Agronomy Society of New Zealand

SYMPOSIUM PROGRAMME
AND
ABSTRACTS

50th Anniversary Symposium
31st August – 1st September 2022

Lincoln University, Lincoln

Agronomy Society of New Zealand Symposium

31st August – 1st September 2022
Stewart Building, Lincoln University, New Zealand

THEME:
Environmental impact and solutions for arable & horticultural farm systems

DAY1: Wednesday 31st August (9.30 am – 5.00 pm)

9.30 am	ARRIVAL & MORNING TEA	
10.15 am	**President's Welcome**	Jo Townshend (on behalf of Craig McGill)
10.25 am	Ambling in arable	Nick Pyke AgInnovate NZ
10.55 am	**Nutrient management for arable systems** Chair: Jo Townshend	FAR
11.00 am	Irrigation scheme nutrient management in an arable dense area	Eva Harris Enviro Collective Ltd
11.20 am	Soil testing for improved nitrogen management	Mike Beare Plant & Food Research, Lincoln
11.45 am	Nitrogen use efficiency	Dirk Wallace FAR
12.05 pm	Agronomic decisions for crop nitrogen management	Murray Craighead Nutrient Solutions Ltd
12.30 pm	LUNCH	
1.15 pm	**Soil protection** Chair: Edith Khaembah	agri-nutrients Ballance
1.20 pm	Creating catch crop options for winter forage grazing	Peter Carey Agritech, Lincoln
1.40 pm	Sustainable vegetable systems	Andrew Barber Potatoes NZ
2.00 pm	Changes and impacts of tillage in cropping systems	Trish Fraser Plant & Food Research, Lincoln
2.20 pm	Soil structure & water storage	Wei Hu Plant & Food Research, Lincoln
2.40 pm	Runoff for cropping farms and guidelines for setbacks	Abie Horrocks FAR
3.00 pm	AFTERNOON TEA	

3.30 pm	**Regenerative agriculture** Chair: David Birkett	AGMARDT FUTURE SHAPERS
3.35 pm	Regenerative agriculture – A New Zealand agronomist's view	Derrick Moot Lincoln University
3.50 pm	What regenerative agriculture means in a New Zealand context	Charles Merfield Merfield Agronomy Ltd
4.05 pm	Regenerative agriculture – a consultant's perspective	Canaan Ahu Agrownomics
4.20 pm	Reducing pesticide/fungicide use in New Zealand arable systems	Hamish Marr Marr Farms
4.35 pm	Panel discussion	
5.00 pm	WRAP UP AND FINISH	
6.30 pm	Anniversary Dinner (Wednesday) • Drinks followed by a Meal • Sponsor talk – Grant Edwards • Keynote speaker – Mike Dunbier	LINCOLN UNIVERSITY TE WHARE WĀNAKA O AORAKI

DAY 2: Thursday 1st September (8.30 am – 3.00 pm)

8.30 am ARRIVAL

8.50 am	**Greenhouse gases and carbon sequestration** Chair: Mariana Andreucci	Hill Laboratories – Tried, Tested and Trusted
8.55 am	Native and exotic trees – carbon, afforestation and research needs	Simeon Smaill Scion
9.15 am	Greenhouse gas emissions from arable and vegetable cropping systems	Steve Thomas Plant & Food Research, Lincoln
9.35 am	Greenhouse gas emissions from perennial horticultural systems	Brent Clothier Plant & Food Research, Palm Nth
9.55 am	He Waka Eke Noa	Michelle Sands HortNZ
10.15 am	Climate change & cropping systems	Jim Salinger Victoria University

10.35 am MORNING TEA — BASF We create chemistry

11.05 am	**Options for farm diversification** Chair: Murray Craighead	Farmlands co-operative
11.10 am	Hops – what is the potential and direction	Kerry Templeton/Ron Beatson Plant & Food Research, Riwaka
11.30 am	Glasshouse crops	Stefan Vogrincic Grower2Grower
11.50 pm	Pure oil – a value added story	Nick Murney Pure Oil NZ
12.10 pm	Hemp – can it live up to the hype?	Jo Townshend Midlands Holdings
12.30 pm	Farming diversification and processing opportunities	Dennis Carter Carter Seed Management

12.50 pm LUNCH

1.35 pm	**Extracting value from commodity products** Chair: Robert Southward	AGMARDT Future Shapers
1.40 pm	Future proofing farming – precision principles in vegetable systems	Dan Bloomer Landwise
2.00 pm	Precision ag for future farm systems	Ian Yule PlantTech Research Institute
2.20 pm	Oats – adding value	Keith Armstrong Global Oats Ltd
2.40 pm	Diverse products for diverse markets	Ivan Lawrie FAR

3.00 pm WRAP UP AND FINISH

Day 1, 10.25 am: Arable address

Ambling in Arable – 50 years

Nick Pyke AgInnovate NZ, Christchurch

This paper was intended to be presented over a year ago and reflect on 50 years of arable that the Agronomy Society of New Zealand had witnessed. However, COVID-19 intervened and in the last two years there have been significant shifts in the arable industry with regard to costs, returns and farm practices. This paper focuses on the agronomic changes in the industry with only brief mention of the political impacts, the business models, input costs and returns to growers.

New Zealand's production of arable crops, apart from seed, is primarily for the domestic market and production has increased steadily over the last 50 years but the area of cropped land has markedly reduced over that same time frame while the population of New Zealand has increased by 2.3 million. Although wheat production has increased from 260,000 t to 400,000 t/annum, with most wheat going to the feed industry, we now produce 17% less wheat per person than in 1970. Whilst yields have increased markedly, changes such as the deregulation of the wheat industry, bulk handling of grains and an outdated transactional business model have increased our reliance on imported grains and feeds such as Palm Kernel Extract.

Agronomic research has led to significant increases in yields of some species but no real change in others. For example, feed wheat yields in Cereal Performance Trials (CPT) have been increasing by almost 200 kg/ha/year over the last 20 years: a 33% increase in yield. Perennial ryegrass yields increased by over 35 kg/ha/year in the 20 years to 2014, almost a doubling of yield. In wheat, genetic gain accounts for approximately 10% of the yield gain while other agronomic changes are responsible for the majority. However, for ryegrass the increased yields reflect the improved agronomic practices, particularly plant growth regulators, grazing and nitrogen, farmers now have available to them. The yields of peas have not changed markedly in 20 years and while commercial maize yields increased from 1970 to 2020 there has been no increase in yield in the last 20 years, although trial reports show there has been genetic gain.

Increased use and efficiency of irrigation have accounted for large increases in yield. In 9 years of CPT activity irrigated wheat yielded on average 2.85 t/ha more than dryland wheat. At today's prices irrigated wheat provided an extra $1740/ha less irrigation costs, which could be around $1000/ha in some irrigation schemes. In a pea trial, with water costed at $2.50/mm, the increased return was $390/ha, while in ryegrass increased returns from seed alone, before the cost of water, were around $2000/ha.

Nitrogen use efficiency in many crops has also improved through an increased understanding of nitrogen demand, often in relation to plant growth stages, such that ryegrass crops are now being produced with 30% less nitrogen (soil + applied) than in the late 1990s and for cereals nitrogen is calculated per tonne produced.

Increased reliance on agrichemicals for weed, pest and disease control and plant growth regulators have both increased and protected yield. In recent years agrichemical resistance and consumer pressures have increased the focus on cover crops, Integrated Pest Management and forecasting to manage these risks.

The role of technology in arable farming to aid production and for reporting to ensure environmental and food quality requirements are met has provided opportunities and challenges. Currently the industry has a large reliance on new genetics to increase yield, provide resistance to disease and improve quality but no ability to use new genetic techniques to advance the industry in future.

For the industry to prosper in the next 50 years there will be an increased reliance on new technologies and research to reduce crop inputs and adjust to climate change, as well as to satisfy environmental, food security and quality requirements of customers.

Day 1, 10.55 am: Nutrient Management for Arable systems

Irrigation scheme nutrient management in an arable dense area

Eva Harris, Enviro Collective Ltd., Ashburton

Acton Farmer's Irrigation Co-Operative (AFIC) is an irrigation scheme which delivers 3,000 l/s of water leased from Barrhill Chertsey Irrigation Limited (BCIL) to over 50 farms east of Rakaia, covering over 20,000 ha. Our farms are over 80% mixed arable and horticulture. Collective nitrogen losses from AFIC are managed by BCIL through a nutrient discharge consent initially issued by Environment Canterbury (ECan) in 2013 and renewed in 2021.

