Indicators in the New Zealand Sustainability Dashboard

An Overview of their Structure and Application

Our Land and Water National Science Challenge

Indicator Working Group

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Dear Richard

As per our contract received 4 July 2017, please find attached our report on the New Zealand
Sustainability Dashboard and the potential for use with the indicators from the Our Land and Water
National Science Challenge. This is the fourth in a series of reports produced by the Indicators
Working Group, chaired by Vicki Compton of the Ministry for Primary Industries. Please note that this
report should be read in conjunction with the restrictions at the end of this document.

We hope that you find this report useful for the future direction of Our Land and Water.

Yours sincerely

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Executive summary

The New Zealand Sustainability Dashboard is a collection of dashboards and methods

The New Zealand Sustainability Dashboard, despite its name, is actually a set of computerised comparison tools, known as 'dashboards', as well as the underlying capabilities and methods for creating dashboards. As originally envisioned, it had the aim of creating a single, comprehensive, national dashboard. It was more feasible to create industry-specific dashboards. In the process of constructing these industry dashboards, the researchers developed key capabilities and tools for this kind of work. The newest tools are flexible and user-driven, and also have the potential to revive the idea of a single national dashboard.

The dashboards collect and report a wide range of useful indicators

Each dashboard is somewhat different, but they all collect useful information from farmers and growers and report on the relative performance of users. The indicators are selected for their relevance to the sectors, and there are instances of indicators being culled because they are not relevant or useful.

We evaluated the dashboards using criteria for fit-for-purpose indicators, developed in an earlier piece of work by the Indicators Working Group in the Our Land and Water National Science Challenge. The criteria are that indicators should be valid, based on accessible data, performance-based, easily communicated and understood, clearly defined and standardised and accepted by stakeholders. In general, the NZSD indicators met these criteria.

Dashboards include process-based and performance-based criteria

Fit-for-purpose indicators tend to be performance-based: they measure the impacts. Many indicators included in the NZSD are process-based indicators: they indicate whether farmers are undertaking an activity or following a process. Process indicators can be weaker because they do not show whether the expected impacts are being achieved. On the other hand, they can be the appropriate indicators when impacts are hard to measure or take a long time to occur, which is the case for some environmental impacts in particular.

There is considerable flexibility to add new indicators

One key concern for Our Land and Water is whether new indicators can be included in the NZSD dashboards. All of the dashboards had processes for including new indicators. The newest approach, DELV, is extremely flexible for user-defined indicators. However, the experience with the dashboards suggests that new indicators need to be relevant, or user groups will not be interested in adopting or including them.

Table of contents

Introduction

The New Zealand Sustainability Dashboard (NZSD) began in 2012 as a research project funded by the Ministry of Business, Innovation and Employment.[1] The founding purpose of the project was 'to establish a flexible and broad sustainability assessment and reporting framework that is applicable to all New Zealand primary industry sectors for the development, operation, refinement and efficient regular reporting of sustainability Key Performance Indicators' (Manhire et al, 2012, p. 1). This report focuses on the use of sustainability indicators within the NZSD.

The NZSD partnered with different primary industries and iwi to create specific sustainability solutions, tailored to each group's unique needs. This report describes the structure of these specific industry dashboards, giving particular attention to how each dashboard utilises sustainability indicators, and assesses the feasibility of incorporating new indicators into each dashboard. In addition to the industry dashboards, the NZSD has worked to develop tools to help facilitate the use of sustainability indicators. A data gathering tool known as DELV and a sustainability communication system known as the National Dashboard are also discussed due to their relevance to sustainability indicator use within the NZSD.

This report outlines the concept of the NZSD, describes the NZSD sustainability indicators framework and details how the individual industry dashboards relate to the wider NZSD project. The report then describes the two key primary industry case studies (wine and kiwifruit) and outlines the structure of DELV, a sustainability data-gathering platform that arose from the creation of a Māori dashboard. DELV has the ability to facilitate the introduction of any sustainability indicator within an enterprises sustainability programme. The report also describes the New Zealand National Dashboard. The National Dashboard provides a mechanism for the reporting and communication of sustainability indicator results across multiple industries and at multiple scales.

For the industry case studies and DELV, we assess the indicators that are included in the dashboards. We use the six qualities of fit-for-purpose indicators described in an earlier report from the Indicator Working Group, *Signs to Look For: Criteria for fit for purpose indicators* (PwC, 2017), to assess the indicators in the Sustainability Dashboard. Indicators should be:

- valid
- based on accessible data
- performance-based
- easily communicated and understood
- clearly defined and standardised
- accepted by stakeholders.

More detail on these criteria is provide in Figure 1.

A key concern for the Our Land and Water National Science Challenge is the use and communication of indicators with stakeholders in industry, research and government. One possible mechanism is the sorts of dashboards created by NZSD. We therefore rate the feasibility of adding in new indicators to existing dashboards, and propose some additional indicators that could be included.

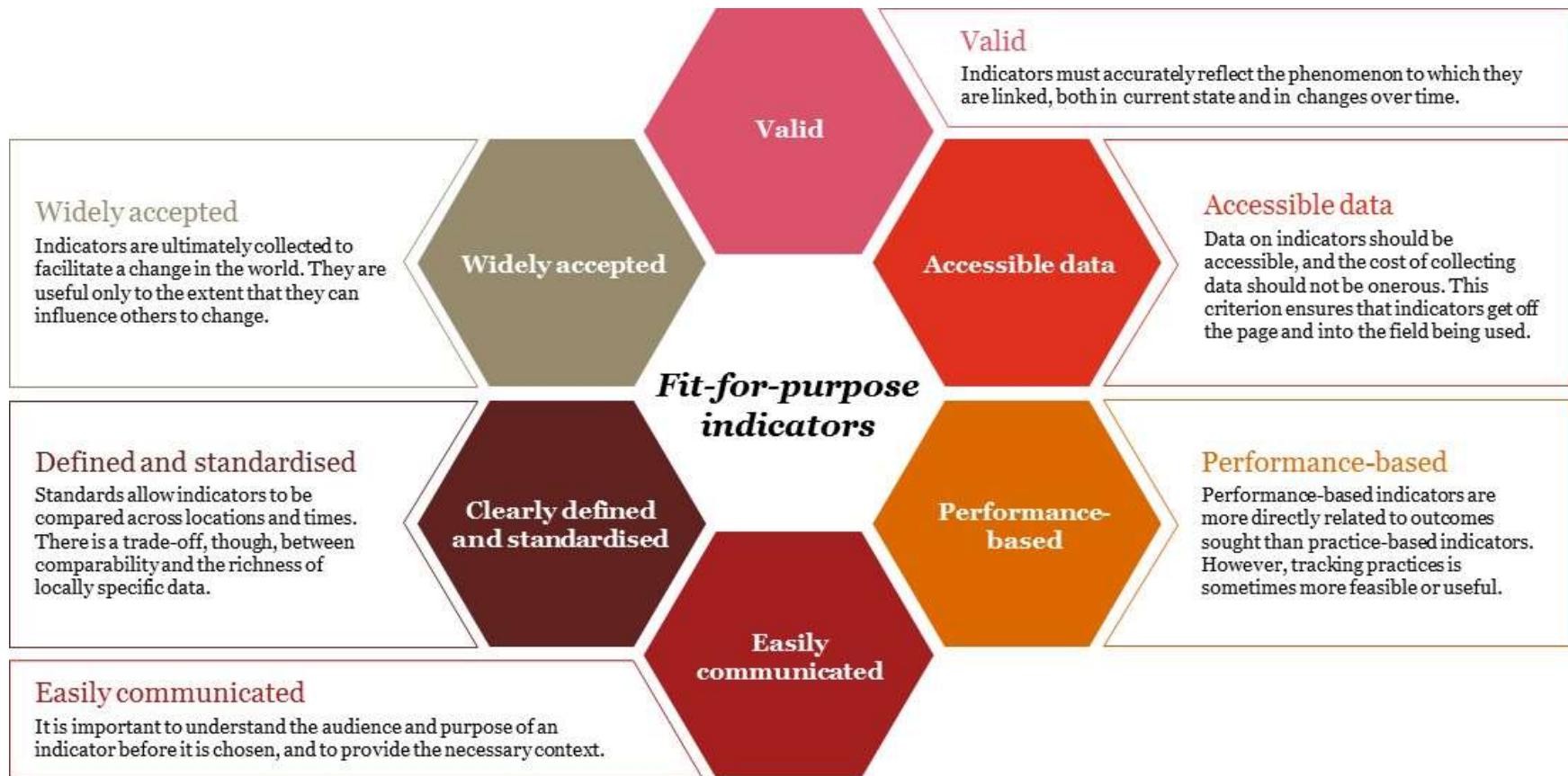[1] www.nzdashboard.org.nz/about.html

Valid
Indicators must accurately reflect the phenomenon to which they are linked, both in current state and in changes over time.

Widely accepted
Indicators are ultimately collected to facilitate a change in the world. They are useful only to the extent that they can influence others to change.

Accessible data
Data on indicators should be accessible, and the cost of collecting data should not be onerous. This criterion ensures that indicators get off the page and into the field being used.

Defined and standardised
Standards allow indicators to be compared across locations and times. There is a trade-off, though, between comparability and the richness of locally specific data.

Performance-based
Performance-based indicators are more directly related to outcomes sought than practice-based indicators. However, tracking practices is sometimes more feasible or useful.

Easily communicated
It is important to understand the audience and purpose of an indicator before it is chosen, and to provide the necessary context.

Figure 1 The six criteria for fit-for-purpose indicators

The New Zealand Sustainability Dashboard

The NZSD is a project to develop sustainability assessment, reporting and learning tools in partnership with different primary industry sectors in New Zealand (NZ). Central to the NZSD is a sustainability assessment framework. The NZSD framework draws on internationally recognised sustainability frameworks and their key generic sustainability performance indicators to ensure that overseas consumers can benchmark and verify the sustainability credentials of New Zealand exports (Hunt et al, 2013). At the same time, the framework has been developed in a way that ensures it remains locally relevant and applicable to the unique requirements of New Zealand and the industries that will use it.

From the NZSD framework, individual industry dashboards are being developed. Industries select indicators relevant to the sustainability of New Zealand society, ecology and land care, and appropriate to the sector and operation of interest within that sector. The NZSD tools are provided through the development of multifunctional web applications that facilitate the uploading of monitoring results from farmers or producers.

The main purpose of the NZSD is to assist primary production industries, and associated operations, with complex management decisions. Many of the challenges facing primary production industries at present, and even more so in the future, fall within the umbrella term of sustainability. The NZSD takes a holistic and comprehensive approach to supporting primary production industries. By including the four pillars of sustainability, the NZSD will not only help primary production industries to comply with ever-increasing demands for market and regulatory performance. It will also help to optimise overall business performance including productivity and profitability, while keeping a focus on environmental and social values. Figure 2 depicts how the NZSD supports the four pillars of sustainability, which themselves support the overall goal of sustainability for New Zealand's production landscapes.

