferences guided plant breeders to select for soft, white wheat cultivars with low ash content that gave high yields. This fulfilled growing demand for wheat as the world population grew, but low mineral content was the trade-off."

Soil organic matter

Soil organic matter content changes under agricultural practices. It's a fact of life. Cultivation increases aeration of soil, resulting in oxidation of organic matter to carbon dioxide, while addition of nitrogen fertilisers changes the carbon/nitrogen ratio putting the soil microbes hard at work to restore the former balance.

Adding organic matter, such as farmyard manure, to the soil increases the SOM content. But surprisingly, leaving land fallow can be detrimental to SOM content because, like us, soil organisms must eat. The question, therefore, of how much SOM has declined under modern agricultural practices is not easy to answer.

In 1852 an arable field trial was established at Rothamsted in the UK. Initially, 35 ton/ha farmyard manure was applied to all plots. But after 20 years this stopped on some plots. More than 100 years later the SOM content is still slowly declining on these plots. But in other plots, where manure application was continued after 20 years, the organic matter content is still increasing.

Since trials are not museum pieces, fertility management was adjusted to accommodate mineral fertilisers, specifically nitrogen fertilisers, resulting in greater yields and greater returns of organic matter from crop residues to the soil. In comparison with unfertilised plots, those receiving NPK fertiliser showed an increase in SOM mainly as a result of higher yields driven by nitrogen.

In Denmark, a survey of buried arable soils from 3,300 years ago, showed that ancient soils contained less organic matter than surrounding present day farm land that received high inputs of farmyard manure. However, those soils had a similar SOM content to modern day arable soils receiving mineral fertiliser.

Numerous long-term experiments, of which 10 have run for more than a century, reveal that SOM concentrations tend to move from one equilibrium value to another, under influence of changes in soil management practices. But there is no indefinite increase or decrease in SOM content.

Changes in SOM content are a slow process. For example, if large applications of farmyard manure are made, half of the annual SOM increase over a century would take place in the first 20 years. Unless dramatic additions of organic matter are made, the changes from season to season will be much less than the error in measurement.

Applications of manure cause large increases in SOM, whereas nitrogen fertiliser results in small increases based on the return of organic material. Small changes in SOM content, however, do have a proportionately positive impact on soil physical properties such as water holding capacity and friability (crumbliness).

SOUTH AFRICAN EXPORT DR HENDRIK VENTER IS TECHNICAL DIRECTOR OF ANALYTICAL RESEARCH LABORATORIES. HE LANDED IN NEW ZEALAND MORE THAN A DECADE AGO, AFTER SERVING AS CHIEF RESEARCHER AT SOUTH AFRICA'S AGRICULTURAL RESEARCH COUNCIL. ONE PhD IN ORGANIC CHEMISTRY IS NOT ENOUGH FOR HENDRIK - HE ALSO HOLDS A PhD IN SOIL SCIENCE.

Nutrient density in food

Proponents of nutrient-dense food are generally antagonistic of mineral fertilisers and more willing to side with manure as a source of plant nutrients, because the more natural approach produces food with higher nutrient density. We can be thankful for far-sighted scientists for having the vision not only to establish long-term trials, but also to preserve grain and commercial seed from more than a century ago.

Returning to Rothamsted in the UK, wheat samples from the Broadbalk Wheat Experiment, established in 1843, showed that the concentrations for zinc, iron, copper and magnesium remained stable from 1845 until the mid-1960s, when semi-dwarf high-yielding varieties were introduced. After the 1960s, concentrations of these elements decreased significantly.

The same trends were also observed whether no fertiliser, inorganic fertiliser or farmyard manure was used, showing that the change in trace element concentrations was caused by genetic differences between old and new varieties and not the fertiliser.

In the early 2000s, Kevin Murphy and colleagues from the Department of Crop and Soil Sciences at Washington State University, USA, grew 63 spring wheat cultivars in replicated plots for two seasons under current crop management practices. These cultivars were used commercially over the period 1842 to 2003, encompassing changes in genetics that were introduced through plant breeding based on trait selection and not genetic modification. Similar to the UK observations, the yield increased over time, while the mineral content decreased.