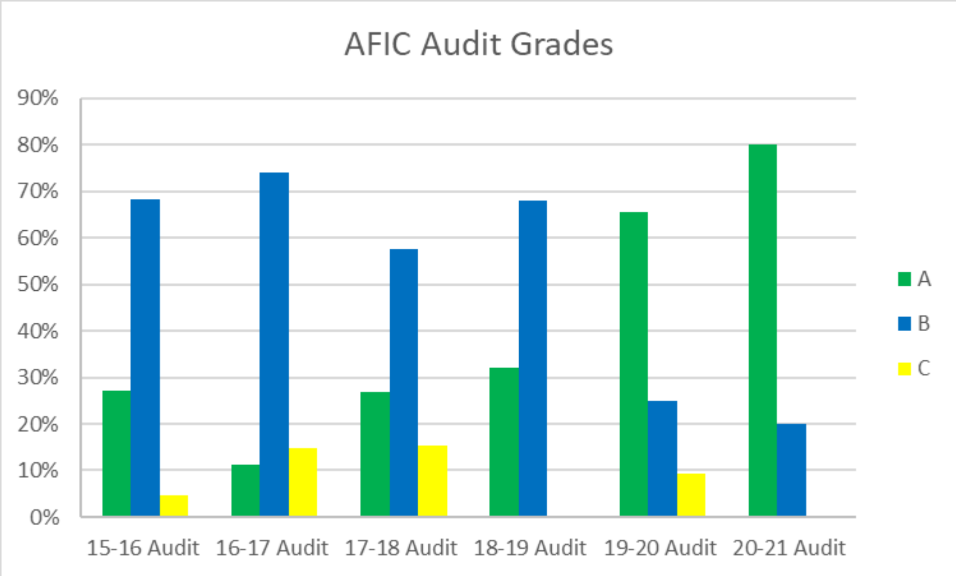
The nutrient discharge consents set up an Audited Self-Management Programme, with a collective cap on nitrogen losses reported annually. The consents have also required every property to have a Farm Environment Plan (FEP), which is audited to standards set by ECan.

Since 2015, we have been supporting farms within AFIC to reduce their environmental footprint through improving on-farm practices and reporting on-farm nitrogen losses through annual Overseer nutrient budgets. Under our new consent, we have been able to move from individual Overseer budgets to a catchment nitrogen load calculator tool called The Matrix. The Matrix utilises GIS mapping software to spatially apply representative nitrogen losses by soil type, farm system, irrigation type and farm plan audit grade.

From our experience, we found Overseer was a challenging and expensive tool for arable and horticultural farmers to manage nitrogen losses on their property. Due to these limitations, early on we focussed on actions which we know improve environmental outcomes from their properties, such as improved irrigation scheduling, reduced N fertiliser use and optimising crop rotations to maximise uptake of N in the soil.

We provide one on one support to the farmers, as well as workshops, handouts and bring in industry professionals to assist with their implementation of good farming practices.

We have been able to measure the improvements of performance through auditing, benchmarking and collating farm system data each year.
Through our auditing system, farms assessed as meeting Good Management Practice (GMP) are awarded an "A" grade. We have seen our farmers improve year on year since auditing was initiated in 2016, with over 95% achieving an "A" grade this past season.



We have also seen improvements in fertiliser use and reductions in N surplus, and widespread adoption of irrigation scheduling tools to reduce water usage.

Our focus going forward is to encourage our farmers to look beyond Good Management Practice and move to "Advanced Mitigation". Advanced Mitigation seeks to further reduce N surplus by optimising irrigation to meet crop demand, identify and target variability, and tidy up sources of contamination into groundwater, such as soakholes or insecure wellheads.

The improvements towards Advanced Mitigation can be captured and reported on using The Matrix, which can demonstrate widespread trends in farm system development and management. We are also starting an extensive groundwater monitoring programme, which we hope will pick up the improvements we are seeing on farm over time.

We have found our focus on improving on-farm practice has been engaging our farmers, as they have seen the benefits in improved efficiencies through reduced costs. Groundwater monitoring data is also supportive in engaging farmers as they can see the impact their decisions have on water quality. While managing nutrients through Overseer still has a part to play when managing intensification, focussing on the tangible aspects of improved farming practices and impacts on water quality has been more effective on a day-to-day basis to support the adoption of better farming practices.

Day 1, 11.20 am: Nutrient Management for Arable systems

Soil Testing for improved nitrogen management

Mike Beare, Cropping Systems and Environment, Plant & Food Research, Lincoln

Recent advances in soil nitrogen (N) testing have focussed on helping growers to better forecast how much additional fertiliser N may be needed to meet, but not exceed, the demand of a growing crop. The goal is to improve N use efficiency that reduces costs and losses to the environment, while maintaining crop yields and quality.

The plant available N that is supplied directly by soil can be divided into two forms:

Mineral N = the plant-available N in soil at the time of sampling
Mineralised N = the N released (mineralised) from soil organic matter during the growing season

Mineral N testing is recommended for growers to estimate the amount of plant available N (i.e. ammonium and nitrate) at the start of the main (spring/summer) growing season, for both autumn and spring sown/planted crops. In most cases, the majority of the mineral N that is available to a crop will be found in the top 30 cm of soil. This is the N that is immediately available for crop uptake.

Mineralisation is a microbial process that involves the gradual breakdown of soil organic matter to release mineral N during the growing season. In cropping soils, mineralisation can contribute a large amount of plant-available N (40 – 300+ kg N/ha/year) that varies depending on soil type, land use history, and soil environmental conditions (especially temperature and moisture). In general, the soil organic matter that breaks down during mineralisation is also gradually replenished during the decomposition of crop residues, roots and other organic wastes (e.g. effluent, animal dung).

The amount of N that mineralises under field conditions is not easily measurable. However, it can be estimated from (1) a test of the soil's N mineralisation potential (i.e. the amount of N released under "optimal" conditions in the laboratory), and (2) an understanding of how change in soil temperature and water content during the growing season affect the actual rate of N mineralisation under field conditions. The new Potentially Mineralisable N (PMN) test, developed by Plant & Food Research, provides a relatively rapid and accurate measure of how much N can be released (mineralised) from a given soil, under "optimal" conditions, over a 14-week period. The PMN test is now available through most commercial soil testing laboratories in New Zealand and is more reliable than the traditional anaerobically mineralisable N (AMN) test, also known as the Available N (AN) test. The AMN test measures mineralisation under highly artificial conditions (high temperature, waterlogged soil) that are not consistent with the field environment and the test has poor precision.

While the PMN test provides a measure of how much N could be mineralised from a given soil under optimal conditions, soil temperature and water content in the field are rarely optimal. The actual amount of N mineralised at a specific soil test site will depend on the local climate during the crop growing season. Research over the last 4-5 years has focussed on developing and validating a method to predict how much

of the PMN will actually be mineralised under field conditions, given variations in soil temperature and water content.
This presentation will describe the background to the new PMN test and the method to predict in-field N mineralisation. I will also discuss the results of field trials that validate the predictions of in-field N mineralisation and provide a practical example of how mineral N and PMN testing can be used to improve N fertiliser forecasting, with benefits for production, fertiliser costs and the environment.

Day 1, 11.45 am: Nutrient Management for Arable systems

Nitrogen use efficiency

Dirk Wallace, FAR Templeton,

The economic and environmental aim of good N management is to match nitrogen (N) supply to crop N demand, this approach gives the best economic return on investment and the lowers the risk of loss to the wider environment. This has always been the aim, but recently there has been mounting regulatory and economic pressure on getting nitrogen management right.
The simplest way of assessing N management is by assessing nitrogen use efficiency (NUE). Simply put, NUE is a measure of how much product was produced per unit of nitrogen supplied. Increasing the NUE of arable systems is a pathway to increase profitability and lighten the sector's impact on the environment.
The descriptor of NUE applied by this work is the agronomic efficiency of applied N (AEN – Equation 1), which describes the incremental gain in yield when N fertiliser is applied compared to a control (Novoa and Loomis 1981; Singh et al. 1998).

$$AEN = \frac{Yield\ N_x - Yield\ N_0}{N_x} \qquad \text{Equation 1}$$

Where *Yield* N_x is the yield achieved with fertiliser N, *Yield* N_0 is the yield achieved without fertiliser N, and N_x is the amount of fertiliser N applied. Nitrogen supply from soil or residues are not considered in this calculation which is a limitation to the use of AEN (Semenov et al. 2007).

Previous work in the Australian cropping sector has demonstrated that using a simple NUE indicator can improve on farm N management (Evans et al. 2016). The basis for the indicator developed by Evans et al. (2016) was the partial N balance (PNB – Equation 2).

$$PNB = \frac{N_{Yield}}{N_x} \qquad \text{Equation 2}$$

Where N_{Yield} is the amount of N exported (kg N/ha) in harvested portion and N_x is the amount of fertiliser N applied (kg N/ha).