By developing and refining a sustainability perspective with NZSD participants, the NZSD anticipates that there will be opportunities to reduce monitoring and regulatory costs, build consumer trust, secure market access and garner support from wider New Zealand society by verification and regular reporting of standardised sustainability criteria (Hunt et al, 2013). NZSD has been designed to help the primary sector make the most of the opportunities. At its core, it is a sustainability assessment framework with desired outcomes, objectives, and indicators for assessing performance. The complex cross-linkages are shown in Figure 3, which interweaves the hierarchy of goals, indicators, etc with the different components of a sustainable industry.

Figure 2 Goals and Pillars of the NZSD

Figure 3 Structure of the NZSD Indicators Framework

The NZSD framework is closely aligned to the Sustainability Assessment of Food and Agriculture systems (SAFA) framework developed by the Food and Agriculture Organisation (FAO) of The United Nations (see SAFA, 2014). However, it also remains locally grounded to ensure it is relevant to New Zealand society, ecology, and land care. By taking this multi-level and multi-scale approach to sustainability, the NZSD provides a practical tool for participants to address their local challenges and a means for communicating this information internationally.

The NZSD framework covers the core aspects of primary production industries and their associated operations in New Zealand across four pillars of sustainability: governance, economic, social and environmental. In total there are 19 outcomes targeted, through 54 outcome focused objectives and 110 indicators. Figure 4 presents an outline of the outcomes and targets.
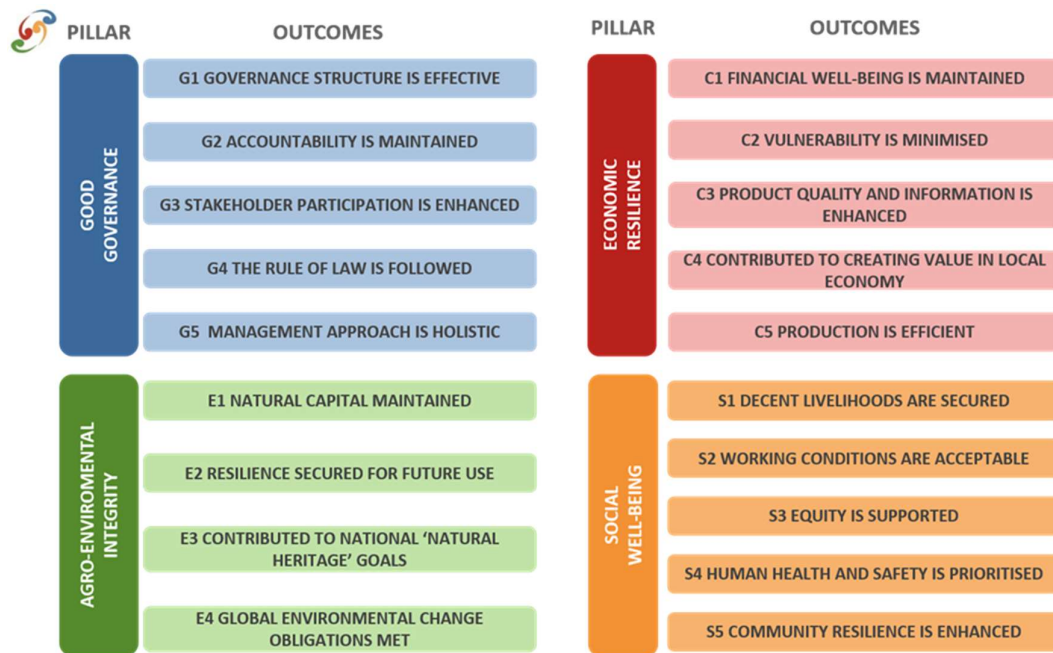
Figure 4 Outcome Level of the NZSD

While each indicator measures progress towards sustainability, they are not measures in themselves. Measures for each of the indicators (some of which will require multiple measures) will not be developed as a generic set included within the framework. Rather, measures are being developed within the context of each industry's dashboard. While the NZSD provides a comprehensive and rigorous framework for assessing sustainability, not all indicators in the framework will be highly relevant for every dashboard industry.

Relationship between the NZSD and associated industries

The NZSD works closely with its case study partners using a co-production model of development. Early visions of the NZSD saw a single sustainability assessment approach being applied across multiple industries. However, it was soon determined that this approach was neither practical nor acceptable to the industry stakeholders. The NZSD then moved towards a different approach whereby it would provide assistance within each of the case study industries to aid them in the development of their own sustainability assessment and reporting systems, while also drawing lessons from this process to apply to other industries.

From the beginning, the NZSD research programme has worked with industry partners to test the practicability of designing and implementing a sustainable dashboard to meet their specific purposes. There were four main case studies which formed the initial NZSD project. They were:

- the Wine dashboard led by Andrew Barber
- the Kiwifruit dashboard led by Jayson Benge
- the Organic dashboard led by Charles Merfield
- the Māori dashboard led by John Reid.

Since the establishment of the NZSD there have been some changes to this arrangement. A significant change was the dropping of the Organic Dashboard and its replacement with the Rangitata Diversion Race Management Ltd (RDRML) case study. The NZSD has also worked with a number of other industries including Forestry, Beef and Lamb, Aquaculture NZ and Horticulture NZ to help develop their sustainability assessment initiatives.

The NZSD is better understood as a co-production and learning undertaking to develop sustainability initiatives. There is no physical/digital *New Zealand Sustainability Dashboard*, but rather a series of industry or NZSD-led initiatives that the NZSD helps to facilitate. However, recent developments within the NZSD have seen the creation of a sustainability assessment platform called DELV which can provide the data gathering functionality for any sustainability dashboard, and the creation of a National Dashboard which can communicate data from multiple dashboards. The NZSD has found that while assessment and reporting tools can be standardised, industry level sustainability assessment cannot. Therefore, there are multiple 'dashboards' within the NZSD. Some are bespoke solutions created by the NZSD, while others are industry-led initiatives that have been supported and enhanced by NZSD research. The following sections outline the key work streams of the NZSD, which are focused on the use of sustainability indicators, and how these indicators are structured within the individual industry dashboards.

The Wine Industry

Description of the Wine dashboard

The NZSD Wine Dashboard works within the Sustainable Wine New Zealand (SWNZ) accreditation programme. SWNZ is a sustainability initiative promoting continuous improvement and adherence to standards that reflect seven 'pillars' as key areas of focus: biodiversity; soil, water and air; energy; chemicals; by-products; people; and business practices. Participation in SWNZ rose to almost 100 per cent between the launch of the policy in 2007 and the target date of 2012 — an estimated 94 per cent or more of New Zealand's producing vineyard area (accounting for approximately 90 per cent of the wine produced) is now SWNZ certified. A further three per cent to five per cent of vineyard area operates under other certified organic programmes. Joining SWNZ is voluntary. However, to be included in New Zealand Winegrowers' national and international marketing, promotional and awards events, wines from vintage 2010 onwards must have been produced under one of the recognized, independently audited, sustainability programmes.

There are currently around 1,737 vineyards and 153 wineries with SWNZ accreditation. Accreditation to the SWNZ standard is achieved through successful completion of annual 'scorecards'. The scorecards differ depending on whether the assessment unit is a vineyard or a winery. The unit of assessment is a single vineyard or a single winery, so that owners of more than one vineyard or winery must complete more than one scorecard.

The scorecards are answerable online through a system known as WiSE (Wine Industry Sustainability Engine). WiSE is based on the SoFi platform from thinkstep, which is marketed as 'enterprise sustainability software'. Using an off-the-shelf solution was seen as an expedient way to develop a digital platform for NZ Wine, as opposed to going through the time and expense of creating a bespoke sustainability assessment platform.

The SWNZ scorecards change often, and it has not been possible to get the latest proposed version of the scorecards. However, previous example scorecards have been made available within the NZSD. Due to privacy reasons it is not possible to detail the exact content of the scorecards; however, it is possible to provide a high level overview of the topics covered and the structure of the questions used. There are two main types of questions found in the scorecards. The first and most common are binary choice questions such as the example below:

> **Q. Compliant with key regulatory requirements? – Yes/No/NA**
>
> Hazardous Substances and New Organisms Act 2006
>
> Health and Safety in Employment Act 1992
>
> Wine Regulations 2006 Act and Wine Act 2003
>
> Animal Welfare Act 1999
>
> Transit New Zealand regulations

There are also a number of questions that require numerical answers, such as the following:

> **Q. Total Capacity in Tonnes** - Total capacity: _____Tonnes

The numerical response questions are more commonly required for topics where the vineyard/winery is already recording their performance statistics. Examples of topics dominated by numerical response questions include water use, agrichemical use and energy use, whereas management and procedural questions typically require a binary choice response. The level of assessment for the questions is always at the enterprise level. Individual responses are then aggregated by NZ Wine to produce insights at higher spatial scales. An outline of the topics covered by the scorecards in 2013/14 is provided in Table 1 below.

Table 1: Section headings from Sustainable Winegrowing New Zealand scorecards

Winery Scorecard Topics, 2013	**Vineyard Scorecard Topics, 2013**
1. Production Information 　1.1. Record Keeping and Internal Assessment 2. Organisation Management 3. Water Management 　3.1. Water and Waste Management 　3.2. Waste Water systems 　3.3. Control and Disposal 　3.4. Matching Cleaning to Disposal 4. Process Methods 　4.1. Use of process aids 　4.2. Use of Diatomaceous earth 　4.3. Process aids disposal 5. Spills and Emergency Procedures 　5.1. Emergency Procedures 　5.2. Spills 6. By-Product Management 　6.1. Disposal of By-Products 　6.2. By-Products - Records 7. Packaging 　7.1. Packaging – Records 　7.2. Packaging – Recycling 8. Energy Resources 　8.1. Resources 　8.2. Energy use 9. Refrigeration 　9.1. Use of Refrigerants 　9.2. Refrigeration Equipment 10. Use of Contractors 11. SWNZ Logo Use 12. Biodiversity Enhancement	1. Organisation Management 2. Resource Management (regulatory) 3. Soils and Nutrient Management 　3.1. Soil Management 　3.2. Nutrient Management 　3.3. Fertiliser Management 　3.4. Compost 4. Ground Cover Management 　4.1. Cover Crops 　4.2. Weed Management 5. Frost Protection 6. Water Management 　6.1. Irrigation Design 　6.2. Irrigation Water Application 　6.3. Water Use – Irrigation 　6.4. Water Use – Frost 7. Plant Protection 　7.1. Source Material 　7.2. Monitoring 　7.3. Disease Control 　7.4. Invertebrate Pest Control 　7.5. Vertebrate Pest Control 　7.6. Agrichemical Management 8. Spills and Emergency Procedures 9. By-Product Management 10. Energy Use 11. Contractors 12. Conservation 13. SWNZ Logo Use

Based on the information gathered through the SWNZ programme, a number of reports are provided to assist the operational performance of both individual growers and a wider range of stakeholders. As an example, a SWNZ spray report is shown in Figure 5. The report gives statistics on the vineyard's spraying and comparable information for the region and the country. Other reports produced based on the SWNZ scorecards and other assessment processes include:

- national report on water use

- national report on energy use

- individual irrigation reports and benchmarks (wineries and vineyards)

- individual energy reports and benchmarks (wineries)

- agrichemical reports:[2]
  - fungicide report – number of applications
  - powdery mildew spray timing report
  - herbicide report
  - mealy bug report
  - powdery mildew report – number of applications
  - powdery mildew report – quantity of sulphur used
  - sulphur rates and row spacing.

