

CAN SMART TOOLS AND TECHNOLOGIES HELP SOLVE THE CHALLENGES IN NUTRIENT MANAGEMENT?

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Abstract:

“If you can’t measure it, you can’t manage it.” While arguably not completely true, this statement still has merit today. Legislation in New Zealand is increasingly focussing on managing nutrient leaching in order to preserve and improve the environment. While being miles away from the restrictions seen in other regions, such as Europe, this has increased compliance requirements of the primary sector. Our research into decision making and information management has shown that formalisation and the use of software solutions / apps is largely driven by compliance requirements arising from this. Other drivers for adoption are the perceived value add and low entry barrier in terms of cost. While documentation is an important means of fulfilling compliance requirements, it can also be a first step towards improvement.

The Agri One Centre of Excellence in Farm Business Management is a Joint Venture by Lincoln and Massey Universities and is funded by DairyNZ and RMPP via the Primary Growth Partnership. Providing an overview for farmers and rural professionals on digital resources is the Toolbox on our web site, which contains reviews of Apps, websites and other helpful tools available in the marketplace (<http://www.agrione.ac.nz>).

Recent developments reflect a movement away from manual paperwork to automatic online recording of data. Smart, connected systems already today exchange information between entities and actors of the primary sector, such as AgHub, SmartMaps and the Fonterra Dairy Diary, thus helping to comply with regulations. Technologies such as variable rate irrigation and soil sensors can provide decision support and can help to prevent nutrient leaching.

In the future, New Zealand farmers will have to be able to be connected to stay on top. Smart systems will increasingly ‘talk’ to each other in order for collected data to be useful to the end-user and to have the biggest impact on their business (the Internet of Things). But all this available technology also creates confusion and requires knowledge and industry capability development to ensure the potential is fully realised.

Introduction:

European vs New Zealand legislation

In light of increased focus on environmental sustainability and agricultural productivity, the management of nutrients to allow for optimal plant growth while preventing leaching, may be perceived as challenging. We can put it into perspective by taking a look at how things are in Europe. First of all, legislation in the EU is very different by being an input driven system. That means legislation tends to prescribe amounts of what can be used, where, and (partly) when. Then, the density and overall more intensive production system is very different compared to NZ, thus increasing the overall nutrient load on the environment. This, by now, has led to some peculiar developments, such as the “Nutrient-Exchange” (German: Nährstoffbörse) in many parts of Germany. In the federal state of North Rhine-Westphalia, over 15,000 farmers are registered for trading manure from high density animal production areas to locations where the nutrient balance still allows for the spreading of organic fertiliser (Nährstoffbörse NRW, 2017). Farmers pay between 7 and 10 Euros per 1,000 litres to be picked up, easily translating to several thousand Euros per farm (Matheis, 2014). In general delivery is free of charge albeit partly including distance charges for up to 200 km distance (Matheis, 2014). All nutrient flows have to be documented and transparent. In some of these nutrient exchanges, farmers can even obtain a “manure flat-rate” when building new barns (Matheis, 2014). In addition, about 1.4 million tons were exported from The Netherlands to Germany, equivalent to about 60,000 cows (Aktuelle Stunde, 2015).

In New Zealand legislation increasingly focusses on farmers managing the nutrient balance in order to prevent leaching and thus preserve and improve the environment. This creates compliance requirements for farmers. According to the famous statement accredited to Peter Drucker, “If you can’t measure it, you can’t manage it”. While being only one part of the story, measurement and documentation are crucial parts for compliance, as well as a starting point to potentially optimise procedures.

Can smart tools and technologies support in this field, and if yes, where to look for potential solutions?

Solution:

Agri One – Joint research between Lincoln and Massey Universities

Agri One is a joint venture between Massey and Lincoln Universities, made possible by the support and funding of DairyNZ and Red Meat Profit Partnership (RMPP) through the Primary Growth partnership. Agri One combines the capabilities of leading New Zealand researchers, industry experts and rural professionals in order to coordinate the supply of education, training and professional development.

Within Agri One, a key project of work is the Centre of Excellence in Farm Business Management (OneFarm) (Fig. 1).