Results will be presented which describe the potential of PNB to retrospectively indicate AEN across three arable crops: maize silage, feed wheat and ryegrass seed. The potential of expanding PNB to consider N management beyond the crop and across the rotation will also be discussed.

References:

Evans, A., Lucas, D., and Blaesing, D. (2016). Nitrogen use efficiency (NUE) and tools for farmer engagement: A good reason for being imprecise. *Proceedings of the 2016 International Nitrogen Initiative Conference*. Melbourne, Australia.

Novoa, R. and Loomis, R. (1981). Nitrogen and plant production. *Plant and Soil,* 58: 177-204.

Singh, U., Ladha, J., Castillo, E., Punzalan, G., Tirol-Padre, A., and Duqueza, M. (1998). Genotypic variation in nitrogen use efficiency in medium-and long-duration rice. *Field Crops Research*, 58: 35-53.

Semenov, M. A., Jamieson, P. D., and Martre, P. (2007). Deconvoluting nitrogen use efficiency in wheat: a simulation study. *European Journal of Agronomy*, 26: 283-294.

Day 1, 12.05 pm: Nutrient Management for Arable systems

Agronomic decisions for crop nitrogen management

Murray Craighead, Nutrient Solutions Ltd., Upper Moutere

Crop rotations in New Zealand can be quite complicated due to the wide range of crops and the use of animal grazing. Therefore, it is difficult to make simple N recommendations. While we have a suite of N tests to aid with recommendations these only measure a small portion of the potentially available N in the soil, or the immediate (mineral) N and so must be used with caution.

In the established cropping areas by far the most important factor in determining N use is the soil type, through its N content, and its ability to hold moisture. This is reflected by the winners of the United Wheatgrower's wheat competition invariably coming from farms with the best soils. Hence precision farming technologies such as electromagnetic scanning, are useful to target N and alter N rates.

Crop history – Some crops such as two-year white clover give high carryover N benefits as they have fixed N for18 months, while continuous cereal growing generally has the lowest N carryover. Crops such as peas generally only fix enough N for their own use and can respond (vegetatively) to N.
The previous crop N fertilizer is less important unless the previous crop does not utilize N well, such as in main or late potatoes. Winter grazing provides significant amounts of immediately available N to the following (spring) crop, affecting both the timing and rate of fertiliser N applied. Cover crops are good for reducing winter leaching. However, like growing crops following long term pasture, there is a delay in N mineralisation and some residues cause a short-term deficit in N. Therefore, more N may be applied at the earlier growth stages as opposed to later, e.g. milling wheat. Changing crop rotations may be an alternative way of utilising this N.

Partitioning of N – it is important to identify what you are trying to achieve when applying N. There are specific recommendations for different grass seed crops because you are trying to weigh growth against stressing a plant to produce seed and grazing; N timing and plant growth regulators also play a role.
Equally with wheat, protein yield is the best way to express N use. An 8-tonne crop at 12% protein removes the same N as a 10-tonne crop at 10% protein and so timing becomes important. Malting barley has much lower N requirements than feed barley and is best controlled by previous crop rotation, while P can also play an important role in brassica crops.

Forms of N – in NZ, the most inefficient form of N, urea is used as it is the cheapest source of N. However, N is also applied in NPK compounds or blends, and as CAN, particularly in horticulture. While nitrification inhibitors play a role in reducing volatilization losses in pastoral situations, they give variable responses in crops. They may have value for late applications where crop height or soil physical conditions exclude further topdressing however in most cases, we can control the timing of N to match critical growth stages, e.g. wheat, without using an inhibitor. Their main benefit in crops may be to reducing germination damage where N is applied at planting.

Timing of N – in autumn sown crops most N is deferred until spring to reduce leaching losses in winter. In spring crops N use is more flexible, as crops grow much more quickly, and yield potentials are generally lower. Often all N can be applied preplanting and/or at early growth stages without compromising yield, e.g. barley, maize. Perennial crops often have specific requirements; hops require monthly N from spring with further tweaking in summer and a long water tweaking to suit harvest patterns. In contrast it doesn't really matter when N is added to blackcurrants unless vegetative growth or bud development are important.

Liquid N can be more efficient than solid N, but foliar uptake is restricted to low rates to restrict leaf burn. With milling wheat either form will lift protein levels. However, at high water rates such as in centre pivots you can apply N more evenly and at low rates to better improve efficiencies.

Efficiencies are lower in annual as opposed to perennial crops due to fertilizer placement, established root systems and better irrigation control.

Day 1, 1.15 pm: Soil Protection

Creating catch crop options for winter forage grazing – lessons from a three-year sustainable farming project

Peter Carey, Agritech, Lincoln

The use of catch crops, such as oats, sown after winter forage grazing, have been shown in small plot and field lysimeter experiments to be an effective mitigation option to reduce nitrogen leaching losses after urinary-N deposition on largely, bare soils at a time of high drainage potential.

We report results from a 3-year sustainable farming futures fund project where research was extended onto commercial winter forage grazing paddocks in Canterbury and Southland to capture urinary-N post grazing in a potentially valuable secondary crop. By doing so we hoped to reduce this N leaching potential and create win-win options for farmers by improving both environmental performance and farm profitability.

The use of catch crops in winter forage rotations was shown to be a successful and valid option for farmers although Southland remains a problematic region where other complementary options are required.

Day 1, 1.40 pm: Soil Protection

Sustainable vegetable systems

Andrew Barber, Agrilink NZ, Sustainable vegetable systems

Sustainable Vegetable Systems (SVS) is a 4-year joint MPI and industry funded project, that is now at the halfway mark. SVS will provide robust empirical data that will inform and develop new vegetable production systems, strategies and tools to manage nitrogen. This is being delivered through a management tool that will help growers implement good nitrogen management practices. In turn this provides practice-based evidence that growers can point towards in their Farm Environment Plans.

Creating a practical, robust, scientifically defendable vegetable nitrogen budget and nitrogen fertiliser guidance is what the SVS project is focused on.
Right now, SVS is transitioning away from the intensive Plant & Food Research run field trials into analysis, model and tool development, and dissemination.
Analysis of the crop nitrogen uptake and concentrations from the previous crop harvests is underway for incorporation into the plant-nitrogen model. Work is also underway on understanding the drivers of leaching events observed in the trials, and on the impact that nitrogen application rates and crop residue breakdown has on soil mineral N.

The tool itself, N-Sight, is at a proof-of-concept stage and is undergoing iterative improvements as it is demonstrated and tested amongst a range of technical and user groups. The tool's foundations are based around a nitrogen budget. This incorporates the anticipated crop nitrogen demand, the preceding crops residue, soil nitrogen mineralisation, the current soil mineral nitrogen level, and the impact of climate. At the most basic level N-Sight will provide guidance on the quantity of nitrogen fertiliser required, and the optimal timings for fertiliser applications based on the modelled plant uptake curve and the user set number of side dressings. The budget is then ground truthed through the season using soil nitrogen testing, most likely a Quick-N test.

In summary SVS is firmly focused on developing a practical nitrogen management tool for growers. This will lead to reduced nitrogen leaching through the optimised use of nitrogen fertiliser, a win for growers and the environment. N-Sight will have multiple benefits of being:

- practical for growers,
- improving nitrogen knowledge and practices,
- provide the evidence required in FEPs to demonstrate Good and Best Management Practices,
- make the invisible visible,
- provide a platform for a conversation with regulators, and
- consequently, reduce nitrogen leaching.

In turn all of this underpins growers' ability to farm into the future.

Day 1, 2.00 pm: Soil Protection

Changes and impacts of tillage in cropping systems

Trish Fraser and Erin Lawrence-Smith, Plant & Food Research, Lincoln

One of the main issues identified by farmers as key to making farms more environmentally sustainable for the future is land management, within which cultivation practices play an important role. The type, intensity, frequency and number of passes carried out using cultivation equipment can have significant impacts on soil organic matter and soil physical and biological condition, as well as the associated abilities of soil to supply and store both nutrients and water, and act as a food source for soil biota. Ultimately, these negative impacts on overall soil health can reduce crop performance. However, results of a series of surveys, conducted over the last 15 years by the Foundation for Arable Research (FAR), have shown that farmers have begun to appreciate the negative impacts of some cultivation practices on soil health. Overall, the surveys revealed a current trend towards the use of increasingly less intensive and/or reduced frequency of tillage as compared to 2007 (Figure 1). This trend brings with it a different set of challenges to face, such as farmers having to deal with increasing incidence of slugs, or practical issues related to voluminous crop residues remaining on the soil surface, often hampering ensuing crop establishment.