SWNZ is based on a self-assessment model whereby members must provide completed self-assessment vineyard or winery scorecards and supporting records, and documentation such as spray diaries or monitoring records, as requested. The self-assessments then go through a third-party audit conducted by Water and Atmosphere Information Ltd (WAI).

All of the individual reports are held on the NZ Wine website and made available to members of the industry. The next steps in the development of SWNZ are focused around reporting and communication of data. Tableau[3] is being used to create interactive reports for industry stakeholders as a replacement for the current PDF and paper based reports.

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[2] From 2015 it was made compulsory for growers to use Grapelink or an approved compatible electronic system to record their spray use.

[3] Tableau is a business analytics and data visualisation platform. See https://www.tableau.com/

Figure 5 SWNZ spray report

Source: SWNZ (2017, p. 31)

Indicators included in the Wine dashboard

Existing indicators

The Wine dashboard currently includes a variety of indicators, as described in Table 1. It includes indicators covering:

- chemical use

- energy use

- waste

- biodiversity

- water use

- good process in crop production.

The indicators in the Wine dashboard can be evaluated against the six criteria for fit-for-purpose indicators, which were described earlier.

Valid

The Wine Dashboard indicators are all measures of the environmental impacts of winegrowing, which make them valid as indicators of sustainability. Most of the indicators measure the resources used in winegrowing or the environmental impacts caused by wine production.

Based on accessible data

The data used in the dashboard is accessible from growers and based on their operations, and it draws from the information required by SWNZ. From the perspective of growers, therefore, the data are accessible. On the other hand, this kind of industry data does not tend to be available elsewhere. The regional and national benchmarks are therefore only available inside the dashboard, and are not based on publicly available data.

Performance-based

Reviewing Table 1 and Figure 5, it appears that many indicators focus on process and procedure rather than impacts and results. This is likely to be the result of several factors. First, several of the areas of impact targeted have impacts far in the future, such targeting climate change through reduced energy use. Other impacts are the cumulative effect of multiple actors, such as water quality near a vineyard. Some impacts are also difficult or expensive to measure, compared with measuring whether a process is being followed. On balance, process-based indicators may be appropriate at this time. The next step would be to link the processes to their actual impacts at specific points in time.

Easily communicated and understood

The indicators are relatively easy to communicate and understand. Some of them require technical knowledge of the use of agrichemicals, which may not be easily understood by the wider public. However, for those in the industry who use and report on the indicators, these should be easily communicated. Deciding whether the indicators are easily communicated is therefore a function of who the intended audience is.

Clearly defined and standardised

The SWNZ is responsible for maintaining the definition and standardisation of the indicators and measures used. The indicators on the Wine dashboard are all commonly defined and standard across all wineries and vineyards.

Accepted by stakeholders

High levels of participation in the SWNZ dashboard do not necessarily indicate that stakeholders accept all the indicators used. Indicators are culled from the dashboard fairly regularly. This may be due to a lack of consensus or acceptance by the growers and other stakeholders. Once the list of indicators stabilises, those indicators are likely to be widely accepted.

Additional indicators

The majority of the SWNZ indicators measure the environmental impacts of winegrowing. It could be useful for the wine industry to consider measuring other impacts, too.

Indicators could be added to measure the economic, social and cultural impacts of winegrowing. These indicators could include:

- labour and employment measures
- community engagement
- compliance with regulations
- financial health
- health and safety measures.

Indicators in these categories would enable the Wine dashboard to measure sustainability in more areas than just environmental. They would also provide a more well-rounded view of how each winery is performing. They could help the dashboard report on the other components of sustainability: good governance, economic resilience and social well-being (see Figure 2).

In addition to covering sustainability more broadly, the Wine dashboard could include more performance-based indicators. The indicators currently included track a winery's processes and compares them to other wineries, but do not relate to specific benchmarks or outcomes. Indicators that track towards a specific goal or target outcome are also useful for measuring sustainability.

Feasibility of incorporating future indicators

It would be feasible to incorporate additional indicators in the Wine dashboard. It is technically possible to make the changes, and there is a process for making changes. The addition of indicators would be decided by SWNZ, which runs the dashboard.

While there are gaps in the indicators used in the Wine dashboard, the process of adding new indicators might be difficult. The process involves an annual review by SWNZ. New indicators are not added often and indicators are removed more often than they are added. Adding new indicators could be particularly difficult where the data is not already being collected.

It may be possible to improve the dashboard in other ways. First, it may be more realistic to focus on new indicators based on data that is currently being collected. This approach fits with the criterion that indicators be based on accessible data. In addition, adding targets or goals to existing indicators would allow them to better measure sustainability without adding entirely new indicators. Adapting the current dashboard to include an aspirational target is likely to encourage greater sustainability, without being too onerous or having to go through the annual review process.

Finally, the dashboard could be strengthened by transforming process-based indicators to performance-based ones. The existing dashboard collects a great deal of data on management practices. The requirements are predominantly for data collection and for the grower to have a management plan for a particular aspect of sustainability. However, they do not usually specify limits, targets or best practice goals. The stringency of the management plan is not specified. For example, requirement 6.6.1 of the winegrowers' scorecard: 'Members should indicate if they have plans or have instigated plans to reduce water usage. This may include practices such as the recycling of irrigation water, minimisation of runoff or use of grey water'. Winegrowers are required only to record whether they have a plan to reduce water use. They are not required to follow the plan (a process-based indicator), or to reduce their water use over time (a performance-based indicator).

The Kiwifruit Industry

Sustainability assessments in the kiwifruit industry

There are two strands of sustainability assessment being used within the Kiwifruit industry. The first is the use of Zespri GAP (Good Agricultural Practices), a derivative of the Global GAP programme, to provide assurance. The second is the development of a voluntary performance-based assessment system being driven largely by the NZSD.

Zespri GAP

One hundred per cent of fruit supplied to Zespri is Global GAP certified. Of this, 95 per cent is through the Zespri GAP system, with the remaining 5 per cent requiring certification for multiple crop types. The Zespri GAP checklist covers all of the requirements of the Global GAP standard as well as other areas covered under NZ law or the Zespri system. In addition, Zespri has tailored its GAP programme to be kiwifruit-industry specific. It has simplified the checklist to include only questions applicable to kiwifruit growers and contractors, and linked the programme to its annual audit programme. Zespri is able to operate as a group called a Produce Marketing Organisation (PMO), and then act as inspector and auditor for entities in the industry.

There are three levels of questions in a Zespri GAP assessment, with different compliance requirements:

* Major Control Points – 100 per cent must be complied with

* Minor Control Points – 95 per cent must be complied with

* Recommended Control Points – no compliance requirement.

All Zespri GAP questions are practice-based and require a binary yes/no answer. Figure 6 below provides an example of the structure of a Zespri GAP question. Next to the assessment question are requirements that need to be met to satisfy the question, and in the final cell are resources or records that could be used as evidence. While the majority of questions are environmental, Zespri GAP also includes GRASP (Global GAP Risk Assessment on Social Practice), which is an add-on module to Global GAP certification. GRASP covers the social element of on-orchard compliance specifically with regard to employment obligations and worker welfare.

5.3 Organic Fertiliser				
5.3.1	Minor	Has the producer taken into account the nutrient contribution of organic fertiliser?	Show evidence that the NPK values of organic fertilisers are known in order to avoid soil contamination	*NPK Values for organic fertilisers*
5.3.2	Major	Does the MSO prevent the use of human sewage sludge and untreated sewage water on the orchard? No N/A	Do not use human sewage sludge or untreated sewage water on the orchard. Ensure your Orchard Nutrient Management Policy is signed and dated	• Orchard Nutrient Management Policy

Figure 6 Example questions from a Zespri GAP assessment

NZSD Kiwifruit dashboard

While Zespri GAP provides the primary vehicle for the kiwifruit industry to monitor and report its sustainability performance, Zespri has recognised the need to communicate performance-based (rather than practice-based) data as well. The first year of the Sustainability Dashboard programme (2013/14) was devoted to preparing two prototype tools, one for orchards and one for postharvest operations (Benge, 2015). Zespri provided co-funding, supported by three postharvest operators (Trevelyan's, OPAC and DMS) and two orchard management groups (Te Awanui Huka Pak and PlusGroup Horticulture). The development of the software for the Kiwifruit dashboard is being undertaken by Aaron Rimmer at Lincoln

Agritech, under the direction of The Agribusiness Group. A prototype has been developed of a multifunctional web application that facilitates the uploading of regular monitoring results and instantly summarises and reports back to the users. Figure 7 provides a screen shot of a data entry page in the Kiwifruit dashboard.

Figure 7 Kiwifruit dashboard data entry page

The NZSD is working with Zespri to develop a bespoke online dashboard to gather and report sustainability performance data. Like the wine industry, the kiwifruit industry also collects detailed information on agrichemical use and other operational details. This information forms the foundation of the Kiwifruit dashboard. However, due to the voluntary nature of the dashboard, there is the potential to add other industry-relevant sustainability indicators that may not be part of Zespri GAP.