Consumer preferences guided plant breeders to select for soft, white wheat cultivars with low ash content that gave high yields. This fulfilled growing demand for wheat as the world population grew, but low mineral content was the trade-off.

Yield increases were a result of genetic improvement, since the older cultivars tested in the USA were unable to yield on par with modern cultivars. The source of plant nutrients had no effect on nutrient density or mineral content, which was genetically regulated, illustrating that there is a tradeoff in plant breeding.

We should be thankful for the technological advances made over time in producing more food more effectively to feed a growing world population and especially for long-term field trials providing answers for questions that did not even exist when these trials were established.

Unlike old landmark buildings that are demolished from time to time, in 1997 scientists in Europe stated they would "contribute to keep the long-term field trials available and functioning effectively as a scientific heritage for future generations."

SAILING THE CROSSWINDS OF CHANGE

Navigating the environmental landscape

Farmers in Canterbury and those operating intensive farms in certain catchments in the Horizons Regional Council are acutely aware of the changing regulation around environmental management and, in particular, nutrient management. Other regions are also feeling these winds of change, with new challenging regulations on the way for the Hawkes Bay Tukituki catchment and the Otago region. In Southland, new dairy conversions now require resource consent for the activity, not just for the dairy shed effluent. Common to all these plans is the reliance placed on the Overseer ® nutrient budget model to determine either or both nitrogen and phosphorus loss from the farm.

Nutrient management, including the use of Overseer, is a core strength for Ravensdown and so it is not surprising that our shareholders, faced with the new regulatory regime, have looked to us for guidance. We are the best resourced organisation in New Zealand to tackle this area, given our large field-based team who are specifically trained in this discipline and are backed by well-developed systems and support. However, even with those resources, it's become clear that business-as-usual could not meet the new demands and the farm consent-specific work sought by shareholders in regions currently most affected.

In addition to the direct demand by farmers, organisations such as dairy and irrigation companies have been looking in our direction for the nutrient budgets for thousands of farmers. Because this work is so resource heavy, and is unevenly applied across sectors and councils, we considered the fairest way to handle the near-tidal wave of work was to introduce a charge for services.

Ravensdown has three pathways to nutrient budgeting, depending on the purpose.

1. Fertiliser Recommendations

Normal predictive nutrient budgets for the farm, to inform fertiliser recommendations, continue to be part of the package for our serviced customers.

2. Compliance

To ensure a farm stays as a permitted activity, baseline nutrient budgets may be required. In Canterbury, many zones require four years of budgets to create a baseline, plus an annual actual nutrient budget from the previous year, to ensure the baseline is not exceeded. Ravensdown has recently introduced the Nutrient Budget Processing Team. This service is charged on a fixed fee, depending on property type and regional council area, due to differing regional requirements.

Complexity is added when Overseer versions change and the baseline must be re-cast using the latest version. Unfortunately, this is not as simple as pressing a button to roll it up. For instance, the latest version - Overseer 6.2, released in April 2015 - requires much more detailed input if the property is irrigated.

The Nutrient Budget Processing Team is also involved in assisting dairy and irrigation companies with their needs, where farmers have agreed. We aim to minimise duplication in these processes.

3. Consents and Farm Sales

Ravensdown Environmental was established in October 2013, for processes involving farm consents and farm sales that require detailed nutrient budgets to establish what future uses are possible. Ravensdown Environmental's experienced consultants charge on an hourly basis. The specialist consulting team helps farmers with detailed nutrient management and mitigation, modelling scenarios of new farm systems, gaining resource consents and having the necessary information for farm sales and purchasing.

This is particularly important in areas such as Canterbury red zone, where the grandparenting rules mean that the nitrogen losses from 2009-13 cannot be exceeded by the new owner. Because expertise is limited and demand is increasing rapidly, the Ravensdown Environmental team frequently has a waiting time to secure its services. Although the team continues to grow, that rate of growth is limited by human resource and skills.