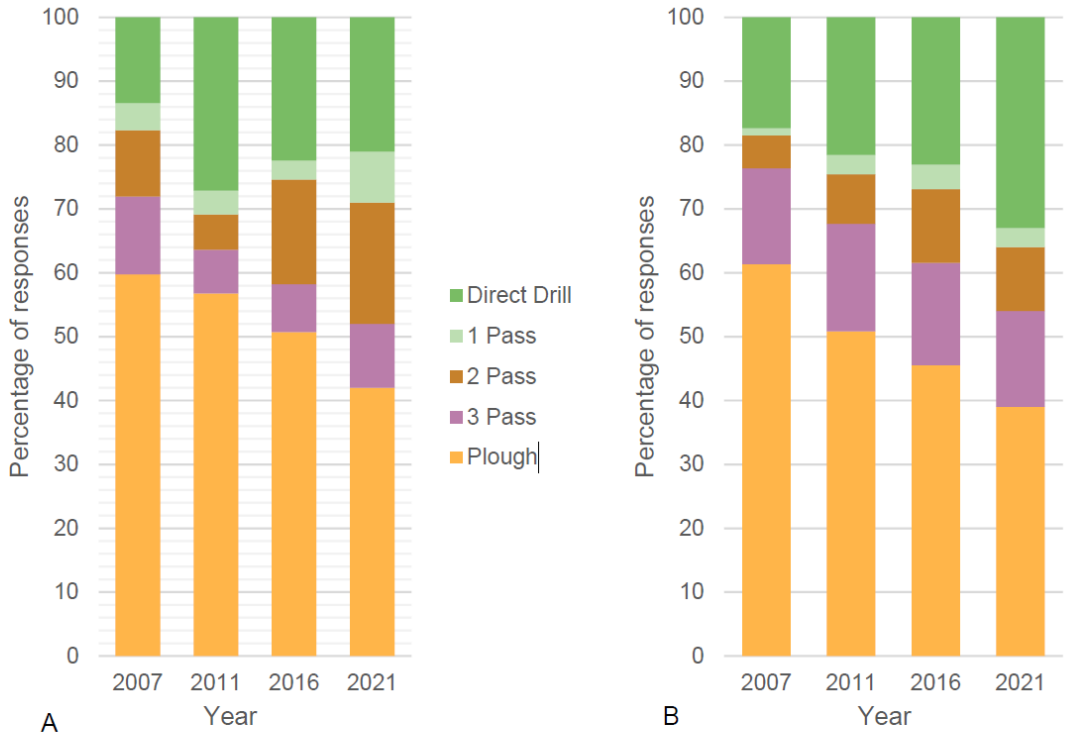


Figure 1: Tillage used to establish crops following grass/pasture for the A) North Island and B) South Island, as supplied by respondents to the FAR cropping sequences surveys conducted in 2007, 2011, 2016 and 2021.

Day 1, 2.20 pm: Soil Protection

Soil structure and water storage

Wei Hu, Plant & Food Research, Lincoln

Agricultural intensification has enhanced productivity but has also negatively affected environmental performance by affecting soil structure and soil functions such as soil water storage and transport. Among various management practices, soil compaction from machinery traffic and livestock trampling and tillage are the main practices that affect soil structure and water storage properties.

Data from our recent literature review and New Zealand case studies will be presented to understand the impacts of land use and management practices on soil structure, water storage properties and environmental performance. The following aspects will be covered: (1) review on soil structural degradation state and its impacts on environmental performance; (2) case studies of impacts of land use and management practices (compaction and tillage) on water storage properties and contaminant losses.

We found that soil structural degradation is common globally, and also in many regions and under different land uses in New Zealand. Soil compaction tends to increase field capacity but decrease air capacity and available water capacity. In Canterbury, soil structure and water storage properties of three soils (Brown, Pallic and Gley soils) were degraded (e.g., reduced available water capacity and hydraulic conductivity) in the irrigated pasture and irrigated cropping compared with dryland pasture. In Waikato, maize cropping degraded soil water storage properties relative to grazed pasture in two contrasting soils (Allophanic and Gley soils). Our studies showed that the degradation of soil structure and water storage properties adversely affected contaminant losses via water (NO_3^-) and air (i.e. N_2O).

Our studies highlighted the importance of maintaining soil structure from degradation for improving both production and environmental performance in various land use sectors. Some knowledge gaps along the “management practices-soil structure-ecosystem services/disservices” chain were also identified.

Day 1, 2.40 pm: Soil Protection

Runoff for cropping farms and guidelines for setbacks

Abie Horrocks, FAR, Templeton

Soil runoff is a risk to the environment because it can reduce water quality and to the farm business because it represents a loss of topsoil. Most runoff and riparian studies in New Zealand have been conducted in pasture systems, with very few studies on cultivated land (Barber *et al.* 2021). To address this issue an MPI Sustainable Farming Fund '*Good Management Practices for Cropping Setbacks*' (2018-2021) was carried out to quantify soil loss from three cropping farms and to explore the circumstances that triggered runoff events on these farms. Setbacks are grass areas adjacent to waterways or at paddock boundaries to reduce runoff velocity, filter sediment and improve infiltration and the project also aimed to compare the effectiveness of different setback widths.

Sediment catchment units were installed at each site to determine how much runoff (L) came from the defined area and how much sediment (by weight) it carried. The plots were positioned in the participating farmer's paddock (30 m^2). The three treatments were:

Control - no additional setback area and the crop went right up to the edge of the plot.
1 m setback - a 1 m setback (3 m^2 additional area at the edge of the crop).
5 m setback - a 5 m setback (15 m^2 additional area at the edge of the crop).

One of the three sites was in a dry area and had negligible soil displaced in runoff. The average annual runoff from the two sites in the higher rainfall areas (one flat site and one 8-degree slope site) had less than 200 kg/ha/yr. Modelled predictions for annual runoff in New Zealand typically range from 400-4000 kg/ha/yr depending on slope and rainfall.

Although runoff events generally coincided with high rainfall periods, management also played an important role in determining soil displacement. Ground cover and compaction (soil saturation was used as a proxy) were of particular importance. There was a linear relationship between the sediment load from four runoff events and the area in fallow (R^2=0.957). The effectiveness of setbacks also varied across the rotation depending on how much ground cover was in the paddock at the time of the rainfall event.

As the setback width increased, soil displaced in runoff decreased. Compared to the control, soil displaced from setbacks was reduced by 37% and 63% for the 1m and 5m setbacks respectively. The relationship between setback width and the amount of sediment in runoff was not linear; the extra benefit from each additional meter decreased in magnitude as width increased.

These data show that in some area's runoff may not be a high risk. Where runoff is a risk, setbacks will work best if they are included in a flexible suite of mitigations customised based on risk assessments and identification of critical source areas on farm. How in paddock management decisions that affect soil quality (residue management, minimising fallows and compaction) and soil displacement will be discussed in the context of cropping specific guidelines.

Barber, A. (2021). Vegetated buffer strips: Background material and literature review. Prepared by Agrilink to support the Vegetated Buffer Strip: Guidance for Achieving Good Practice.

Day 1, 3.30 pm: Regenerative Agriculture

Panel discussion to follow – Chair David Birkett, Leeston

AGMARDT

FUTURE SHAPERS

Regenerative agriculture – A New Zealand agronomist's view

Derrick Moot, Dryland Pastures Research Group, Lincoln University

The term regenerative agriculture has exploded into common vernacular in the last 5 years – but what does it mean? That question has perplexed agronomists the world over. This paper describes the origins, evidence and myths associated with regenerative agriculture. The public popularity of regenerative agriculture fits within a wider narrative that the global food system is broken, and this is the way to fix. But is it? Claims that organic and regenerative agriculture can provide the solutions are examined and the common ground between regenerative and conventional agriculture highlighted. This includes the role of nitrogen in agricultural production and how the New Zealand dairy and sheep and beef sectors have responded to that need over the last 30 years.

Alongside the promotion of regenerative agriculture are claims that these practices enhance "soil health" and sequester carbon to reduce the impacts of agriculture on climate change. These ideas are scrutinised and their relevance in different agricultural systems globally and in New Zealand are highlighted. In particular, the loss of soil carbon is related to the land use after forest clearing. In the major cropping areas of the world these forests were replaced by arable farming which has reduced soil carbon levels. However, in New Zealand the forest soils with low carbon were replaced by pastures that have increased soil carbon levels. Importantly, the time frame required to measure soil carbon changes is highlighted and the fate of carbon returned to soils as litter and humus is described.

The soil is a major focus for farmers interested in regenerative agriculture with the concept of nutrient upwelling and closed loops prominent. The validity of these ideas will be discussed including the need for the major macronutrients to support nitrogen fixation as the driver of pasture production. Finally, the ability of multispecies mixes to enhance yield and quality of pastures will be challenged based on recent research results from Lincoln University.

Ultimately, the challenges that regenerative agricultural processes present will be discussed in the broader context of faith versus science-based evidence to drive agronomic decision making.