Unlike Zespri GAP, the Kiwifruit dashboard has been developed primarily for the collection and reporting of numerical performance data. This facilitates the production of benchmarking information as shown in Figure 8, Figure 9 and Figure 10. Figure 8 provides a screen shot of benchmarking for an individual orchard, in which the orchard performance on several indicators is graphed against industry performance. Figure 9 provides a view of performance on a single indicator over time. Figure 10 shows a tool that allows users to construct visualisations of industry performance.
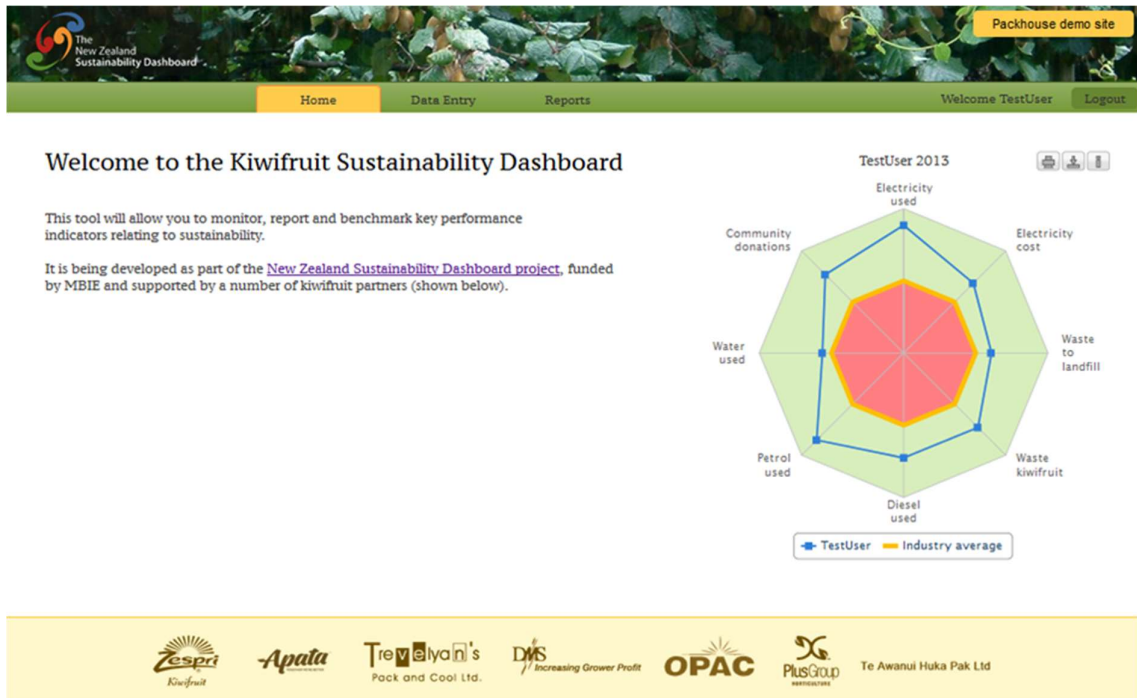
Figure 8 Indicator performance benchmarking using a spider chart
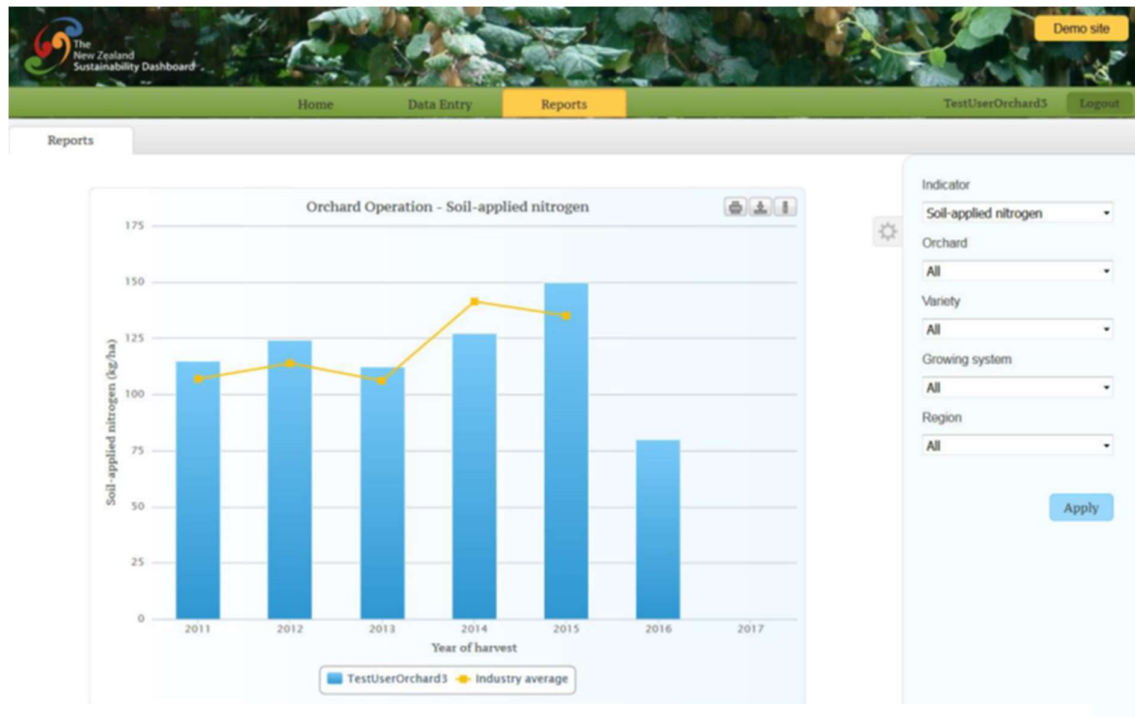
Figure 9 Soil nitrogen benchmarking
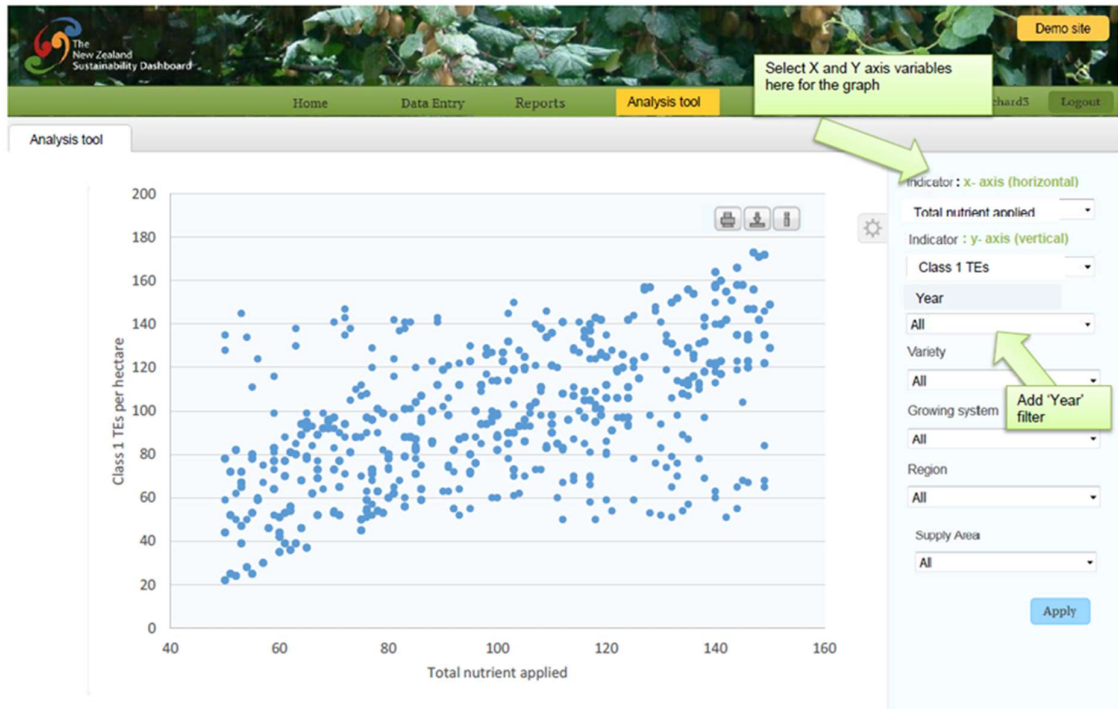
Figure 10 Industry-wide performance analysis

Indicators included in the Kiwifruit dashboard
Existing indicators

The Kiwifruit dashboard currently includes 19 indicators for kiwifruit orchards and 14 indicators for packhouses and coolstores. The indicators cover four aspects of kiwifruit operations:

- productivity
- efficiency
- environmental effects
- market orientation.

Table 2 and Table 3 list the indicators included and their classification.

Table 2: Growers – indicators included in the Kiwifruit dashboard

Indicators for growers	Type of indicator
Class 1 Tray equivalents	Productivity
Fruit size	Productivity, market orientation
Dry matter component of fruit	Productivity, market orientation
Taste (based on dry matter component and size)	Market orientation
Orchard Gate Return	Productivity, efficiency
Reject fruit	Productivity, efficiency
Water used	Efficiency, environmental effects
On-orchard costs	Productivity, efficiency
Number of frost days	Productivity
Soil applied nutrients	Efficiency, environmental effects
Copper sprayed	Efficiency, environmental effects
Semi-natural habitat (proportion of orchard title area)	Environmental effects
Woody vegetation (proportion of orchard title area)	Environmental effects
Plant available phosphate in soil (Olsen P)	Efficiency, environmental effects
Soil acidity (pH)	Efficiency, environmental effects
Available Nitrogen	Efficiency, environmental effects
Soil organic matter	Efficiency, environmental effects
Soil copper	Efficiency, environmental effects
Community donations	-

Table 3: Packhouses and Coolstores – indicators included in the Kiwifruit dashboard

Indicators for packhouses and coolstores	Type of indicator
Electricity used	Efficiency, environmental effects
Electricity cost	Efficiency, environmental effects
Waste disposal cost	Efficiency, environmental effects
Recycling	Efficiency, environmental effects
Waste to landfill	Efficiency, environmental effects
Reject fruit	Production, efficiency
Water used	Efficiency, environmental effects
Community donations	-
Petrol and diesel used	Efficiency, environmental effects
LPG used	Efficiency, environmental effects
Refrigerant costs	Efficiency, environmental effects
Refrigerant loss	Efficiency, environmental effects
Product greenhouse gases	Efficiency, environmental effects

The indicators in the two dashboards can be evaluated against the six criteria for fit-for-purpose indicators.

Valid

Growers – The indicators used in the growers' dashboard are valid. They are accurate measures of the productivity, efficiency and environmental impact that they are designed to track. Although 'taste' at first glance may be considered subjective, Zespri and Plant and Food Research have conducted considerable research to validate quantitative measures of taste based on dry matter proportion.

Packhouses and coolstores – The indicators for the coolstores and packhouses dashboard focus on the environmental effects of storing and packing fruit, with one indicator ('reject fruit') covering production efficiency. The indicators validly represent the main environmental effects of a packhouse or coolstore, such as climate change, waste and water use.

Based on accessible data

Growers – The indicators in the dashboard are collected as part of Zespri GAP, so the data are available to growers for input into the dashboard. As with other industry data, comparison data and regional and national data are not publicly available. Benchmarks are therefore built up internally in the dashboard, based on data from users.

Packhouses and coolstores – The indicators are likewise based on data already being collected for other uses, so they are based on accessible data.

Performance-based

Growers – The indicators are a mix of performance- and practice-based. All of the financial indicators are performance-based. Many of the environmental indicators are performance-based, measuring the state of the environment in and around the orchard (eg soil nitrogen, soil phosphorous, soil acidity), while some describe or quantify practices (amount of water used, amount of copper sprayed) without reference to whether or not the environment can support such practices. For practice-based indicators the dashboard still allows an orchard to compare its results to other orchards across the country. However, benchmarking depends on wide uptake of the dashboard, and means that poor results may only be highlighted if they are anomalous, rather than systemic in the industry.

