Pointing the way: indicators for a better Aotearoa New Zealand

Final report of the Indicators Working Group for the Our Land and Water National Science Challenge

September 2019

pwc

Strictly private and confidential

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27 September 2019

Re: Indicator Working Group final report

Dear Caroline

As per our contract received 4 July 2017, please find attached our final report for the Indicators Working Group of the Our Land and Water National Science Challenge. The report summarises the research and findings of the Group over its six individual projects and the past two-and-a-half years.

This is the 12th in a series of reports and journal articles associated with 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 in Appendix C.

We have very much enjoyed having the opportunity to conduct this research and to be part of the Our Land and Water Challenge. We wish you well with your future work.

Yours sincerely

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Executive summary

We know a lot about the indicators needed for a better land-based sector, and we have some of the data already. There is also demand for more.

Stakeholders are already using the results of indicator research and the Indicators Working Group

The results of the Indicators Working Group (IWG) in general suggest that indicators – understanding and defining the required indicators and gathering data – are not a limiting factor for improving the land-based sector. There is incomplete and imperfect information, as well as demand for better indicators and more data, but there is enough current information to support changes in policy, production and marketing practices for the primary sector.

Some stakeholders are already using the indicator research conducted and profiled by the IWG. Research groups and industry organisations are using the Sustainability Dashboard and Next Generation Systems indicators with farmers. PwC has contributed to discussions that relied on IWG research with The Treasury, Statistics NZ, ministries, ministers and industry bodies. The IWG work tended to suggest that research efforts around agri-environmental indicators were more advanced than government policy that required the indicators.

We found a considerable amount of indicator work and associated data

Throughout the IWG programme, we found people, projects and organisations that understood the indicators that were important to end-users. Our stocktake of indicator projects collected information on 28 projects and programmes that were focused on indicators and collecting data. Later, we found others that were collecting data and making it available to some end-users.

Each individual project in the work programme considered a different group of people, a different geographic scale, a different purpose, and/or a different methodological approach. As a result, each project produced somewhat different findings. However, across all of the projects, similar information about indicators was uncovered. People making decisions about the land-based sector – whether farmers, policy-makers or researchers – want to know whether land uses are financially viable and environmentally sustainable.

We found some areas for further work:

- Some government priorities have not been tightly linked to indicators or data around sustainability.
- Some data is closely held, for commercial, privacy and other reasons.
- There is demand for more indicators, in terms of both indicator design and available data.
- No single entity has the resources or mandate to curate relevant indicators and data.

The IWG investigated how to use indicators and associated research to meet OLW goals

Our Land and Water (OLW) set up the IWG to focus on two related issues:

- Supporting government with international obligations regarding sustainability and reporting
- Helping the primary industry with understanding and changing land use practices.

The work was intended to support the twin OLW goals of increasing economic returns from the primary sector while maintaining or improving environmental performance. The IWG investigated the use of indicators in six individual projects to draw out general lessons. The work was generally framed as providing a way to facilitate sharing of information among government, industry and research.

The work programme of the IWG combined depth and breadth. It started with two wide-ranging projects to provide orientation for the working groups: a stocktake of current work and a review of indicator theory. The IWG then conducted essentially four case studies, two of which involved primary research and the other two mainly secondary research. The primary research investigated indicators for resilience at the community level and indicators of sustainability at the national and international level. The secondary research worked with other research teams involved in assessing the performance of the land-based sector in order to understand their use of indicators. The work programme thus covered indicators at different geographic scales for different purposes and stakeholder groups, but all linked to the economic and environmental goals of OLW.

Introduction

The report summarises the programme of work of the IWG and offers a few high-level lessons.

Purpose of the IWG

The Our Land and Water (OLW) National Science Challenge was charged with transforming the agriculture sector in New Zealand. The mission for the first phase of OLW was to enhance primary production and productivity while maintaining and improving New Zealand's land and water quality for future generations. The mission was translated into two long-term goals:

- Double the total value of export production to close to 40 per cent of GDP (Economic goal)
- Improve the performance of key indicators of land and water resources by 20 per cent at the enterprise and catchment scales (Environmental goal).