Day 1, 3.50 pm: Regenerative Agriculture

What regenerative agriculture means in a New Zealand context

Charles Merfield, Merfield Agronomy Ltd., Christchurch

Regenerative agriculture (RA) is not easy to define as it has multiple layers and facets. At one level it is farmers putting their hands up and admitting they are part of the 'problem' (in terms of agriculture's impact on planetary systems such as biodiversity loss and climate heating) and trying to find solutions to reduce their impacts. At an agronomic level, RA attempts to integrate a range of well-established sustainable farming practices (such as conservation agriculture, diverse rotations, and min and no-till) and more innovative techniques (such as long grazing residuals, diverse plant species mixtures and biostimulants). RA is outcomes focused and includes increasing: social health, soil health, biodiversity, stock health and welfare and profitability. Most importantly RA is a mindset, a different way of looking at and conceptualising both the farm and farming. Grelet et al. (2021) identified a number of mindsets such as 'the farm is a living system', 'question everything', 'failure is part of the journey', 'harness diversity', 'minimise disturbance', 'maximise photosynthesis', etc. A key foundation of the mindset is viewing farms as circular complex adaptive systems (which is what they are) rather than a linear production line which is the mindset in intensive agriculture.

This needs to be set in the current global context. Frameworks such as the Nine Planetary Boundaries (Steffen et al. 2015) continue to show that we are destroying the biophysical system that sustains humanity. Agriculture is right at the heart and is a cause of the majority of the global problems humanity faces (Zimdahl 2022). To fix these problems there needs to be a revolution in agriculture (RSA Food Farming and Countryside Commission 2019).

It is starting to appear that a tipping point to that revolution may have occurred in the last couple of years. Agroecology is increasingly promoted as the alternative to intensive agriculture. For example the EU's Farm to Fork strategy is embedded in agroecology, and all sections and international panels of the UN now promote agroecology as the future of agriculture. New Zealand projects such as 'A Lighter Touch'[1] are aiming to reduce pesticide use, including through agroecology. RA is a form of agroecology, as is organic agriculture and agroforestry. I suggest therefore that RA is as much a symptom of the increasing move from intensive agriculture to agroecology, but with specific branding. It also aligns with the objective of moving NZ from commodity producers into higher value primary produce, in part by selling the story of how that food is grown.

RA therefore offers one of many paths for primary producers to transform away from intensive agriculture into agroecology.

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Day 1, 4.05 pm: Regenerative Agriculture

Regenerative agriculture – a consultant's perspective

Canaan Ahu, Agrownomics, Christchurch

Introduction:

-Who Agrownomics is -What we stand for, our philosophy, independent, soil consultants -Where we came from – "you are what you eat"

Regen Definition:

-Alignment to nature's principles can impact on the reduction of our inputs -Regen is more about the trajectory than a specific destination

Nutrient density:

-Outline the decline in nutrient density, historically yield focused, not on its health-giving properties or bioavailability -Example of this in arable -Triage the context minerals, microbes, management, organic matter

Regenerative context:

-More factors to yield than N, setup, structure, co-factor mineral relationships -What other factors are limiting to nutrition -Microbial support – Trichoderma example

In Field Challenges:

-Marrying regen principles to commercial objectives -Working with weather constraints -Meeting the farmer where he is at -Getting off the prescribed recipe wheel

Positives experiences we have had so far:

-Water retention – increases of 10-30% in many cases -Lower nutrient levels required to sustain production (particularly N) -Increasing rooting zone & soil structure -using set up crops (primers) and significance in the potential here

Summary Conclusion:

-NZ opportunities -There are always areas to improve where we are, reducing need on synthetic reliance -Create safe to fail tests, if it holds truth on small scale then continue to test it out on larger scales.

-Treat soil as soil – it's a house for microbes, mineral warehouse, water tank and giver of life, more than a medium that we plant into.

Day 1, 4.20 pm: Regenerative Agriculture

Reducing pesticide/Fungicide use in New Zealand arable systems

Hamish Marr, Marr Farms, Methven

There is no disputing the impact that chemistry has had on agriculture and food production globally. Since the 1950's green revolution, production on farm has increased at exponential rates and largely because we can control the weeds, the insects and the diseases. However, in 2022 the problem we face is a future where our customers are increasingly aware of and demanding less chemical inputs in food production, we have regulation globally that continues to limit availability, and we have an increasing level of resistance and efficacy issues.

Chemicals in general have allowed agriculture to thrive at scale, brought with them a degree of fail-safe insurance but enabled farmers and agronomists to forget about the basics of whole farm system dynamics. It is this point, whole farm system management that is the key determinant in reducing chemical usage not simply cutting rates or whole applications. It is about changing the management attitude towards them and not basing our rotations around what chemicals we can use on what crop and that spraying is the only option.

The answer lies in considering a suite of options in a continuum and not following recipes which is very common. These "options" or "tools" include assessing all crops for their resistance to disease and insect pressure prior to planting, increase the length of rotations, include livestock, multispecies cropping, understand that weed control is actually managing the weed seed bank, on farm trials and data collection, plant nutrition, plant breeding, residue management, fertilisers and cultivation to name a few and there are many more. It is the incorporation of these management factors and attitude that are the building blocks of what we call Integrated Pest Management and is now commonplace in many parts of the world, particularly Europe.

There is no doubt that the amounts of chemical options available to farmers is decreasing and some will pose very real problems and require complete rethinks on farm. We cannot simply do away with chemicals, but we need as an industry and value chain to utilise all the knowledge we have learnt until now so that we can be responsible with the ones we have left.

Day 2, 8.50 am: Greenhouse gases and carbon sequestration

Hill Laboratories
TRIED, TESTED AND TRUSTED

Native and Exotic trees – carbon, afforestation and research needs
Simeon Smaill, Scion, Christchurch

- Species selection – natives or exotics – has become an emotive issue in afforestation efforts. This has led to strong viewpoints, such as afforestation efforts for carbon should entirely focus on natives, leaving exotics solely for fibre production. Our contention is that a mix of approaches is the most effective approach to meet our climate change targets while also allowing native forests to thrive.

- Exotic pines are simple to establish, grow fast, and sequester carbon at much faster rates than our native tree species. Our slower growing native trees species are much more expensive to establish, and generally require considerable post-planting support to control predation and competition with weeds. From a purely data driven perspective, there is no debate when it comes to afforestation for carbon sequestration.

- It is true that the carbon stored in mature native forests can exceed that in pine – but the issue is the time frame required to achieve this climax state, and the risks of failing to attain it. While small native tree woodlots planted on high quality sites can grow well with appropriate support, pines on the same sites still sequester carbon much more quickly - and our climate change targets require rapid large-scale afforestation, predominantly on poorer sites.

- The other factor to consider is the massive pool of carbon currently stored in our native forest estate, and the pool of carbon that could be stored in the areas of naturally regenerating native forests. Research driven policy to protect the former, and enhance the latter, has the potential to make a more substantial impact on carbon sequestration than attempts to afforest natives in new areas.

- However, the public desire for natives, and the enthusiasm this brings for afforestation efforts, is clear. Options such as afforesting with pines to act as a nursery for later native plantings has been demonstrated to be an effective practice at small scales – and could also work over much larger areas. Research that quantifies the co-benefits (e.g. biodiversity) of different forest types is also needed so that realistic trade-offs can be made by landowners.

Day 2, 9.15 am: Greenhouse gases and carbon sequestration

Greenhouse gas emissions from arable and vegetable cropping systems

Steve Thomas, Plant & Food Research, Lincoln and Sam McNally, Maanaki Whenua Landcare Research, Lincoln

Much of the focus on reducing New Zealand greenhouse gas emissions from primary production is on livestock farming. This is not surprising given the large contribution of livestock to the national greenhouse gas inventory and the New Zealand economy. Consequently, there have been few studies of emissions from arable and vegetable cropping systems, and fewer measurements. However, national commitments to reduce agricultural greenhouse gas emissions and new reporting requirements for farmers have renewed interest in quantifying emissions from cropping systems. Quantifying emissions from arable and vegetable rotations is challenging. Unlike perennial cropping and livestock-only systems, it is important to account for multiple crop sequences spanning several years in arable and vegetable systems, and in mixed cropping systems the emissions from livestock also need to be included. Using a simple modelling approach, we investigated where the greatest greenhouse gas emissions occur in arable and vegetable crop rotations. We followed methodologies used to estimate national emissions and defined "representative" rotations in consultation with industry experts.

Based on this simple accounting-type approach, the single largest contributor to total greenhouse gas emission in the arable rotation was grazing, reflecting the large warming potential of methane. Nitrous oxide emissions from residue return and fertiliser were the next largest contributors, while emissions from fuel were generally a small contributor (10%) to overall emissions. Annualised total emissions from vegetable cropping rotations were similar to arable rotations, with about three-quarters of the emissions coming from fertiliser and crop residue returns. Fuel emissions were similar in both systems.