Packhouses and coolstores – Most of the indicators used are practice-based. However, for the kind of environmental issues they are targeting, this is not unusual. Climate change and waste are too long-term and widespread for one firm's impact to be measurable in direct performance-based indicators, so practice-based indicators are more appropriate.

Easily communicated and understood

Growers – All of the indicators are easily communicated. The environmental indicators are clear in what they are describing. The financial indicators are easy to describe to a layperson without much specific knowledge of the horticulture sector. While the details of how taste has been quantified as an indicator may be complex, it is easy to communicate the idea that an indicator can be used to select kiwifruit for taste.

Packhouses and coolstores – While some of the measurements of the indicators involve technical elements, the indicators themselves are easily communicated and easy to understand. For indicators such as 'recycling' and 'water used', it is easy for a layperson to understand the purpose of the indicator and what it is trying to measure.

Clearly defined and standardised

Growers – All the indicators are clearly defined and standardised, either as raw amounts (such as water used or number of frost days) or in standard units (such as pH for acidity).

Packhouses and coolstores – All the indicators used are clearly defined and standardised as they are generally standard environmental measures of industrial activity. They therefore have a common definition and are standard across the industry.

Growers – It is unclear how well accepted these indicators are by stakeholders. While Zespri GAP is widely used to certify practices, the dashboard is still being rolled out and has not yet seen the wide uptake necessary to show that indicators are widely accepted by the industry.

Packhouses and coolstores – Similarly, the packhouses and coolstores dashboard has been recently prototyped and is being trialled at the moment. It is therefore too early to determine whether the indicators chosen are widely accepted by stakeholders.

Additional indicators

The Kiwifruit dashboards comprehensively cover indicators for direct environmental impact and direct financial return. They also include an additional indicator, 'Community donations'. With this indicator, the dashboards seem to be making an attempt to indicate the level of community involvement. Although community involvement as an employer is more than community donations, as an indicator it meets many criteria of a good indicator. The indicator could be further developed to include specific categories, such as cash donations, school programmes, etc.

The dashboards could add additional indicators on community/civic involvement to support the concept that the community donations indicator is seeking to illustrate. In particular, there are no indicators on employee welfare or labour practices. Additional indicators might cover topics such as:

- accident rates – the number of workplace accidents each year

- compliance with employment regulations – all employee contracts in compliance with labour laws

- workplace safety practices – whether safety regulations are being adhered to

- employee satisfaction – rates of staff turnover

- labour productivity – number of trays produced per person.

Feasibility of incorporating future indicators

It is feasible to incorporate new indicators into the dashboards. The dashboards themselves are flexible and can be modified to include new information. In addition, the institutional process for making changes seem well defined. Zespri, as the Produce Marketing Organisation for kiwifruit exporting from New Zealand, sets standards for kiwifruit growing and packing. The standards for record keeping and management include:

- traceability

- propagation material

- site management

- soil management

- nutrient management

- water management

- pest management

- agrichemical use

- worker health and safety and welfare

- hygiene

- equipment

- environment and conversation

- record-keeping.

The practice requirements to keep records and actively manage issues in each category mean that growers are already collecting the data they would need to add indicators into the dashboard, and Zespri is already overseeing that process. Therefore, it should be feasible to add new indicators into the dashboard for kiwifruit growers.

One potential issue is that, at the time of writing, the dashboards have limited uptake. Use of the dashboards is entirely voluntary. If they become burdensome, they are unlikely to be widely used. A balance must be struck between keeping the dashboards useful and informative for a variety of audiences, and ensuring they are user-friendly.

DELV and the Māori Sustainability Dashboard

Description of the dashboards

In addition to the primary industry dashboards, the NZSD also proposed the creation of a Māori Sustainability Dashboard. This work is led by John Reid from the Ngāi Tahu Research Centre at the University of Canterbury. In addition to laying the theoretical foundations for a method of sustainability assessment tailored to Māori enterprises, John Reid also led the development of a digital assessment tool which has applications well beyond Māori enterprises. This section will focus on the DELV assessment approach, rather than the theoretical development of the Māori Dashboard. For more information, Reid et al (2013) provides an account of the key concepts behind the development of the Māori Dashboard.

Unlike the Māori Dashboard, DELV has been developed to have general applicability to any type of enterprise, and can function as a 'dashboard' application within any industry. This flexibility makes DELV particularly interesting for the Our Land and Water Challenge. The DELV process begins by constructing a set of sustainability questions that are relevant to the enterprise. These questions may be formulated specifically for the enterprise (as is the case in the Māori Dashboard), or they could be co-opted from another assessment approach. An example of the second option is the NZ GAP assessment which has been re-created in DELV, so that a NZ GAP assessment can be undertaken within the DELV platform. DELV has the ability to create questions based on any type of metric (eg practice-based/performance-based/distance to target etc). An outline of the DELV process is provided in Figure 11, which describes four steps to creating a DELV dashboard.
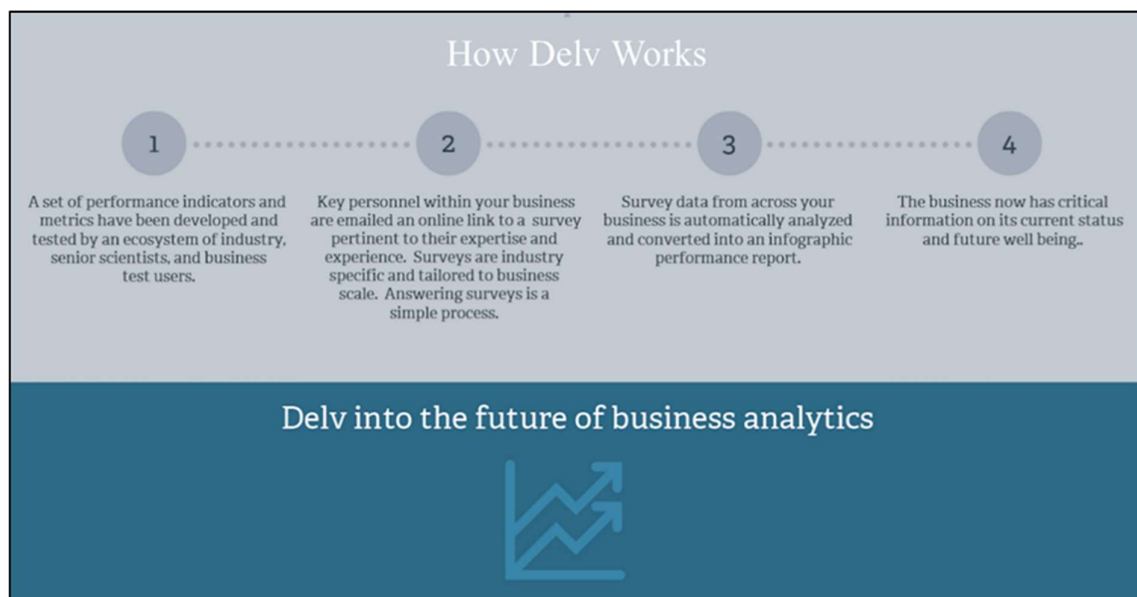

Figure 11 The DELV assessment process

The DELV platform was initially based on the Google suite of tools. Questions were sent from DELV to participants using Google Forms. Responses were stored in Google Sheets within the enterprise's own account. In early 2018, DELV moved to a custom-built application that retained the ease of use and customisability of the earlier system. This was done to allow a wider range of programmes to interface with

DELV's application programming interface (API), so that Google compatibility is not required. It also allows greater scale of users.

DELV assessments are based on a modular approach. A module may be an indicator like 'Soil Quality' or 'Livelihoods'. Within each module are a number of questions. DELV takes a hierarchical approach to an enterprise, recognising that questions that may be important at an executive or governance level may not be relevant at a farm or factory floor level. Therefore, in setting up a DELV assessment, the administrator selects different people in the organisation to receive specific assessment modules to answer. Upon completion of an assessment, the user is provided with automated results, an example of which is provided by Figure 12. It shows a spider graph in which a number of sustainability practices are compared in the past (red area) and the present (blue area).

The DELV platform is fully operational and was being trialled with Ngāi Tahu enterprises in 2017. The final version of DELV will be launched early to mid-2018. There are also plans to create an 'open' version of DELV. It will be a generic sustainability assessment that any person or enterprise can access and complete. This open assessment approach, in addition to data gathered from the industry dashboards, will feed into the National Dashboard, which is described in the next section.

Indicators included in DELV
Existing indicators

DELV comprises a wide set of modules, each with a set of indicators. The modules are categorised into four groups depending on the objective of what is to be measured:

- social objectives

- financial objectives

- environmental objectives

- cultural objectives.

DELV currently includes 27 modules, with a total of 595 indicators among them. Table 4 shows the DELV modules and the number of measures currently used for each one. The table also links the modules to two overarching frameworks: The Treasury's Living Standards Framework[4] and the United Nations Sustainable Development Goals.[5] It is beyond the scope of this report to evaluate all 595 indicators. We evaluate the indicators at a general level below.

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[4] http://www.treasury.govt.nz/abouttreasury/higherlivingstandards
[5] http://www.un.org/sustainabledevelopment/sustainable-development-goals/
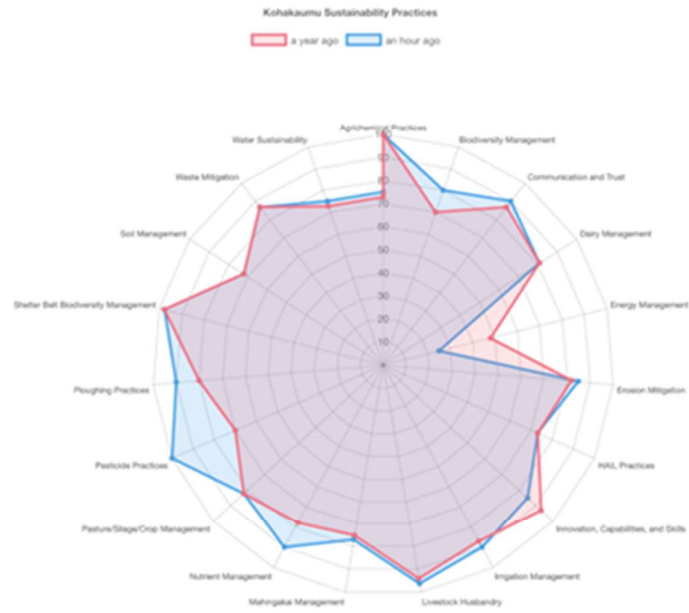
Figure 12 DELV reporting results against multiple indicators

Table 4 List of DELV modules and indicators

DELV module	Number of indicators	Living Standards Framework Capitals†	UN Sustainable Development Goals‡
Aerial Fertilizer Practices	2	Natural, Financial	2, 12, 15
Agrichemical Practices	8	Natural, Financial	2, 12, 15
Basic Production Indicators	29	Natural, Financial	2
Biodiversity Management	79	Natural	15
Dairy Production Indicators (Comprehensive)	53	Financial	2, 12
Culture and Wellbeing	8	Social, Human	3, 8
Dairy Management	29	Human, Financial	2, 12
Dairy Overseer Assessment	4	Natural, Financial	6, 12, 15
Energy Management	15	Natural, Financial	7
Financial Management	11	Financial	8, 12
HAIL Practices	24	Financial, Human	8
Health and Safety	8	Human	8
Innovation, Capabilities and Skills	19	Human	4, 12
Irrigation	33	Natural, Financial	6, 12
Livestock Husbandry	50	Natural, Financial	15
Mahinga Kai Management	23	Social, Natural	2, 3, 15
Nutrient Management	19	Natural, Financial	2, 12
Nutrient Management Plan	4	Natural, Financial	2, 12
Pasture/Silage/Crop Management	35	Natural, Financial	2, 12
Planning and Process	30	Financial, Human	8, 12
Shelter Belt Biodiversity Management	8	Natural, Financial	12, 15
Soil Management	22	Natural, Financial	12, 15
Soil Ploughing Practices	12	Natural, Financial	12, 15
Staff Management	42	Human, Financial	8
Wahi Tapu Protection	4	Social, Human	8
Waste Mitigation	6	Natural, Financial	12
Water Sustainability	18	Natural, Financial	6

† The Living Standards Framework is based around four capitals: Natural, Human, Social and Financial/Physical.