To support the work, OLW determined that improved use of indicators was important. First, it commissioned a thought-piece on indicators.[1] Next, it engaged PwC to organise and lead the Indicators Working Group, chaired by Vicki Compton from the Ministry for Primary Industries. The IWG was to focus on two issues:

- supporting government with international obligations regarding sustainability and reporting
- Helping the primary industry with understanding and changing land use practices.

The IWG sought to act as a liaison or sharing forum for people and organisation from government, industry and research. The members of the IWG and stakeholders involved through the programme are provided in the appendix.

Background

The primary sector is important for the New Zealand economy. As reported by the Ministry for Primary Industries in the Situation and Outlook for Primary Industries for June 2019, the sector accounted for 80 per cent of New Zealand's merchandise exports (ie non-services exports), as well as 15 per cent of employment for the country and 11 per cent of gross domestic product (GDP). These figures include both the direct output of the primary sector (eg sheep and cows) and their subsequent processing into products for consumption and export (eg food products manufacturing).

Statistics NZ reports on the number and size of farms in its Environmental Reporting Series.[2] It reported that the number of farms in 2016 was 52,785, down from 69,510 in 2002. It also found that the total land area in farming decreased 10.3 per cent over those years. Sheep and beef farming is by far the largest agricultural land use; farms covering 10.8 million hectares included sheep and beef farming.[3] The next highest land use was dairying, which involved farms covering 4.0 million hectares. One caveat to the numbers is that the information was drawn from a

[1] Garratt, L., Ausseil, A-G, Williams, T., Dominati, E., Dymond, J. (2016). Co-innovation leads to high impact indicators. Lincoln: Our Land and Water.

[2] http://archive.stats.govt.nz/browse_for_stats/environment/environmental-reporting-series/environmental-indicators/Home/Land/farm-size-and-numbers.aspx

[3] Sheep and beef and dairy farm data are from the Ministry for the Environment, Environmental Reporting, Farm size – Area of large commercial agricultural activities, 2002, 2007, 2012.

data set of businesses registered for goods and services tax (GST). As a result, some unknown number of smaller farm businesses were likely not included in the analysis.

Given the number and size of farms, the economic performance of the primary sector is important for rural communities, both now and in the future.[4] Farmers and rural people are interested in supporting the industry to improve the profitability of the sector and its contribution to the local economy through employment and local economic linkages. They will need to understand how potential land uses compare to existing ones. For that, they will need indicators that tell them about trends and potential performance.

The environmental impacts of the primary sector are also under scrutiny. Two key environmental issues in New Zealand are climate change and water quality. With climate change, important questions are how to reduce greenhouse gas emissions from agriculture in order to meet carbon emissions targets, and how agriculture can adapt to changing conditions. Water quality issues centre on understanding the impact of current land use, improving the quality of waterways and reducing the impacts of nitrogen, phosphorus, sediment and micro-organisms. All of these issue require an understanding of the current state of the environment, pressures on the environment and the impacts of those pressures. Indicators are an important part of achieving that understanding.

Other issues are also affecting the primary sector. Throughout the work of the IWG, many different issues have been mentioned by farmers and community members. Regulation is a key concern, especially the number of regulations and their combined impact on farming businesses. Another concern was market trends and demands from overseas consumers and market gatekeepers. Farmers and communities alike are concerned about population trends in rural areas, availability of non-farm employment, the reduction in services in some locations, health care delivery, access to transport and more.[5] Some of these issues have more impact on farms as businesses, while others are more directly relevant for communities.

Our Land and Water was created as one of the National Science Challenges. The Challenges were large mission-led science programmes tasked with tackling large, complex problems that had social importance – so-called 'wicked problems'. Supporting the economic performance of the primary sector while maintaining the environment was selected as one of these wicked problems. Because the mission is complex, there are many stakeholders across government, the primary industries and research. OLW investigated the possibility of improving outcomes through co-innovation and indicators.[6] The mission of the Challenge and the foundational work on indicators led to the creation of the Indicators Working Group. The aim was to explore better communication and coordination across stakeholders with the aim of creating better understanding and ultimately better outcomes. Doing that requires some common understanding of the state and trends for the primary sector and the environment, and indicators have a role to play in creating and maintaining that understanding.