Many regional rules are now seeking farmers to produce a Farm Environmental Plan (FEP). Ravensdown Environmental is not allocating resources to this function at this stage due to the high demand for the specialist use of Overseer nutrient budgets and linking these to consent or farm sale processes. Ideally, farmers should be developing their own FEPs, based on industry and council templates.

Engage Ravensdown Environmental when:

- **Nutrient budgeting moves into future scenario modelling**
- **A nutrient budget is to be used directly for consent purposes (or ensuring a consent is not triggered by new farming practices), beyond referencing to baseline for compliance**
- **Modelling is being done for a farm sale or lease (either for a seller or potential purchaser)**

Introducing Free 15

In Ravensdown Environmental's work we come across a range of situations where the environmental issues on farm are challenging and have potential regulatory and legal implications. We recognised that the complexity of environmental legislation and differences in each regional and district council mean specialist help may be required. We are able to help with referrals for matters as diverse as irrigation, consenting and legal support.

In discussions with Ravensdown's specialist Resource Management law firm, Anderson Lloyd, it became clear that farmers were reluctant to seek legal guidance and were unclear who to turn to in these specialist situations. Getting initial guidance on their resource management situation would help farmers have more certainty on ways to tackle their concerns. Together with Anderson Lloyd we came up with Free 15 - using one of five specialist RMA lawyers throughout NZ for an initial phone consultation on consenting and enforcement issues, for up to 15 minutes, at no cost. That might help give farmers peace of mind, or if more in-depth consideration or assistance is required, Anderson Lloyd is available to assist. Referrals to Free 15 are made through Ravensdown Environmental, or your local Agri Manager.

RICHARD CHRISTIE IS RAVENSDOWN'S GROUP MANAGER DEVELOPMENT. HE HOLDS A BAgSc FROM LINCOLN UNIVERSITY AND AN MBA FROM OTAGO UNIVERSITY.

Perspective: Mark Christensen

Nutrient Management

Across the country, regional councils are preparing second generation regional plans regulating the discharge of nutrients from farming to give effect to direction from central government. The current picture is confusing, but as new regional plans come online, it should be possible to identify the best approaches for environmental outcomes and consenting and compliance requirements.

Overseer as a compliance tool

A number of the regional planning regimes rely on nutrient limits or baselines, where compliance is assessed using Overseer. The implications of regular updates to Overseer need to be considered.

Different versions of Overseer will calculate different nutrients losses for the same inputs and this difference can be significant. For plans using a baseline approach, a comparative assessment can be achieved by recalculating the baseline using the same version of Overseer as will be used to assess nutrient outputs for the current year.

Central Government direction

Central government direction and court decisions regarding implementation of the National Policy Statement (NPS) for Freshwater Management will be relevant to the development of regional plans. For example, the National Objectives Framework, introduced in July 2014, requires identification of values applying to freshwater bodies and management to achieve minimum standards for each identified value.

Meanwhile, the recent Environment Court decision regarding Plan Change 5 for the Tukituki[1] has considered the NPS for Freshwater Management and the objective of maintaining overall water quality in a region.

The Court rejected an 'overs and unders' approach which allows for degradation of some water bodies provided others are improved. This was judged incompatible with the Resource Management Act (RMA) function of regional councils to maintain and enhance water quality, and the requirement that water quality standards do not lessen water quality unless consistent with the purpose of the RMA.

[1] *Ngāti Kahungunui Iwi Inc v Hawkes Bay Regional Council [2015] NZEnvC 50*

Looking forward

Control methods of non-point source discharges vary widely. An absence of regional cohesion reflects a lack of national direction, coordination and information sharing between councils.

The pros and cons of different approaches, in terms of environmental outcomes, ease of application and compliance requirements, will become more apparent as the plans are implemented. Hopefully, as time goes on, we learn collectively from best practice and start to have a more uniform approach.

"as new regional plans come on-line, it should be possible to identify the best approaches."

MARK CHRISTENSEN IS A PARTNER IN NATIONAL LAW FIRM ANDERSON LLOYD. HE IS A RENOWNED EXPERT IN RESOURCE MANAGEMENT WHOSE WORK INCLUDES CONSENTING WATER, MINING, ENERGY, INDUSTRIAL AND PROPERTY DEVELOPMENT PROJECTS, AS WELL AS DUE DILIGENCE ON A NUMBER OF LARGE TRANSACTIONS.