Figure 1: Overview on Agri One

Within the Centre, joint research is done between Massey and Lincoln Universities as well as scholarships, guided by the Five Themes:

- Strategy and Structures
- Resilience and Decision Making
- Farm Systems
- Data
- Human Capability

Where to look: The Toolbox – an ‘online library’ of smart tools and other resources

Another focus for the Centre is improving connectivity between the agricultural community and research and a part of this is done via the website, which includes a Toolbox (Fig. 2), blogs, webinars and a large community of researchers, farmers, rural consultants and other stakeholders around the world with interests in farm management. The [Toolbox](#) acts as an ‘online library’ for smart tools and other resources available to the New Zealand primary sector. It lists over 400 entries in a wide range of categories with additional search filters to narrow down the search and to compare appropriate available solutions. In combination to this, there is a wide range of [blogs](#) providing a running commentary on recent developments in this field.

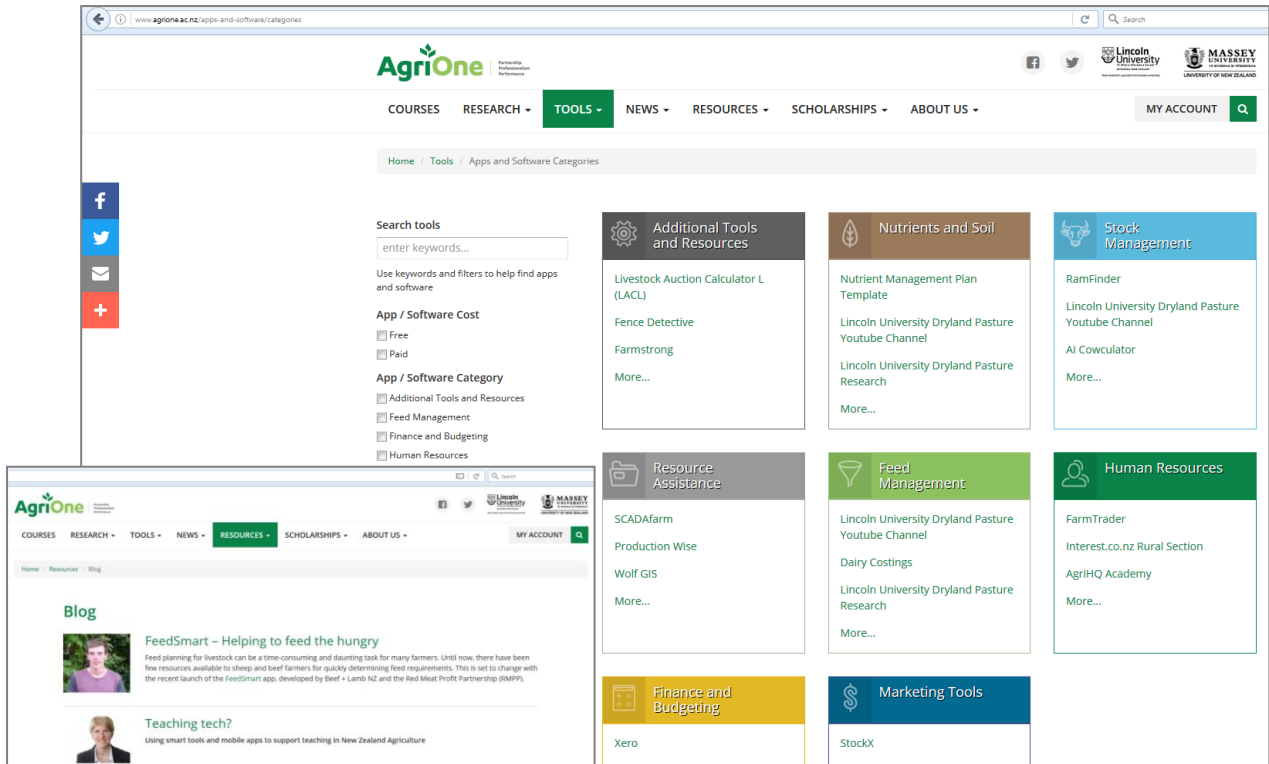


Figure 2: The Toolbox and blogs, an 'online library' for smart tools and other resources

All this is aimed at supporting farmers, rural professionals and other people in the primary sector to make better informed decisions.

What kind of smart tools and apps are out there to help?