Purpose of this report

The purpose of this report is to provide a final overview from the Indicators Working Group. In particular, we want to draw together the high-level lessons from the work – the view of the results when we look across all the individual pieces of work and publications. Therefore, the report does not provide an in-depth discussion of the prior work. That information may be found in the other report and articles, which are available through the OLW website.[7] Instead, the goal is to provide a few key messages for stakeholders and end-users to understand and carry into other work.

[4] Brown, M., Kaye-Blake, B., & Payne, P. (Eds.). (2019). Heartland Strong: how rural New Zealand can change and thrive. Palmerston North: Massey University Press.

[5] Kaye-Blake, W., Stirrat, K., Smith, M., & Fielke, S. (2017). Testing indicators of resilience for rural communities. Palmerston North: AgResearch.

[6] Garratt, et al (2016).

[7] https://ourlandandwater.nz/incentives-for-change/indicators-working-group/

Description of the work and outputs of the IWG

Work programme of the IWG

The work programme from OLW was divided into five specific projects and reports, spaced over two and a half years. PwC added a sixth task as a foundational piece of research for the programme. In additional, the IWG held regular meetings, and additional contacts and discussions were facilitated. The specific activities and outputs are available in period reports to OLW, including annual reports.

The work programme included:

1. research on criteria for good indicators
2. a stocktake of indicator research
3. primary research on resilience indicators for rural communities
4. collaborative work on indicators for the United Nations (UN) Sustainable Development Goals (SDGs)
5. an investigation of the Sustainability Dashboard and additional indicators
6. a workshop on indicators for Next Generation Systems.

The publications that resulted are summarised in the appendix to this report with key findings and graphics. The programme produced 10 reports (including this one) and two journal articles. Some of the work was co-funded by AgResearch, Targets for Sustainable and Resilient Agriculture and the Temperate Agriculture (TempAg) network.

In order to understand the key messages from the programme, it is helpful to have some understanding of the individual projects. They are therefore summarised in the next section.

Summary of individual projects

1. Research on criteria for good indicators

The whole IWG programme focused on indicators. PwC therefore decided that the first step should be to define an indicator and establish the criteria that described good or fit-for-purpose indicators. This understanding was then carried through the whole programme – each project linked back to the foundational criteria research. The research was desk-top, secondary research to pull together assessments from other researchers. We found that there were several definitions of indicators available and several good rubrics that could be applied. We decided to create our own set of six key criteria that were applicable to the work of the IWG. The report defined an indicator as ‘a relevant variable that is measurable over time and/or space that provides information on a larger phenomenon of interest and allows comparisons to be made’.

The criteria for ‘good’ or ‘fit for purpose’ indicators were:

1. accepted by stakeholders
2. valid
3. clearly defined and standardised
4. based on available or easily accessible data
5. easily communicable
6. performance-based.

Some observations come out of this work:

- The definition of an indicator and the criteria for good indicators were well developed in the literature, both in the academic literature and in government reports (eg statistical publications). It was useful to review the prior work and have a consistent definition throughout the project, but indicators as a topic are well understood.

- In subsequent pieces of work, we returned again and again to our six criteria. We included them in written reviews and in workshop activities with stakeholders from government, industry and research. This was an important role for the IWG as a group focused on indicators. We ensured that the criteria for good indicators remained at the core of conversations about what to measure and why. As shown in our various reports, many indicators that were recommended in the course of the research did not meet the criteria and therefore may not be suitable to support the OLW in meeting its goals.

2. Stocktake of indicator research

The next piece of work involved creating a base understanding of the data available in New Zealand. To do this, the IWG contacted public and private groups that were known to have data sets, and also relied on the members of the IWG (listed in the appendix) to investigate data held by their organisations. It created a short form to collect key pieces of information about each data set – the lead agency involved, the data collected, etc. The final list included 28 data sets or indicator programmes in the public and private sectors.

Some observations about this project:

- The PwC team found it somewhat difficult to gather information about indicator data sets. Emails were not answered and information was not provided, and we found it difficult to create engagement with the task. We do not know how much more indicator data exists beyond the information we obtained.