Regional Examples

Horizons One Plan

- Identifies the most at-risk catchments and, in those catchments, controls all existing and new intensive farming, requiring landholders to obtain resource consent.
- Where the landholder has implemented a nutrient management plan and complies with specified nitrogen leaching maximums, consent must be granted.
- Where farms cannot meet the nitrogen leaching maximums they require consent as a restricted discretionary activity and will benefit from identifying a programme to reduce leaching (even if leaching maximums, are not ultimately achieved).
- Nitrogen leaching maximums are set according to individual land use capability classifications and reduce over time to lessen pollution of waterways.

Bay of Plenty - Rotorua Lakes

- Low nitrogen leaching activities are permitted.
- Activities meeting the nutrient benchmark are also permitted.
- Plan applies a grandfathering approach, where nutrient benchmarks are set for each property based on a set period of historic discharges.
- Increases above the nitrogen discharge allowance (NDA) must be granted consent where they are offset by the NDA on another property.
- Consent can otherwise be sought for discharges above the nutrient benchmark as a restricted discretionary activity.

Canterbury Land and Water Regional Plan

- Proposed plan (subject to High Court appeals) provides regional rules, which may be overridden by sub-regional (or zone) specific rules.
- Most sub-regional rules are still under development, but in most cases will be more restrictive than the regional rules.
- Within the regional rules, nutrient allocation zones are identified and classified (red to green) depending on whether water quality outcomes are being met.
- Farmers are required to calculate a nitrogen baseline for the period 2009 - 2013.
- Nutrient management rules depend on zoning. They range from requiring all activities to obtain consent and prohibiting any increase above the nitrogen baseline, to a permitted regime dependent on nitrogen leaching rates, with some provision for increases in leaching.
- Farm management plans will be required for all consented farming activities.
- Different rules apply where water is supplied by a qualifying irrigation scheme, where nutrient discharge is controlled by consent conditions for the scheme.

Hurunui Waiau River Regional Plan

- Sub-regional plan was developed in advance of the Land and Water Regional Plan.
- Sets a total catchment load limit that applies as the permitted threshold for the Hurunui River, along with in-stream toxicity limits.
- A no-allocation regime, so this is left to be resolved through consent applications. There is also no ability for farmers who improve their operations to capture the headroom created for their own use.
- At this stage, there is no catchment load for the Waiau River and the permitted activity regime is reliant on in-stream toxicity limits.

Otago Regional Plan: Water for Otago

- Regime for controlling discharges of nitrogen to land that will apply from 2020, although records of nitrogen loss must be kept from 2014.
- Rules identify three sensitivity zones with nitrogen discharges of 15, 20 or 30kg/ha being permitted accordingly.
- There is ability to apply for consent where the nitrogen limit is not met.

Southland

- Consents are required for dairy conversions.
- A regional land and water plan that will address nutrient discharges is being prepared.

Regulations are often changing. Seek guidance on how amendments may affect you.

Parasites needn't be a sting in the tail

Think those hard winter frosts killed the parasites in your pastures? That there will now be fewer worms in stock? Unfortunately, the short answer is no.

Frosts will kill off some larvae and stop worm eggs developing, but it does not mean that animals are now magically free from the threat of parasitic worms. Understanding what is going on at grass level can help ensure stock health is not compromised by worms as spring approaches.

Suitable climatic conditions can allow infective larvae (L3) to survive for 12 months or longer in the pasture environment. At steady temperatures between 5 and 10°C, infective larvae are inactive and worm egg development is greatly reduced.

The high levels of infective larvae on autumn pastures will gradually decline during winter months, potentially reducing the threat to animal health, but these residual levels can still pose a real risk. A few days of warm weather as spring approaches can result in a rapid build-up of parasites on the pasture again.

Every herd and flock is different and farmers should carefully assess the need to drench stock on their own farms. This assessment is best done by monitoring changes in body weight and condition score, feed levels, evidence of scouring, sheep to cattle ratios, grazing management and faecal egg count scores.