‡ The 17 Sustainable Development Goals are integrated and connected, so linking modules to specific Goals is somewhat simplifying.

The indicators in DELV can be evaluated against the six criteria for fit-for-purpose indicators.

Valid

By dividing the modules clearly into four groups based upon what is to be measured, it is clear what each indicator is being used for. The indicators in each module validly represent the phenomena they purport to represent and are therefore valid.

Based on accessible data

The full range of indicators has not been reviewed. It is likely that some indicators are based on accessible data, whether accessible to the enterprise or publicly accessible, while other indicators could be harder to obtain. Given the modular nature of DELV and its flexibility, it would be easy for users to focus first on the accessible data.

Performance-based

The indicators used are a mix of performance- and practice-based. As an example, usually Biodiversity Management indicators are performance-based, and Dairy Production indicators are practice-based. For the environmental sustainability of business activities, generally practice-based indicators are more appropriate as they will describe a business's contribution to a wider environmental issue. A performance-based indicator will describe the state of an environmental issue but will conflate the contributions of many different actors. For this reason, where environmental issues are driven by many dispersed sources rather than a single point source, practice-based indicators will be more appropriate for describing the sustainability of the participants.

Easily communicated and understood

The target audience for DELV is business and community leaders, particularly iwi leaders. By taking a holistic approach, iwi leaders can see how the business enterprises they are responsible for are serving their community across multiple dimensions. The indicators are clear and easily communicated to the appropriate audiences.

Clearly defined and standardised

The indicators included in DELV operate at different scales, but are each clearly defined and standardised for the scale at which they operate. For example, Biodiversity Management indicators can operate either at the farm scale or the region scale. The module clearly defines what is meant depending on the scale involved.

Accepted by stakeholders

The open-source nature of the DELV modules allow for new indicators to be added easily, with limited moderation of the indicators that are included. This may lead to indicators with very narrow acceptance being included, but also allows for stakeholders to add new indicators as they please.

Additional indicators

The indicators that are currently included in the DELV modules appear to be comprehensive. They cover multiple dimensions of sustainability, from environmental to economic, social and cultural as well as a range of spatial scales. There are no obvious gaps of indicators that are missing from the list of those currently used. If a full investigation were warranted, a survey of sustainability indicators, such as Wustenberghs, et al (2015), could be a useful source for identifying gaps in coverage. As suggested by Table 4, directly connecting the indicators to frameworks used by policy-makers, such as the Living Standards Framework, the Sustainable Development Goals or the various Roadmaps, could be useful.

Feasibility of incorporating future indicators

DELV's modular design makes it particularly straightforward to incorporate additional indicators. New modules can be developed to provide information on different aspects of operations, or different types of businesses. Within each module, questions can be targeted at different levels within the organisation (see Figure 13). Modules were written in Google Forms and it is straightforward to develop new modules, or to add additional indicators into existing modules.
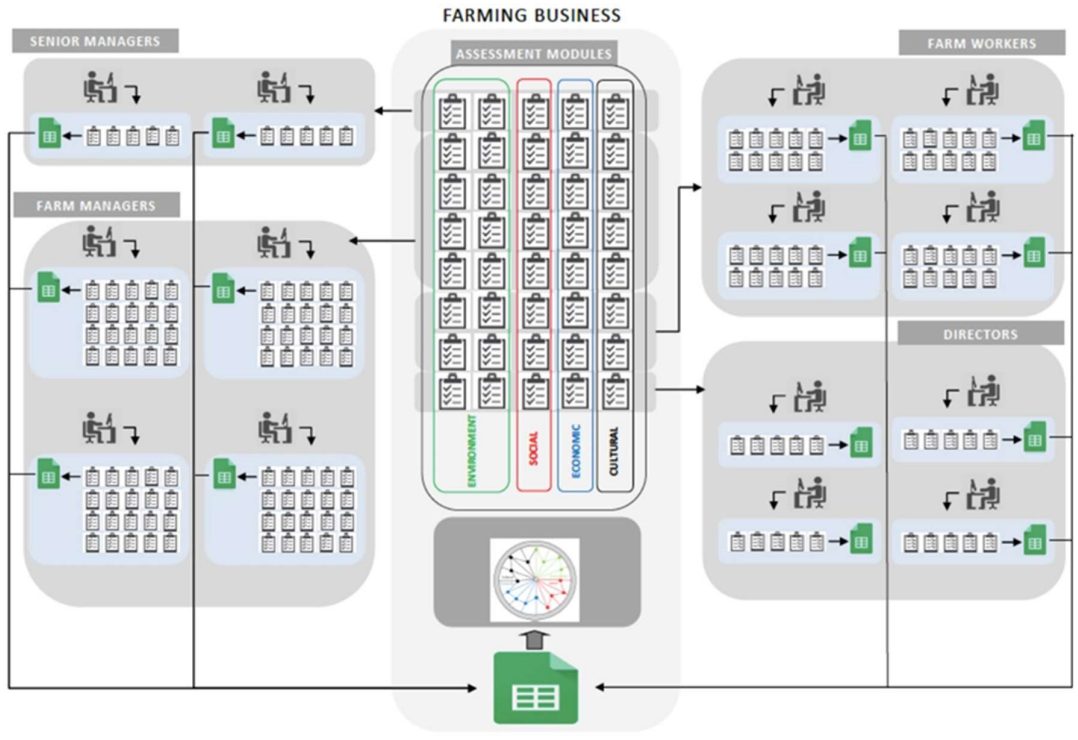
Figure 13 Illustration of DELV's modular approach to sustainability reporting

Additional dashboards

Horticulture NZ

The NZSD has a different relationship with Horticulture NZ than it does with the wine and kiwifruit industries. Horticulture NZ is not a case study in the sense of the other industries. Rather, the NZSD is applying knowledge gained through other activities to assist Horticulture NZ in their sustainable development. Currently, there are 1,360 NZ GAP certified growers across 170 crops. NZ GAP uses the same structural form as Zespri GAP, as both are based on the Global GAP standard. Questions therefore are practice-based, have different levels of importance and are audited by a third party. There are currently no plans to develop a horticultural dashboard that goes beyond the NZ GAP requirements.

The NZSD National Dashboard
General requirements of a national approach

Sustainability assessment may need to address multiple demands at multiple scales. First, there are the important stakeholders, each with their own goals for sustainability assessment. They may include:

- Policy-makers
- Farmers
- Marketers
- Local communities
- International consumers
- Scientific community
- Industry bodies
- Non-governmental organisations
- Domestic consumers
- The general public.

Next, there are the multiple spatial scales at which sustainability is relevant:

- Farm level
- Catchment Level
- Regional level
- National level
- Global level.

Stakeholder groups at each level will have different expectations around a range of sustainability assessment issues, such as:

- Privacy of data
- Selection of indicators
- Important drivers to respond to
- How data should be communicated
- Who should participate, and how
- What the goals are
- Purpose of the assessment
- Level of simplicity
- How data should be aggregated
- Who is responsible for costs
- How change should be implemented
- Transparency
- Harmonisation with other requirements
- Reliability/accuracy of the data.

Finally, creating a nationally relevant sustainability dashboard has some requirements that are additional to the industry dashboards. It would need to be:

- Based on an indicator framework shared between sectors
- Capable of making comparisons across sectors

- Able to support reporting at regional and national levels

- Integrated with international standards and norms.

Meeting these goals, across all the stakeholders and scales, is likely to require indicators that are broadly applicable. They will likely have more breadth than depth, so that the data are accessible and their use is easily communicated and understood.

Current state of the National Sustainability Dashboard

The current state of the National Sustainability Dashboard takes into account these challenges. Expecting that, in the short term, a standardised national reporting framework would not be adopted at an industry level, dashboard development is taking a generalised approach for a framework to be used by multiple industries. The National Sustainability Dashboard does not therefore define a set of common measures. Instead, it defines a set of common indicators and uses each industry's own metrics to measure progress against the indicators.

NZSD is also aligning the work across the different scales. The National Sustainability Dashboard has an explicit requirement that the measures should align with international standards and be guided by international markets and stakeholders, but as well they should be locally relevant. At higher scales, such as at regional or global levels, common metrics are used. The data collected is being aligned with the requirements of the Environmental Reporting Bill at a regional level, initiatives like the New Zealand Story (an initiative of Tourism New Zealand, New Zealand Trade & Enterprise and Education New Zealand) at a national level, and global initiatives such as the United Nations Sustainable Development Goals. Further development could also align the NZSD with other frameworks that are relevant to policy-makers, such as the Living Standards Framework or agency Roadmaps.

The information required is being collated using both top-down and bottom-up approaches. For the top-down work, existing data sets at international, national and regional levels are being used to populate the higher levels of the National Sustainability Dashboard in a top-down manner. For the bottom-up work, industry-level data is being gathered and entered into the National Sustainability Dashboard. The work of selecting the most appropriate indicators is drawing on the prioritisation work done in the NZSD, which developed a method for strategic selection of indicators (Whitehead 2017).