- Across all the data sets, there is remarkable coverage. There is commercial, financial and physical data that has relevance for the economic and environmental goals of OLW. The data covers the main land uses in New Zealand, not just sheep and beef and dairy but also kiwifruit, wine and other land uses.

- There are harmonisation issues. Data is not produced on a consistent basis with regard to unit of analysis, spatial reference, temporal reference, definition or construction. Sometimes, these differences limit the usefulness of data. At other times, the difference can be overcome with averaging, allocation and expert judgment.

- From an economic perspective, there appear to be incentive issues related to sharing, harmonising and using indicator data. The issues relate to a key tension regarding data: it can be expensive to produce, very valuable at the right time and place, and inexpensive to share. The tension plays out in different ways. For the private sector, data is a way to create a unique understanding of customers and stakeholders. It can be used to create a unique selling proposition (USP) or position, so the incentive is to hold data close. For the public sector, making data widely available can allow many users to analyse and interpret it, but funding the initial data collection is expensive and beyond the means of public sector entities.[8]

"On the one hand information wants to be expensive, because it's so valuable. The right information in the right place just changes your life. On the other hand, information wants to be free, because the cost of getting it out is getting lower and lower all the time. So you have these two fighting against each other." – Stewart Brand.[9]

3. Resilience indicators for rural communities

The most substantial piece of work undertaken as part of IWG was primary and secondary research into the use of indicators to measure the resilience of rural communities in New Zealand. The work was co-funded by AgResearch

[8] This tension was explored in other work with regard to weather data in New Zealand. See PwC. (2017). Weather permitting: review of open access to weather data in New Zealand. Wellington: Ministry of Business, Innovation and Employment. https://www.mbie.govt.nz/assets/5b3b826f79/weather-permitting-review.pdf

[9] Doctorow, C. (2010). 'Saying information wants to be free does more harm than good'. *The (UK) Guardian*, 18 May. Doctorow attributes the quote to Stewart Brand at the Hackers Conference in Marin County, California, in 1984.

through the Resilience Rural Communities programme and by the Temperate Agriculture (TempAg) network. It involved case study research with four communities. Two sets of workshops were held, one in 2017 and one in 2018, to gather qualitative and quantitative data from community members. At the same time, statistical analysis was conducted on data from Statistics NZ and other official sources. The aim was to determine whether it was possible to validate indicators of community resilience. In particular, we were interested in determining whether there were identifiable thresholds between resilience and vulnerability. The results showed a complex relationship between external indicators and community sentiment. Although a process for determining a resilience threshold was demonstrated, its validity would need to be tested on a larger sample.

This work also led to similar community workshops in the United States (Vermont), an analysis of a national set of data for New Zealand and additional workshops for communities and government agencies on the topic of resilience.

This indicator research demonstrated the following:

- Indicators developed from official statistical data are somewhat valid. They do indicate, to some extent, whether communities are doing better or worse.

- Community members provide a different perspective on community resilience. Their perspective has a complex relationship with statistical indicators: it might agree with some but conflict with others. They also provide the qualitative narrative about issues that relate to resilience.

- The later nationwide data analysis, undertaken as part of Resilient Rural Communities, found that several of the separate indicators used to create a resilience index were very highly correlated. This finding suggested that resilience and vulnerability in rural communities could be 'overdetermined' – a combination of factors can all be working to push a community into a particular condition.

4. Indicators for the UN SDGs

Another project also involved collaboration and co-funding with Resilient Rural Communities. As part of a multi-year research programme based in the United Kingdom (UK), the IWG and AgResearch investigated the potential use of indicators to model pathways to resilience for New Zealand agriculture.

The project had two distinct parts. The first part, led by PwC, involved exploring potential indicators for the UN SDGs. At first, the work focused on SDG 2, Zero Hunger, which was the focus for the UK team. Later, the work was expanded to include other SDGs and Targets. The work involved engaging with government entities to understand their work with respect to SDGs. In addition, PwC held two workshops with government, industry and research stakeholders in order to develop potential indicators.