For example, a farmer who does not typically drench ewes pre-lambing may find this year that feed levels and ewe condition scores are both below where they usually are. Worms pose a bigger threat under these conditions, leading to reduced lamb birthweights, milk production and lamb and ewe survival. With careful consideration, drenching ewes pre-lambing this year may well be justified.

Combination drenches are regarded as the best way to treat parasites in stock and slow the development of drench resistance. Ravensdown faecal egg count reduction tests, carried out over a number of years, show that cost-effective double combinations such as Combo™ Low Dose continue to work well eliminating parasite burdens in sheep and cattle.

Combo™ Low Dose drench is used to control roundworms in sheep and cattle, including Ostertagia and strains that are resistant to either the benzimidazole (white drenches) or levamisole (clear drenches), lungworm, tapeworm and adult liver fluke.

Used in the prescribed way, Combo™ Low Dose is generally safer to use in young stock compared to the some of the macrocyclic lactone products, commonly known as MLs (the family of drenches that include Abamectin and Moxidectin), making it an ideal drench to use in young dairy calves weaning in spring.

Combo™ Low Dose is a double combination oral drench containing:

- 45.3 g/L oxfendazole (white drench)
- 80 g/L levamisole (clear drench)
- Minerals (selenium, copper, cobalt, zinc & iodine)
- Dose rate: 1mL/10kg live-weight
- Withholding periods: Meat 10 days; Milk 35 days
- Pack sizes: 5 litre backpack & 20L drum

JULIE WAGNER, VETERINARIAN, PRODUCT MANAGER, ANIMAL HEALTH

DON'T LET SLUGS SURPRISE YOU

Slugs can be devastating to newly sown crops and pastures, so ensure you check your paddocks before drilling.

BY GEORGE KERSE, RAVENSDOWN PRODUCT MANAGER, AGROCHEMICALS

Check before you sow

When scouting paddocks, look for slugs underneath sticks, stones, thick layers of trash and even cowpats.

For a more accurate assessment, place at least five wet sacks or mats in the paddock with some slug bait underneath, leave them out for a couple of nights and check underneath in the morning.

If you find an average of three or four slugs are under the sack, you could have a problem.

In newly-sown crops or pastures, slugs migrating in from the fencelines can cause damage. Even if slugs seem hard to find, it's a good idea to broadcast slug bait around the outside of the paddock.

Combine forces to manage slugs

Cultural practices can help reduce the opportunity for slug populations to increase to damaging levels. Remove trash from the previous crop to reduce their food source and minimise suitable habitats. Consider mob stocking, which closes cracks in the soil and tramples slugs. Slugs are not good at burrowing into soil, but they do like crawling down to shelter in cracks, so fine firm seedbeds are better than loose cloddy ones.

Cultivation helps reduce slug numbers, so minimum till or direct drill crops are more at risk.

Spray out resident vegetation and broadcast slug bait with your starter fertiliser before drilling. This way, bait is introduced at the same time as other slug food sources are drying up. Endure slug bait mixes and spreads evenly with fertiliser, saving on application costs.

Plan around drilling

In most situations, broadcasting bait is more effective, because it takes care of the slugs in between the drill rows.

In conditions where drill slots remain open after direct drilling, sowing slug bait down the spout will help control slugs that crawl into the open drill row.

Continue monitoring after drilling, particularly if slug populations are high or conditions are favourable. Where risk is high, it's a good idea to apply repeat application of bait. For example, two applications of 4-5kg/ha Endure slug bait would be more effective than a single application at 8kg/ha.

Right tool for the job

Consider the active ingredient in your bait. Metaldehyde is less harmful to beneficial insects such as earthworms and carab beetles - predators of slugs - so you can use repeat applications if necessary. Methiocarb bait, on the other hand, is recommended to be only used once per season because of its toxicity to earthworms, which are essential for healthy soil.

Pasta-based Endure slug bait uses metaldehyde as the active ingredient, distributed evenly throughout, so it is not at risk of being washed off in wet conditions. The size and shape of Endure bait means it spreads evenly - important for effective slug control.