While highlighting key sources of emissions expected across these farming sectors, this approach is too simple to reflect important effects of the environment (i.e. soil and climate), seasonal variability and location within the farm, and how specific farm management practices (e.g. fertiliser application, tillage, irrigation, residue return, fallow periods) interact with these biophysical factors.

Understanding the importance of these factors together with understanding of their farm environment, farmers might adapt practices to minimise their impact. Factors that are important in producing emissions include soil aeration or soil wetness status, compaction, surplus of inorganic nitrogen and maintenance of crop cover. These could be managed by altering tillage type and timing, and optimising timing, form and rates of fertiliser applications and residue returns. In most situations reduced greenhouse gas emissions will have added benefits of reduced soil, nutrient, and water losses without impinging upon production.

Day 2, 9.35 am: Greenhouse gases and carbon sequestration

Greenhouse gas emissions from perennial horticultural systems
Brent Clothier, Plant & Food Research, Palmerston North

In 2018, the Productivity Commission stated that "… land use will need to change substantially if New Zealand is to transition to a low emissions economy". They also said that "… growth in horticulture (from a relatively small base) will likely also play a significant role in reducing emissions". Here I quantify what the biogenic greenhouse gas (GHG) emissions are from the perennial horticultural production-systems of kiwifruit, apples and grapes, using IPCC protocols. As well, I will outline which areas within New Zealand that horticulture might expand into through a consideration of the natural capital assets of equable climates and suitable lands. The Productivity Commission also said that "… an emissions price [on GHGs] that covers all land use should be the main driver of land-use change. A well-designed Emissions Trading Scheme will incentivise land-use change". I calculate what impact a putative carbon price of $50 T-$CO_{2-e}$ might have on the EBIT (Earnings Before Interest & Taxation) of perennial horticultural production-systems.

There are also other ways to assess the climate-change impacts of GHG emissions and one of these is through a full Life Cycle Assessment of cradle-to-grave emissions associated with a product. In 2008-09, we calculated the carbon footprint of a New Zealand apple exported to foreign markets. This has just been updated, and I now report on the contemporary carbon footprint of a New Zealand export apple.

Day 2, 9.55 am: Greenhouse gases and carbon sequestration

He Waka Eke Noa

Michelle Sands, HortNZ

He Waka Eke Noa – the Primary Sector Climate Action Partnership was formed in 2019 to design a practical, credible, and effective system for reducing emissions at a farm level, as an alternative to government policy to bring agriculture into the New Zealand Emissions Trading Scheme (NZ ETS).

He Waka Eke Noa is developing a practical framework to support farmers to measure, manage and reduce agricultural emissions; recognise, maintain, or increase integrated sequestration on farms; and adapt to a changing climate.

This report outlines recommendations from the primary sector and Māori agribusiness Partners (the Partners) for a farm-level pricing system as part of a broader framework to encourage emissions reductions.

The Partners recommend a **farm-level split-gas levy**. Its key features are:

- Farms calculate their short and long–lived gas emissions through a single centralized calculator (or through existing tools and software linked to this).
- On-farm emissions determine the levy cost rather than the use of national averages.
- Recognition of reduced emissions from on-farm efficiencies and mitigations as they become available.
- Incentives are provided for uptake of actions (practices and technologies) to reduce emissions.
- Different levy rates to short- and long-lived gas emissions.
- On-farm sequestration is recognised.
- Levy revenue is invested in research, development, and extension including a dedicated fund for Māori landowners.
- A System Oversight Board will work closely with an Independent Māori Board to provide recommendations on levy rates and prices and set the strategy for use of levy revenue.

The Partners have worked to design a system that is effective, practical, credible, integrated, and equitable.

The Partners recognise that creating incentives and opportunities to reduce on-farm emissions requires a broader approach and framework than just focusing on a system for pricing emissions.

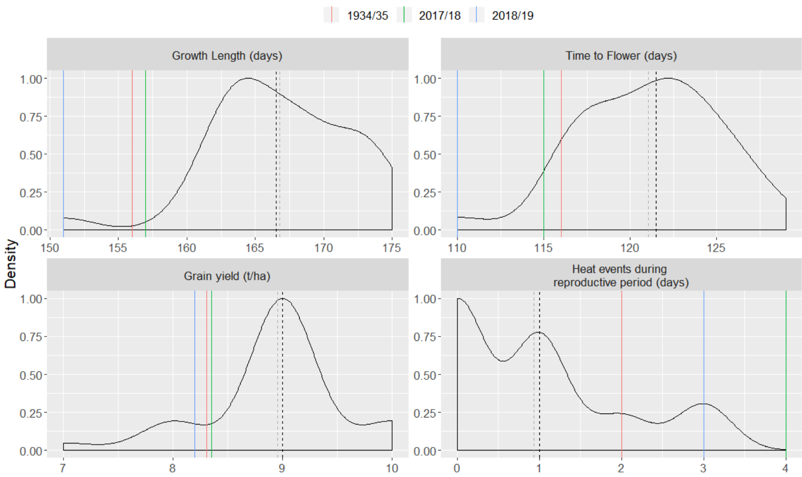
Modelling estimates that the combination of existing government policy and applying farm level split-gas levy would reduce CH_4 emissions by 10—11.6% and N_20 emissions by 5.8-6.1% by 2030.

Further information is available on the website: www.hewakaekenoa.nz

Day 2, 10.15 am: Greenhouse gases and carbon sequestration

Climatic change & cropping systems
Jim Salinger, Victoria University

Climate change in New Zealand will probably have the greatest impact on arable farming through changes in climate variability and climate extremes. New Zealand farmers and growers are increasingly required to manage risk associated with climate events, and this will continue into the future with the possibility of increased risk in some regions. In general, from climate scenarios, temperatures in New Zealand are expected to increase faster in the North Island than in the South Island, and faster in winter than in summer. The difference in average rainfall between western and eastern parts of New Zealand is likely to become stronger, with rainfall probable to increase in the west of the country and decrease in the east. These changes are likely to be more pronounced in winter than in summer.
Arable crops may generally benefit from warmer conditions and higher carbon dioxide levels in the atmosphere. However, potential yield increases will require higher fertiliser inputs. Availability of water for irrigation will be an important factor to achieve the potential gains, particularly in Canterbury, where there will be increased drought risk. Climate change is likely to be generally positive for arable cropping. Higher temperatures will allow earlier sowing of crops, and they will generally reach maturity faster – depending on sowing time. Higher temperatures could lead to decreased yields, but the fertilising effect of higher levels of carbon dioxide will potentially offset this, resulting in yield increases for temperate crops such as wheat and barley. Crops such as maize, which utilise carbon dioxide differently to the temperate crops, with no yield response to higher levels of carbon dioxide.



Simulated physiological responses of irrigated spring wheat during three heatwave years (1934/35, 2017/18 and 2018/19) in Lincoln, Canterbury, New Zealand. Dashed lines are the median (black) and average (dark-grey) of 30 years (1981-2010).

In warm years, modelling of grain yields in wheat are reduced by the acceleration of crop development towards flowering and early harvest, as the crop has less time available to intercept sunlight and convert it into biomass through photosynthesis. The change in flowering date also shifts the timing when the sensitive period to heat stress occurs, illustrating the interplay of both seasonal- and threshold-type damage effects in warm years. The above warming of climate, its variability and extremes will be discussed on the impacts on the arable crops of maize and wheat.

Day 2, 11.05 am: Options for farm diversification

Hops – what is the potential and direction

Kerry Templeton and Ron Beatson, Plant & Food Research, Riwaka

Introduction

Hops (*Humulus lupulus* L.) is an important crop in the Nelson/Tasman region of New Zealand. It is a perennial species native to the Northern Hemisphere, commonly found at latitudes 35–55°N. It was introduced into NZ by pioneer settlers and the first commercial crop was produced in Nelson in 1843. Hops grow well in the NZ temperate oceanic climate, where production is based around the successful breeding of unique cultivars suited to NZ conditions. There are currently ~1500 ha under production and ~1000 ha more planned. Currently, over 80% of the NZ production is sold at the premium end of the international market. For much of the last 100 yrs hops have been a commodity crop, grown primarily to provide the bittering component of beer (alpha acid). This had led to the hop industry being in constant boom/bust cycles and breeding programmes worldwide chasing ever higher alpha acid yields.