The second part of the project involved modelling. The goal was to re-parameterise an existing model from the UK using New Zealand data. It could then be used to model the pathways towards achieving success on the indicators identified in the first part of the project. This part of the project encountered a number of issues and setbacks, including staffing issues with the core project in the UK. As a result, it has been partially successful but has not achieved the full vision of the programme.

This project is the basis for a few observations:

- The process identified some indicators that could be used to measure and monitor progress towards the SDGs.

- Consistent with the intention of the IWG, the expectation was that government stakeholders would provide guidance on indicators for achieving the SDGs in New Zealand. Researchers would then be able to incorporate those indicators into their research in order to produce policy-relevant findings. In the event, the team found that the IWG-organised workshops were developing new knowledge about SDG indicators. The team was also unable to obtain officially approved guidance on indicators from government entities.

- The criteria for good indicators were useful in guiding the workshops and in providing a basis for post-workshop assessments of the feasibility of indicators.

- The issues with the modelling work demonstrated the difficulties of working with data in complex models. Because of the issues with access to data and with data harmonisation, it can be difficult to repurpose a model built in one context for some other context and purpose.

5. The Sustainability Dashboard and indicators

The Sustainability Dashboard is a project that was funded by the Ministry of Business, Innovation and Employment. It has produced several industry-specific dashboards that allow farmers and orchardists to benchmark their own performance against that of their industry peers. The work with industry-specific dashboards has led to further work across industries, and this work is on-going. The aim was to make information available to primary sector producers to help them improve their economic and environmental performance.

The IWG was tasked with understanding the potential for using the Sustainability Dashboards as a tool to support OLW. One specific question concerned the feasibility of expanding the dashboard or dashboards with new indicators. A researcher in the Sustainability Dashboard programme worked with the IWG to prepare a report, based largely on the researcher's work, about the programme and the potential use of indicators.

This work found the following:

- Dashboards are a useful tool for communicating indicators to primary producers.
- The Sustainability Dashboard programme's various dashboards can be expanded relatively easily to include the sort of economic and environmental information that is important to OLW and policy.
- The programme encountered difficulties with regard to making data available and harmonising data across industries. These difficulties put some bounds around the potential use of indicators in the dashboards for measuring and monitoring trends for the economy and the environment.

6. Next Generation Systems and indicators

Next Generation Systems (NGS) is another multi-year research programme that sits in OLW. The focus is on high-productivity systems being pursued by entrepreneurial farmers: 'Next-generation systems may include redevelopment or redesign of existing enterprises and production systems, wholly new or novel enterprises, and new technologies that add options across temporal and spatial scales.'[10] NGS is fully aligned with the OLW goals of improving the economic performance of the land-based sector while maintaining the environment. It seeks to understand better those farm systems that are performing well on both economic and environmental dimensions in order to share the lessons more widely across the sector.

The IWG sought to understand the use of indicators in NGS. PwC facilitated a workshop with the principal investigators from NGS in which they described the systems they were studying, identified the key stakeholders in each system and produced a list of key indicators that would be meaningful for those stakeholders. In the workshop, those key indicators were assessed using the criteria for good indicators developed by the IWG (see above and page 18). The researchers themselves represented one of the stakeholder groups for IWG. Through their research, they worked closely with a second stakeholder group: industry and farmers. The workshop therefore produced a list of indicators that were relevant to two of the three IWG stakeholder groups. The final product from the work with NGS was a report that summarised the systems and presented the indicators.

This final project of the IWG led to the following observations:

- The researchers could identify important indicators, and these indicators were similar to ones identified in prior IWG work.

[10] Renwick, A., Wreford, A., Dynes, R., Johnstone, P., Edwards, G., Hedley, C., King, W., & Clinton, P. (2017). Next generation systems: A framework for prioritising innovation. In: Science and policy: nutrient management challenges for the next generation. (Eds L. D. Currie and M. J. Hedley). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 30. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 9 pages.

- The indicators were a combination of economic and environmental indicators. There exists data for some of them, while there is insufficient data for others.

- The researchers described complex systems, and were mindful that farm systems were embedded in larger economic, social, cultural and environmental systems.

- Despite the complexity, researchers were able to identify simple indicators that would be meaningful for themselves and for land managers. The indicators would be useful for assessing performance and managing the farm systems.