Figure 14 provides an illustration of the National Sustainability Dashboard requirements.
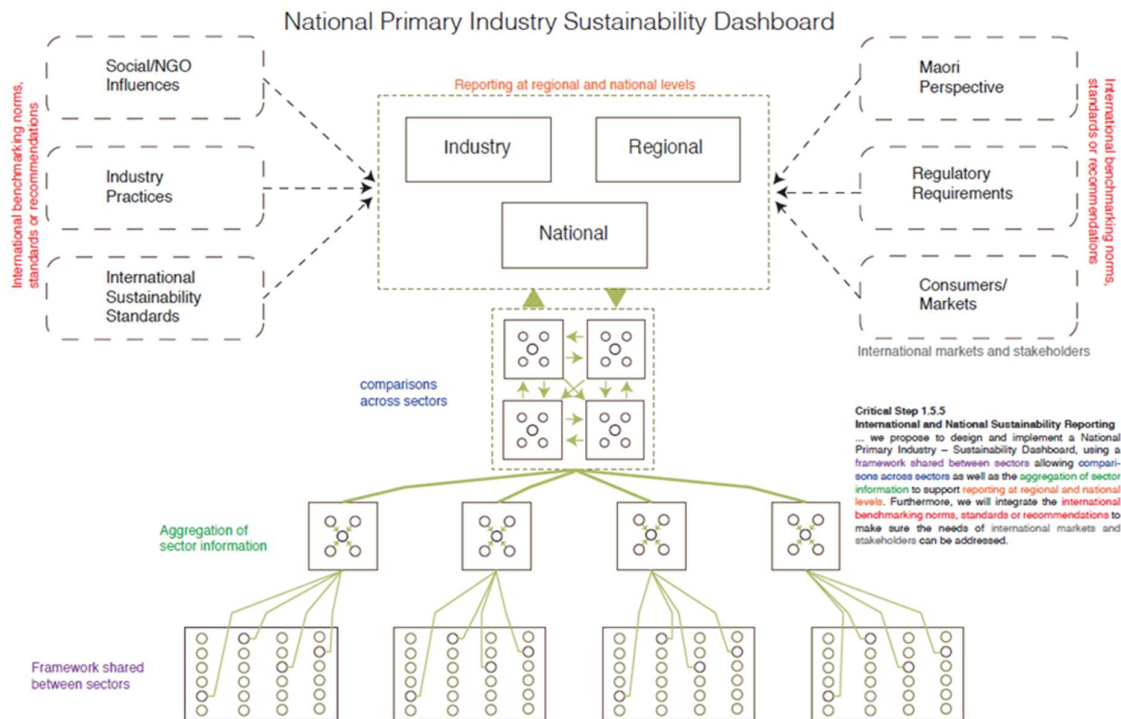
Figure 14 National Dashboard Requirements Illustrated

A test version of the National Sustainability Dashboard was developed using Tableau visualisations and a website interface. This development version contains five sustainability indicators across three pillars (environment, economic and social). Each indicator reports data across multiple scales as shown in Table 5. Figure 15, Figure 16 and Figure 17 present an illustrative example of different ways in which the National Dashboard is capable of presenting data from these indicators, at the global, national and regional scale, respectively.

Table 5 National Sustainability Dashboard indicators, scales and reporting units

Indicator	Global scale	National scale	Regional scale
Land use	Countries	Regions	Industry
Water quality	OECD countries	Catchments	
Water use	Countries	Regions	Industry
Gross domestic product	Countries	Regions and sectors	
Wellbeing	Countries	Regions and sectors	

The National Sustainability Dashboard concept is still under development and is subject to change. The next step in its development will be the inclusion of sustainability assessment data from the Wine and Kiwifruit dashboards. The inclusion of this data will illustrate the National Sustainability Dashboard's potential to report on a sustainability indicator from the farm level to the international level across different industries.
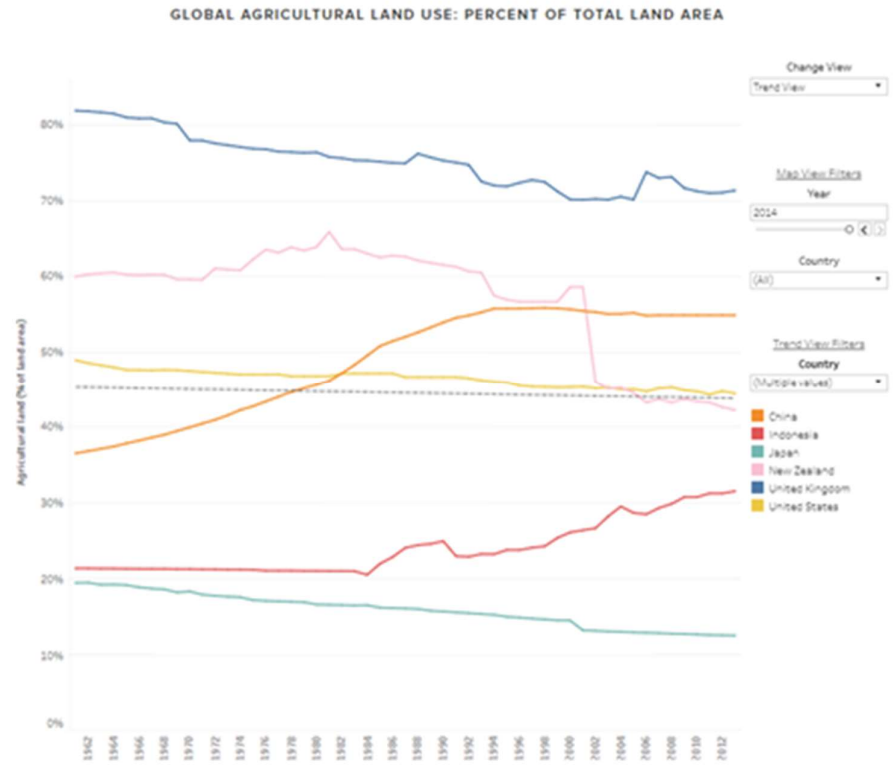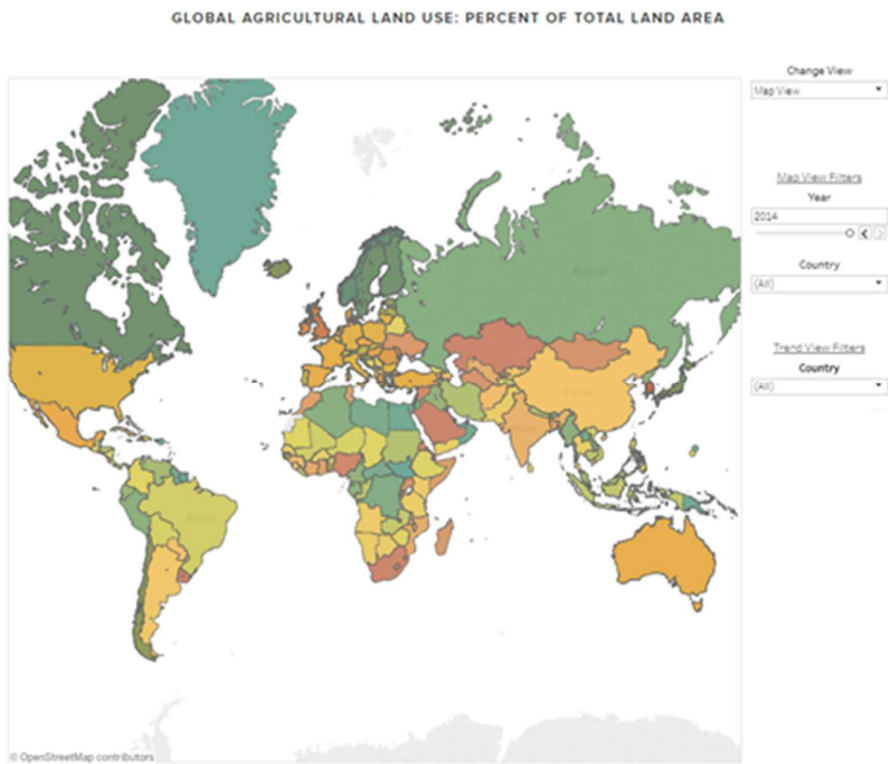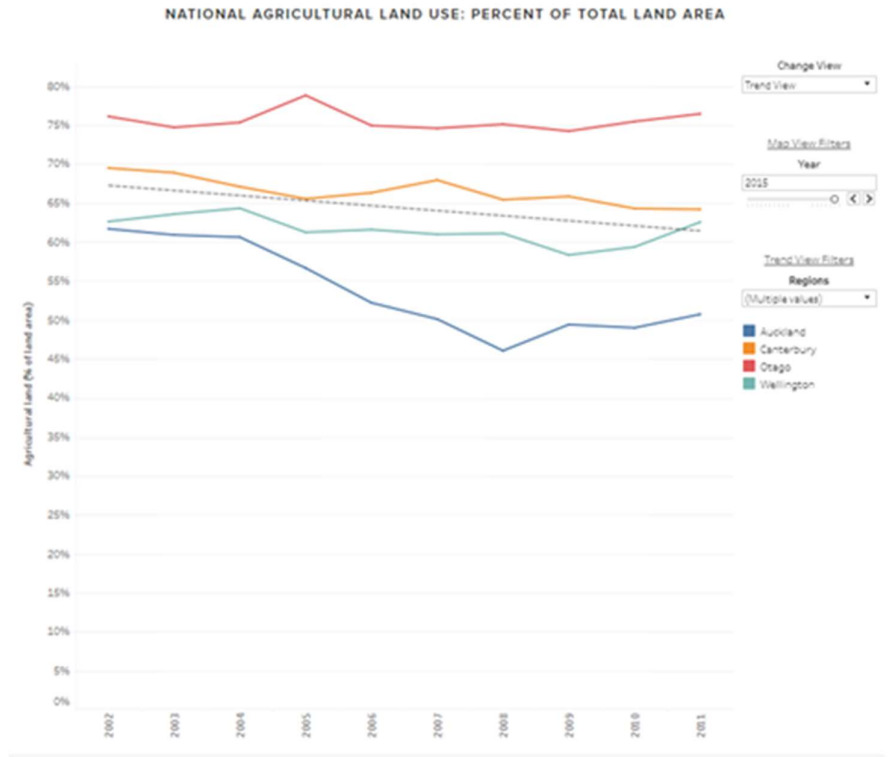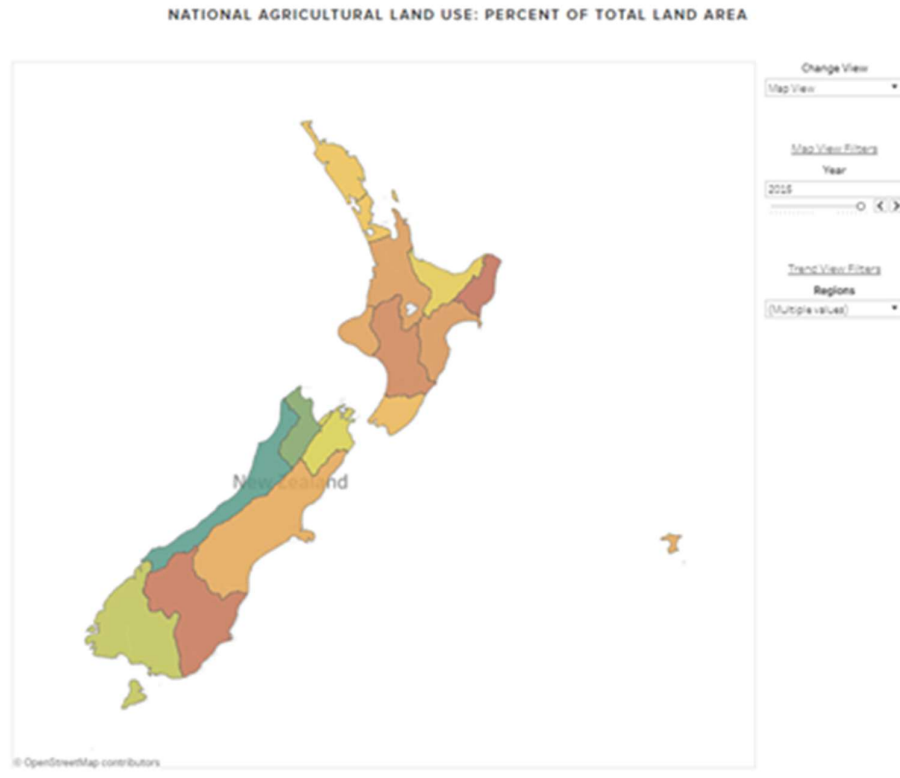
Figure 15 Global agricultural land, map and trend