There are smart tools and other technologies out there to support the primary sector in keeping with best practise and documenting compliance. The Toolbox currently lists over 40 tools and resources in the 'Nutrients and Soils' category, many of which tackle the nutrient challenge.

[Overseer](#), while not being 'smart' in the definition of being connected to other tools or the cloud, is by far the most widely used model in New Zealand to determine nutrient leaching and other potential challenges as well as opportunities.

The two big New Zealand fertilizer companies have developed their own smart solutions for fertilizer management, but are also offering a wider range of modules / options. This is [Ag Hub](#) from Balance and [Smart Maps](#) from Ravensdown, both of which offer record keeping, nutrient management and other farm management related solutions.

The use of tools like these is constantly increasing and new tools are being developed, such as the MitAgator, a PGP funded project with Balance that aims to bring nutrient budgets to life visually (Risk et al., 2015).

There are also more holistic farm management tools on the market, many of which include different levels of nutrient management or compliance requirement options, such as

environmental planning in FARMIQ or record keeping and farm mapping in Agri360 and Cloud Farmer.

Other, more specific tools include the DairyNZ Farm Dairy Effluent Spreading Calculator which allows farmers to calculate nutrient loadings and application rates for their dairy effluent based on a number of customizable inputs. The Ag PhD Fertilizer Removal by Crop application is another reference where fertilizer applications can be planned for a farm by selecting a crop and the desired yield for that crop, which will calculate the amount of vital crop nutrients that the desired yield will need. The University of Wisconsin N Price Calculator (N\$) is an app that allows to compare the price of various forms of nitrogen fertilizer products in terms of their price per pound of nitrogen – while adapted to the US metric system, this tool allows for "apples to apples" comparisons.

All of the existing tools, and others, can be viewed and compared within the Toolbox.

Conclusion:

One important point remains: how do we make best use of the tools?

Above compliance was covered, which, according to Agri One research into decision making, is one main driver of adoption of new technologies. Another driver for adoption is perceived value-add. So how can we get the most of the tools we use and actually use the data to transform into knowledge, feeding back into the system and generating better profits for the farmer?

Here lies the complexity of the issue:

- Not only document – improve
- Optimise plant environment
- Minimise leaching
- Maximise profit

New Zealand farmers will have to be able to be connected to stay on top. Smart systems will increasingly ‘talk’ to each other in order for collected data to be useful to the end-user and to have the biggest impact on their business (the Internet of Things). These are developments not out on the horizon, but already in our midst (Fig. 3).

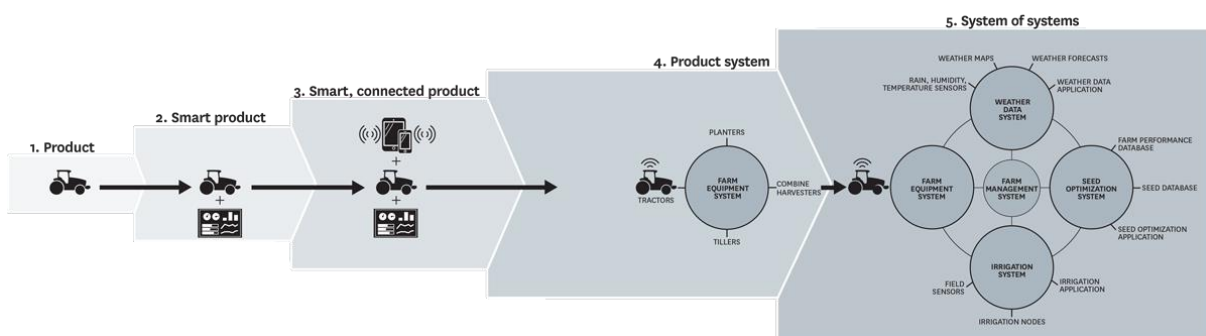


Figure 3: Technology development in Agriculture. (Porter and Heppelmann, 2014)

As depicted by Porter and Heppelmann (2014), the connectivity of products (the Internet of Things) is progressing into the primary sector. Already today a lot of production systems work as a “smart, connected product” or a “product system”, whereas the “system of systems” is something the supply industry is currently working towards. In their article from 2016 Sarni et al. even go so far as to call the Internet of Things the catalyst of “The second green revolution”.

All this available technology also creates confusion and requires knowledge and industry capability development to ensure the potentials are fully realised.

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