The rise of craft beer

In the early 2000s the nascent craft brewing industry started moving towards beers that used hops as one of the major sources of flavour and aroma — this included India Pale Ale (IPA) and Pale Ale styles. These beers proved popular with consumers and, importantly for the hop industry, used significantly more hops per litre of beer. As these styles and their variations continued to evolve and change, the flavour and aroma of the hop became the defining characteristic of many of these styles. This drove demand for particular flavour and aroma characteristics in the hops, with citrus and tropical fruit being two of the most common characteristics sought. This in turn led to sustained growth in the NZ hop industry since ~2010 as demand for hops high in novel flavours and aromas boomed. Several NZ cultivars contribute very high levels of these novel flavours and aromas and have been the driving force behind the growth of the industry in NZ. This in turn has led to significant interest in growing hops in other areas of NZ. Results of a regional study, conducted at three sites across NZ, will be presented. The sites chosen were Kerikeri (Northland), Motueka (current hop region) and Clyde (Central Otago).

What is the potential for hop growth?

The trials were initiated in 2016 and monitored for 4 years. Harvest data relating to yield and basic chemistry (quality) traits were measured.

Results suggested there were subtle differences in chemistry across the three sites, but importantly these differences were apparent within the year-to-year variation we saw from the Motueka site.

Yield data from the three sites were more telling as to the potential for commercial hop production in each of the regions. Kerikeri proved the most challenging of the sites in which to get good production. Heavy and early two-spotted mite infestation caused on-going issues in maintaining good plant quality. Lack of winter chill also appeared to be a problem for some cultivars, although not all at Kerikeri. Cultivars 'Cascade' and 'Pacific Jade' appeared to have similar growth patterns at all three locations. Another unexpected difference between sites was harvest date, which was up to 1 month earlier in Kerikeri for all cultivars tested.

Motueka and Clyde had similar yield and growth performance and the colder climate in Clyde had no noticeable effect on the growth of the plants. The plants in Clyde were in general 2 weeks later emerging in spring when compared with Motueka, but flowering and harvest dates remained the same.

Day 2, 11.30 am: Options for farm diversification

The current situation and future opportunities in the greenhouse sector
Stefan Vogrincic, Grower2Grower, Kerikeri

Current state of greenhouses: Covering protected cropping with a focus on hothouse vegetable production

1. Low Tech Tunnels
    - Large developments for berry production, tropical fruits, nurseries, kiwifruit
2. High Tech
    - Many small-scale developments
    - Minimal to little new plus 5 ha (high tech) greenhouses built in the last 20 years.

Like most industries the vegetable greenhouse industry has shrunk in terms of businesses but increased in area over the past 25 years. A lack of returns from domestic and international markets has contributed to a massive reduction to upgrade with new technology available worldwide. Example Lighting systems not being introduced due to high capital/op-ex costs even though ROI stack up.

Current Issues:
1 Energy

- Natural Gas
- Coal
- Recycled Oil
- Lack of renewable alternatives (transport and calorific values impacting volume required)
- No local liquid CO2 producers
- ETS

2 Labour

- Critical shortages, low paid industry (no more money to pay)

3 Old Structures

- Almost zero recapitalisation/retro fitting into old structures due to lack of certainty (Lack of energy transition options key for instability amongst business)

4 Pests and Disease

- White Fly/Psyllids TPP/Mites/Aphids/Thrips
- Botrytis/Moulds/Canker/Blight/Viruses/

5 Border Incursions

- Pest and disease are a constant biosecurity risk. Right or wrong - control measures in New Zealand are limited, pathways for registering, inoculants/vaccines, new IPM or chemistry is problematic.

6 Compliance

- Ongoing costs to business. ETS, RMA – Consents, Water Management, Air Quality,

Opportunities:

- New Technology – 100% environment control, Robotics, (FTEK Rlap example), AI, Hot lime labs, Lights (dimmable LED's)
- CONTROL Sustainability – nothing compares to greenhouse
- Green Field (Geothermal, biofuel) opportunities from being forced to relocate
- Insular – older properties to new products – Tropical fruits etc
- Water, land, (ultrafiltration systems and new RO units)
- Renewable electricity/lights
- Employment/Self sufficiency
- High Tech – Vegetables, flowers, MC, Berries, Leafy greens, Herbs
- Low Tech – Kiwifruit, Berries, Sub-Tropical Fruit, Asparagus

Day 2, 11.50 am: Options for farm diversification

Pure Oil – a value added story

Nick Murney, Pure Oil NZ

Our story is one of creating a bulk business first with a transition to value-add and branding.

We are into our 10th year of business and over this time Pure Oil NZ has developed into New Zealand's leading oilseed producer and manufacturer of quality oilseed products and brands.

The business is underpinned with 80 dedicated Grower Suppliers in the South Island who we share a commitment to sustainable farming practices.

Our Grower Suppliers produce high oleic rapeseed, conventional rapeseed (canola), high oleic sunflowers and GE free soya beans.

The previous 10 years is based on:

- Utilisation of a large asset
- Improvement of agronomy
- Diversification to other oilseed crops
- Development of new markets - local and aboard
- Product development
- Branding and marketing to end user consumers

The pathway for the next 10 years:

- Belief in core values and business purpose
- People – PTE
- Staying agile to remain competitive
- Balancing value add contributions to bulk business
- Improving environmental impacts

Day 2, 12.10 pm: Options for farm diversification

Hemp – can it live up to the hype

Jo Townshend, Midlands Holdings, Ashburton

Cannabis sativa is an annual plant originating from central Asia. It has been cultivated for thousands of years, for its fibre, health and recreational purposes. Modern production is targeted at numerous markets including textiles, construction and engineered composites, nutrition and functional foods, cosmetics, nutraceuticals, recreational and medicine. This species is also reported to be a 'super' soil phytoremediator and carbon sequester with a high water use efficiency.

The growing, processing and trading of hemp seeds and stalks to produce hemp foods and fibre from of low THC (<0.35%) Industrial Hemp in New Zealand has been legal under licence since 2006 with the Misuse of Drugs Act (Industrial Hemp) Amendment Regulations 2006 & 2018. While Medicinal Cannabis was legalised when the Medicinal Cannabis Scheme came into effect on 1 April 2020 with the commencement of the Misuse of Drugs (Medicinal Cannabis) Regulations 2019. This permits licenced companies to grow and manufacture cannabis prescription medicines containing cannabinoids including high THC dosage. Recreational Cannabis remains an illegal activity in New Zealand, after narrowly being defeated in a national referendum in 2020.

Growing hemp is not without its challenges, starting with the current regulatory framework right through to product manufacturing, marketing and sales. Like all new crops, there is a relatively low level of agronomic understanding amongst growers, limited genetics and a lack of scale for processors to evaluate and incorporate into products. There are widely different international laws on the growing, processing and selling of cannabis products, making navigation of Export markets challenging.

In 2019 Sapere (report commissioned by MBIE) concluded that the cannabis industry is rapidly evolving globally. This report valued the NZ opportunity (domestic + export) at $320 million for the pharmaceutical grade market and a further $1.1 billion for cannabis health products (mainly driven by CBD). In 2020 Dr Nick Marsh completed a report at the request of the NZ Hemp Industries Association. This report covered all gambits of possible hemp/cannabis use and concluded the annual market potential could be as much as $2 billion. A third report in 2021, also completed by Sapere (this time for MPI) was published. MPI wanted a better understanding of the potential market opportunities for industrial hemp in the food, seeds and fibre markets. Sapere modelled four potential scenarios for the future trajectory of the global industrial hemp market and the market share NZ may achieve. Their most likely scenario would see a $30 million hemp industry by 2030.

Who is right and who is wrong? To say it's complicated is an understatement and the devil is truly in the detail. Hemp itself offers a lot but may still deliver very little without regulatory reform, industry co-ordination, government support and education of the consumer.

Day 2, 12.30 pm: Options for farm diversification

Farming diversification and processing opportunities

Dennis Carter, Carter Seed Management, Leeston

How not to go broke on a 100 Ha highly productive Arable/Horticultural Farm, while looking after the Environment taking calculated risks and seeking value added opportunities.

My Background:

1. Experience, Knowledge, History, opportunities, and relationships.
2. No choice but to set up our own seed processing plant when the local seed processing company failed to dry and process our radish seed to the standards required by our overseas customer.
3. Our Farm and the Gross Margin indicators
4. Why we grow the crops that we grow.
5. The Blackcurrant set up story.
6. The opportunity to start a Process and marketing company when a major processor closed the factory doors in Nelson.
7. Environmental impacts and solutions for arable and horticultural farm systems.
8. Some practices we are implementing on our farm along with many other farmers

Day 2, 1.35 pm: Extracting value from commodity products

AGMARDT
FUTURE SHAPERS

Future proofing farming – precision principles in vegetable systems
Dan Bloomer, Landwise, Hawkes Bay

Put simply, precision principles for farming can be summarised as doing the right thing, at the right rate, in the right place, at the right time. It is associated with electronics and data acquisition and processing to aid decision making and implementation, often with a level of automation.