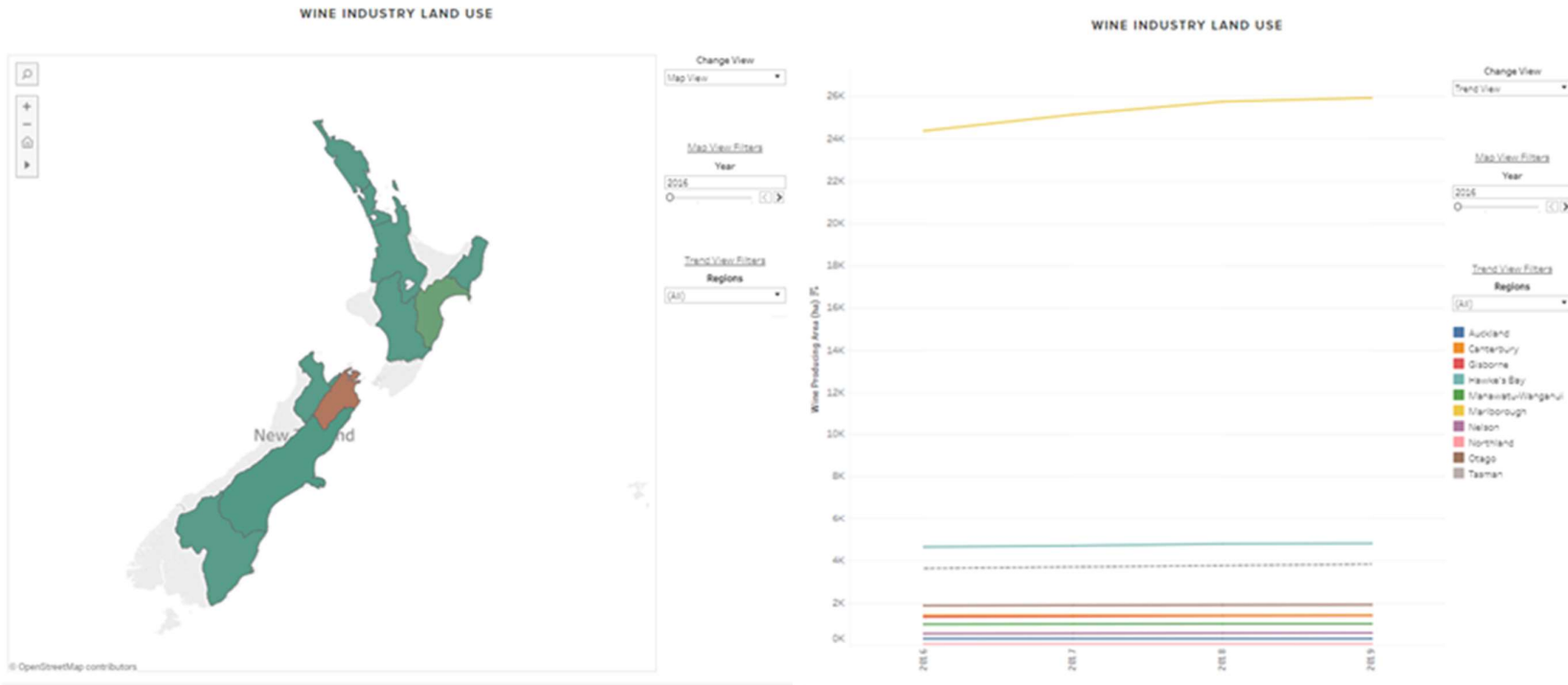**Figure 16 National agricultural land, map and trend**

Figure 17 Regional and industry land use, map and trend

Conclusion

This report has provided an overview of the NZSD, the individual case studies and dashboards and the data gathering and reporting initiatives. Across the case studies, there have been differences in how the dashboards were developed and how the indicators are collected and used. The NZSD ties them together by providing a sustainability indicator framework that acts as a reference document for industries looking to develop their own assessment system. The NZSD indicators are not meant to be prescriptive, which is reflected in the lack of specified metrics for the indicators. Instead this level of detail is left to individual industries to determine.

- The wine industry's sustainability undertakings are based on the SWNZ programme. SWNZ utilises a range of indicators, all targeted at a vineyard or winery level. SWNZ indicators may be practice-based or performance-based depending on the issue.

- The kiwifruit industry currently relies primarily on Zespri GAP to underpin its sustainable development. However, the NZSD is working to develop a Web-based dashboard for kiwifruit growers and post-harvest operators. Unlike Zespri GAP, which is practice-based, the Kiwifruit dashboard relies heavily on performance metrics, and allows for the collection of important information, such as spray use data.

- The Māori dashboard evolved into a complete system of sustainability assessment tailored to a Māori worldview. While the initial assessment approach is primarily practice-based, the development of the Māori dashboard also resulted in the creation of a flexible piece of sustainability assessment software known as DELV. DELV provides the ability to gather data on any sustainability indicator, whether practice- or performance-based, across a range of different roles within an organisation.

- The National Sustainability Dashboard was developed to complement both DELV and the industry dashboards as well as provide a platform where sustainability indicators can be introduced in a top down manner, as opposed to the bottom up approach the NZSD has taken towards the individual industry dashboards.

We evaluated the indicators in these dashboards against established criteria for fit-for-purpose indicators. In general, the indicators are valid, based on accessible data, well defined, standardised and easily communicated. One way the indicators could be strengthened would be to increase the number of performance-based indicators. Practice-based indicators are appropriate for some issues, but they can paint a false picture of sustainability. If the link between those practices and good outcomes is not strong, these indicators can provide the illusion of useful activity.

The last criterion – that indicators should be accepted by major stakeholders – is one where the dashboards have focused effort. To effect change on the ground, indicators must be accepted by those who can make that change. Indicators that are easy to measure and track are more likely to be used and accepted by those who use them. However, indicators also need to give an accurate idea of progress towards targets. These indicators may be less easily accepted by stakeholders, because they can be more complex and require more effort. Thus, it is important to strike a balance between acceptability and other criteria.

The last concern, which comes from the Our Land and Water National Science Challenge and is related to the work of the Indicator Working Group, is whether these dashboards can be extended to include new indicators. Across all the dashboards, it is clear that they are sufficiently flexible to accommodate new indicators, at least from a technical standpoint. They also have user groups and industry bodies that provide institutional support for the dashboards. Thus, there are processes and protocols for extending the existing dashboards. In addition, the recent dashboard DELV shows exciting promise for flexible, user-defined sustainability evaluation tools using indicator sets that are either tailored to specific audiences or widely accepted for broad applicability. The NZSD appears to have considerable capability to absorb new indicators.

The NZSD should be understood as a shared enterprise for the improvement of sustainability assessment, reporting, and learning across different industries and iwi. It should not be understood as a single platform for the assessment of sustainability across multiple industries. The implications of this is that the NZSD facilitates the use of sustainability indicators in multiple different ways, from supporting established sustainability certification schemes such as SWNZ, to creating bespoke sustainability indicators and assessment systems such as the Kiwifruit dashboard. As Our Land and Water research identifies important indicators or develops new ones, NZSD provides a framework for communicating those indicators to industry groups, growers and other interested people.

References

Benge, J. (2015). *New tools to lift industry performance*. Kiwifruit: New Zealand Kiwifruit Journal, January/February, pp. 20-22.

Hunt L., C. MacLeod, H. Moller, J. Reid and C. Rosin (2013). *Framework and KPIs for 'The New Zealand Sustainability Dashboard': Reflecting New Zealand's Economic, Social, Environmental and Management Values*. NZSD Research Report, 13/09, accessed 1 September 2017 at www.nzdashboard.org.nz/research-reports.html.

Manhire, J., H. Moller, A. Barber, C. Saunders, C. MacLeod, C. Rosin, D. Lucock, E. Post, F. Ombler, H. Campbell, J. Benge, J. Reid, L. Hunt, P. Hansen, P. Carey, S. Rotarangi, S. Ford and T. Barr (2012). *The New Zealand Sustainability Dashboard: Unified Monitoring and Learning for Sustainable Agriculture in New Zealand*. NZSD Research Report, 13/01, accessed 1 September 2017 at www.nzdashboard.org.nz/research-reports.html.

PwC (2017). *Signs to Look For: Criteria for fit for purpose indicators*.

Reid, J., T. Barr and S. Lambert (2013). *Indigenous Sustainability Indicators for Māori Farming and Fishing Enterprises. A Theoretical Framework*. NZSD Research Report, 13/06, accessed 1 September 2017 at www.nzdashboard.org.nz/research-reports.html.

SAFA. (2014). *Safa Sustainability Assessment Of Food And Agriculture Systems: Guidelines, Version 3.0*. Rome: Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/nr/sustainability/sustainability-assessments-safa/en/

SWNZ (2017). *Plant Protection National Report: Benchmarking and Individual Reporting*. Blenheim: Sustainable Wine New Zealand.

Whitehead, J. (2017). *Prioritizing Sustainability Indicators: Using Materiality Analysis to Guide Sustainability Assessment and Strategy*. Business Strategy and the Environment, 26(3), 399-412. doi:10.1002/bse.1928

Wustenberghs, H., Coteur, I., Debruyne, L., & Marchand, F. (2015). *TempAg pilot activity 1.1.1: survey of sustainability assessment methods*. Merelbeke, Belgium: Institute for Agricultural and Fisheries Research.

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