LEARN MORE: ASK WHETHER YOUR SLUG BAIT IS FERTMARK TESTED, SO IT SPREADS CONSISTENTLY EVERY TIME WHEN MIXED WITH FERTILISER.

THE MIGHTY BRASSICA

High in energy and protein, brassicas pack a nutritional punch. Whether you're looking to finish young stock, seeking a summer-safe crop or simply a forage that will weather a potentially dry season, brassicas are some of the best of the bunch.

In New Zealand, brassicas are also used to avoid animal health-related problems such as ryegrass staggers and facial eczema. Not only do they reduce the risk of health-related issues, brassicas leave the soil in good condition for re-establishing new pastures. And thanks to a colossal root structure that can burrow well below the root-depth of other crops to seek nutrients and water, they are an ideal part of any crop rotation programme.

Looking at establishing brassica? Here's some handy hints to maximising the returns from your efforts.

1. Search and select

Choose the total area you want to sow based on feed requirements. Versatile brassicas work as part of a regrassing programme and longer-term cropping sequences.

Having a good crop rotation is an important part of sustainable farming practice. It is possible to continue cropping the same paddock for multiple seasons. However, the risk of weeds, pests and diseases will rise if this continues for years, affecting yield and feed quality.

Test your soil at least six months before sowing so you know in good time what fertiliser your brassicas need.

Optimum nutrient status for brassica:

Soil pH	Olsen P	QT Potassium	Sulphate-S	QT Magnesium
5.8-6.2	25-30 (sedimentary and ash)	5-8	3-8	8-10

2. Spray-out

Brassicas, like every crop, will be more successful if the old crop or pasture and weeds are removed, because they compete for vital nutrients, water and space. Glyphosate is one of the best herbicides to use, but it does not control all weeds. And don't stop with herbicide - use an insecticide to reduce the number of damaging insects.

3. Prep the seed bed

Create a fine, firm and weed-free seedbed and, if you're direct drilling, remove as much of the previous paddock trash as possible. This will reduce the effect insects may have on the establishing crop and reduce the drag on nitrogen available from microbes breaking down the trash, freeing it up for the newly sown crop.

Pre-emergence herbicides control weeds before they have a chance to compete with the crop. Trifluralin (Triflow 480) controls a range of broadleaf and grass weeds, some of which are difficult to control with post-emergence herbicides, like chickweed, spurrey and wirweed. Trifluralin does need to be incorporated into the soil prior to sowing, but this can be part of the normal seedbed preparation process in cultivated situations.

4. Establishing the crop

The quicker the plants emerge and establish, the quicker they can start photosynthesising, which makes for a better yield. But, there is a trade-off between sowing early to maximise yield and how quickly a crop can establish. The warmer the soil (given adequate moisture) the faster the establishment.

Sowing too early in colder soils will slow down establishment, increasing the risk of weed competition. The soil temperatures need to be at least 10°C and rising prior to sowing brassicas.

Sowing depth is also important as forage brassica seeds are small and require shallow drilling, ideally 10-15mm, for quick establishment.

Use treated seeds and slug bait to reduce the impact any insects may have on the emerging plants.

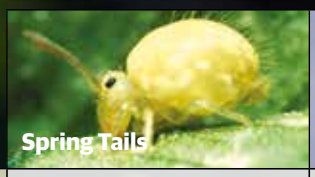
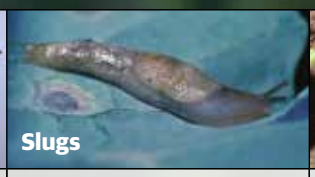
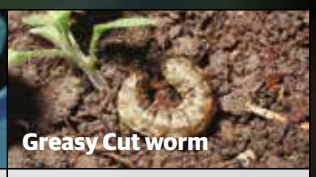
Using a nitrogen-based starter fertiliser, such as Cropmaster DAP, will help establishment by providing ready access to nutrients for the small emerging plants.

Research from D. R. Stevens et al. (2008) has shown that adding urea in early spring, before double spraying for brassica crops to be sown in December, can help boost the crop yields to a level similar to that achieved with N fertiliser applied later in the season.