A number of factors can be identified as slowing adoption of precision principles in mainstream vegetable production. "Vegetables" are very minor crops (compared to maize, wheat, soybeans) and thus attract lower levels of investment in R&D of precision tools. There are dozens of different crops each with different needs and machine observable signatures, and as many grow from planting to harvesting very quickly, there are limited opportunities for intervention.

Fresh vegetable production especially is not broadacre; rather it is characterised by small management units that change constantly. The large number of crops grown several times a year, with multiple plantings each, requirement for rotation, for ongoing planting and harvest despite weather provides challenges. With high complexity already inherent in the farming business, more is not wanted, so any system for adoption needs to be relatively easy to implement.

The technical opportunities for aiding precision in vegetable production include GPS guidance and autosteer to do things in the right place, equipment on/off and rate control to use the right amount, sensors to get timely information, and data processing to help do the right thing.

Of these, automatic steering is probably the widest adopted technology with all significant growers having some capability, which typically increases over time as the obvious benefits of production efficiency and ease become apparent. Additional guidance for even more precision can include camera systems seeing the rows and aligning equipment. Other more common technologies include fertiliser application rate control with ability to apply variable rates, and section or individual outlet control on planters and sprayers to avoid overlap.

Use of crop sensors is not significant although technology is arriving. There is considerable interest in weed recognition, and work on pest and disease identification for automation of controls.

My observations of a range of vegetable growers suggests most are not ready for advanced precision growing, especially if it requires expensive investment and a high technical capability. But there are places where they can get much more precise in what they do with little cost and low technical demand. Refining basic nutrient management and ensuring nutrient and water application are more precise have obvious commercial and environmental benefits, by minimising waste and leaching, and growing higher quality produce.

We have worked with growers to understand how the Nitrate Quick Test can enhance management of nitrogen in their systems. As the most dynamic of the crop critical nutrients, and the one most under review through regulation, it easily justifies attention. The quick test is cheap and simple and gives good information for decision making. We know one grower using the quick test before any nitrogen fertiliser application takes place, and after the crop is harvested to close the information loop.

Day 2, 2.00pm: Extracting value from commodity products

Precision ag for future farm systems
Ian Yule, PlantTech Research Institute, Tauranga

Looking back is a good place to start when looking forward. If we are going to predict what precision agriculture and future farming systems will look like, we should examine past trends.

When considering what has been successfully adopted and what has not made the desired progress it could be useful to split the development of precision agriculture into two categories. 1) Advanced mechanisation, and 2) Precision agronomy. The big learning for me has been that most researchers and precision agronomy developers have failed to take account of what farmers want and need, they have really underestimated the farmers desire to make their lives better, (easier, to be able to carry out operations more efficiently and accurately). It is not that farmers are lazy, but agriculture and farming are very complex. If we add further complexity, we limit the number of farmers that are reached. Advanced mechanisation is part of a longer trend, from mechanisation, advanced mechanisation to automation. Mechanisation supplied energy and power to greatly improve labour efficiency and output. The current generation of advanced mechanisation gives a higher level of control to operations as well as improving the quality, consistency and work rate, control of implements is an obvious example. Automation is happening in some sectors such as fruit and vegetable production.

A further clear difference is that advanced mechanisation tends to deal with immediate or internal problems when the pressure is on, it can help ease the stress of farming. Precision agronomy could increase complexity in an already stressful and complex situation. It is also a slightly external or detached process that requires additional planning and execution. I think farmers are often very focused on the immediate problems of the day, they have to be.

In June 2022 the 15th Biannual International Conference on Precision Agriculture took place in Minneapolis, it marked 30 years since the first conference. That first conference was entitled "Soil Specific Management" and was strongly focused on soil nutrients. There seemed to be an initial oversimplification that it was all about nutrients. We know in the context of New Zealand agriculture that it is not. Precision agronomy has broadened out, New Zealand was one of the first countries to make great progress in precision irrigation for example. An interesting paper was presented in the latest Minneapolis conference where a group of researchers had thrown the precision agriculture play book at a field to be planted in barley and asked four agronomy services companies to provide recommendations for the crop. They received four different recommendations some which they felt were directly contradictory. How often are our farmers receiving contradictory advice or politicised advice.

In terms of future farming systems, automation could start to become part of our daily operations, the importance of water to our industry and how we handle climatic variation as also an important consideration. Compliance: market, carbon or water quality could create further problems by increasing complexity.

The question I would like to pose is, just as there was an expectation by the precision agronomy experts 30 years ago that their recommendation would be adopted, I wonder if a similar level of expectation is being expressed by external parties and compliance, and we really run the risk of making those lives, who are focused on farming the land, much more complex and less certain. Part of the solution is about how we handle, produce and permission on-farm data, but I think there needs to be far greater engagement, thought and effort with all parties to make farmers lives better, otherwise I do not see how we will be able to collectively improve our performance.

Day 2, 2.20 pm: Extracting value from commodity products

Oats – adding value

Keith Armstrong, Global Oats (NZ) Ltd., and Bill Angus, Global Oats (UK) Ltd.

New Zealand's limited capacity and flexibility for processing (traditional) covered seeded oats, especially in the North Island, could be overcome by diversifying the crop so that two types of oats are cultivated in New Zealand. Both covered seeded (traditional) oats, to continue supplying existing food markets, and hulless (naked) oats to encourage the development of alternative processing systems for specialty oat food and feed markets.

Hulless oats are not yet commercial farm crops in NZ. But hulless oats need to be developed, and new recently developed cultivars need to be tested in commercial settings to encourage more oat food chain innovation by new entrants and existing food enterprises that recognise their value. Expensive dehulling equipment is not needed. The disposal of its low-value hulls are discarded in the field during combine harvesting, just like the wheat crop.

Of the two oat types, 'hulless' and 'covered' there are no identified intrinsically new technological or functional characteristics that distinguish a **hulless** groat from a **dehulled** groat. Conventional covered oats, (*Avena sativa*), are a covered grain where the lemma and palea (hull) is **retained** (Fig i) with the groat at harvest. Hulless oats (*Avena nuda*) are a naked grain where the lemma and palea is **released** (Fig ii) during combine harvesting

Hulless oat production presents new opportunities for growers and product developers, enabling new companies to develop alternative and innovative oat processing technologies with a smaller factory footprint. Hulless oats make up 90% of the commercial oat crop in China, grown there for centuries for food and feed, with an expanding product range - oat pasta, noodles, rice/oat mixtures, plus many more miscellaneous foodstuffs and beverages.

Plant genetics has overcome the agronomic deficiencies of old hulless oat cultivars and genetic stocks. A comparison of groat yields between a range of control entries (conventional versus hulless oats) in the past three seasons from the UK National List trials show very similar groat yield results.

Continuous sources of adapted hulless oat genetics are coming on stream. New naked oat genotypes, developed from the NZ/UK shuttle oat breeding programme are progressing through the UK national list system for registration. Further evaluation of naked oats will be taking place in the forthcoming 2022 season.

Day 2, 2.40 pm: Extracting value from commodity products

Diverse products for diverse markets

Ivan Lawrie, FAR Templeton

Never more than in recent times have we seen the wide range of preferences that consumers bring to market. There is an over-abundance of information brought to us by infinite media channels about edible products developed and sold globally. Food fads, food celebrities, environmental and social governance brought into the food value chain and changes in working habits in a post-covid world all contribute to that diversity of choice.

So, is there a right and a wrong product to come off our farms? – There are trade-offs everywhere and here is where marketing can get tarnished by greenwashing. Food that can be seen as clean and environmentally friendly by some, can be seen as engineered and highly processed by others.

Then there is the eternal debate about food and health, those on fasting, those on keto diets, veganism, gluten free, etc. There is a market for the health conscious and there is a market for comfort food that tastes good and brings gratification to the eater, as we have learned from recent consumer studies commissioned by FAR. Moreover, we should be paying attention to the economy. The buying capacity of the middle class is being severely compromised by the deteriorating value of money in their pockets. Grocery inflation for New Zealand is at 7.6% and rising. Those who had choices and preferences before, may now be having to settle for more conventional and standard food options.

For all the hype around exotic and fancy choices, on March 24th 2020 as NZ headed towards its first lockdown it was bread, flour and pasta that had completely vanished from shelves. During lockdown the sales of retail flour increased 500% in the first week. This also shows that rapid changes in consumer behaviour can be brought upon by external factors kicking in suddenly.

A lot has been written about "The Consumer", but really there are *"Consumers"* and some of those even behave differently on a Monday than they do on a Friday. The New Zealand farming sector is still in the enviable position to cater for many different *"Consumers"* and promoting one product does not imply that we must bad-mouth the other.

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