5. It's not over yet

Regular crop monitoring is essential. Look first for any sign of insect damage and secondly for weeds. Even if you've used insecticide and seed treatment, insects are mobile and can come in from surrounding areas. Continue to monitor after establishment as other pests such as aphids and caterpillars can cause significant damage at more advanced stages.

Beat off brassica threats

	 Spring Tails	 Nysius	 Slugs	 Greasy Cut worm
Damage Symptoms	– Damaged cotyledons and emerging growing points, causing damage up to the fourth leaf stage – Half-moon notches in emerging leaves – Place card on the ground and tap, looking for insects 'springing' onto it	– Damages seedlings at ground level – Causes ring-barking effect	– Damage to establishing brassica crops – Chewing of cotyledons and leaves	– Larvae eat young seedling at or just below ground level – Plant wilting
Cultural Control	– Reduce trash in seed bed	– Reduce trash in seed bed	– Reduce initial populations via • Mob stocking • Cultivation • Heavy rolling – Reduce trash in seedbed – Monitor slug numbers	– Cultivation
Chemical Control	– Treated seed – Toppel® 500 @ 200mLha + Widespread® 1000 @ 25mL/100L water, in 200 litres of water per hectare	– Cropcote Plus™ Seed Treatment – Toppel® 500 @ 1.25L/ha + Widespread® 1000 @ 25mL/100L water, in 200 litres of water per hectare	– Endure® @ 4-8kg/ha – Where slug numbers are high it is more effective to apply 2 applications at 4-5Kg/ha than a single application at the higher rate	– Halexcs @ 40mL/ha + Widespread® 1000 @ 25mL / 100L water, – in 300 litres of water per hectare – Toppel® 500 @ 600mL/ha + Widespread® 1000 @ 25mL/100L water in 200 litres of water per hectare

Companion Herbicide	**Granit** (Tribenuron-methyl)	**Backup** (Thifensulfuron-methyl)	**Dicam 480** (Dicamba)	**Multiple** (Clopyralid)	**Pasture Guard 2,4-D 680** (2,4-d ester)
	(40 g/ha)	(20 g/ha)	(625 mL/ha)	(0.7-1.0 L/ha)	(1.5-3.0 L/ha)
Extra Weeds Controlled	Clovers, sheep sorrel, thistle, ragwort, wireweed, yarrow	Buttercup, dock	Clovers, dandelion, dock, mallow, pennyroyal, ragwort, sheep sorrel, thistles, mayweed, wireweed, yarrow	Clovers, dandelions, plantains, thistle, yarrow	Nettles, ragwort, storksbill, thistles
Plant-back Period	14 days	14 days	0 days	0 days	28 days

Companion Insecticide	**Toppel 500** (Chlorpyrifos)						**Halex^{CS}** (Lambda-cyhalothrin)
Insects Controlled	Springtails	Army caterpillar	Cutworm	Nysius	Argentine stem weevil	Porina caterpillar	Cutworm
	200ml/ha	500ml/ha	600ml/ha	1.25L/ha	1.25L/ha	1.25-1.7L/ha	40ml/ha

Source Code

In case you would like to learn more, we have collated this list of sources cited in our articles. Most of these are available online. If you'd like more information, or you'd like to discuss an article written in Ground Effect by any Ravensdown specialist, give the Customer Centre a call on 0800 100 123 to arrange a chat.

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THE SAYING "NEVER WORK WITH CHILDREN OR ANIMALS" DIDN'T APPLY TO HUNTING HORSE TONKA, WHO TOOK IT UPON HERSELF TO SUPERVISE AS PHOTOGRAPHER NIC STAVELEY SHOT LUCE WILLIAMS ATOP FOXY BROWN.

The Last Word

We hope you enjoyed the first edition of Ravensdown's Ground Effect. Let us know what you think, or if you'd like to contribute to the next edition. Email us or share your thoughts online through our social media channels.

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On behalf of New Zealand, we'd like to thank those who are actually doing agri-science and capturing insights for the good of the country.

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Contributors

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Ground Effect

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