Summary of the work programme

The work programme of the IWG combined depth and breadth. It started with two wide-ranging projects to provide orientation for the working groups: a stocktake of current work and a review of indicator theory. The IWG then conducted essentially four case studies, two of which involved primary research and two of which were mainly secondary research. The primary research investigated indicators for resilience at the community level and indicators of sustainability at the national and international level. The secondary research worked with other research teams involved in assessing the performance of the land-based sector in order to understand their use of indicators. The work programme thus covered indicators at different geographic scales for different purposes and stakeholder groups, but all linked to the economic and environmental goals of OLW.

Lessons from the IWG

These insights are based on the work of PwC in the IWG

The work programme of the IWG was somewhat fragmented. Because it involved six discrete projects over two-and-a-half years, and included the members of the working group, researchers from the IWG and researchers from associated programmes, PwC provided the only constant throughout the process. The insights in this report are based on the experience of PwC and have not been tested with all the other participants from the work programme.

We have a good idea of what we need to know

Each individual project in the work programme considered a different group of people, a different geographic scale, a different purpose, and/or a different methodological approach. As a result, each project produced somewhat different findings. However, across all of the projects, similar information about indicators was uncovered. It was particularly telling that, during the final project involving Next Generation Systems, this entirely different group of principal investigators produced an entirely predictable list of key indicators. People making decisions about the land-based sector – whether farmers, policy-makers or researchers – want to know whether land uses are financially viable and environmentally sustainable.

Financially, key indicators focused on net returns, such as gross margins (revenue less direct costs) or EBIT (earnings before interest and tax). These indicators show whether a land use can pay for itself and return something to the grower. At higher geographic scale, indicators focused more on diversity – diversity of production and exports, for example – but still with the overlay that revenues need to be sufficient to pay for production costs.

Environmentally, key indicators focused on water quality. This is currently an important issue for New Zealand and has been for several years. The relevant indicators are well known: nitrogen, phosphorus, sediment, *E. coli*, phytoplankton and macroinvertebrate community index. Additionally, greenhouse gas emissions was an important environmental metric. These indicators were important regardless of geographic scale.

Data exists for these indicators, but may not be available

To monitor and evaluate land uses according to these indicators, we need data. Across our work, we found that data was either collected and available, collected but not available or not collected. We also found that this was true across the different stakeholder groups. The table below provides some observations.

It is difficult to summarise data availability for indicators, because there are a number of issues involved. One issue is the incentives to make data available. Researchers may not have the incentive – for example, funding – to make data widely available. Industry likely has incentives to restrict access to data; they collect data because it is useful and then need to restrict access in order to retain the benefits of the data. Government has multiple incentives across levels and agencies, which can operate to restrict data collection and dissemination. However, these incentive problems are not resolved with better communication. At the beginning, the IWG aimed to explore better communication across stakeholders; it does not appear that communication is either the problem or the solution.

A second issue is the curation of data. Although there is a large amount of indicator data available, it is not centralised (available from one source) and not harmonised (produced on a consistent basis with regard to unit of analysis, spatial reference and temporal reference). There is no entity across the stakeholder groups that has a continuing mandate to collect and maintain economic and environment data for the land-based sector. Although there are platforms that could be used, such as the data.govt.nz service at the Department of Internal Affairs, creating and maintaining a database of indicators requires resources and authority, neither of which is currently available.

Table 1 Summary of data availability and issues by stakeholder group

Data is…	Research	Government	Industry
Collected and available	There are large-scale research projects focused on creating data sets and making them available. Smaller-scale research projects are also making data available. The data can be quite specific in terms of application or structure. Other research works with available government and industry data.	Government ministries and agencies make available a large amount of data. There is increased effort in gathering more indicator information (eg Indicators Aotearoa New Zealand) and harmonising data from multiple sources (eg Ministry for the Environment's improving of environmental reporting data).	Major land-use industries make some data available. They include DairyNZ, Beef+Lamb, Forestry Owners Association, Zespri, Pipfruit New Zealand and others. Further industry data is available through Crown Research Institutes, Statistics NZ and the Ministry for Primary Industry.
Collected but not available	Smaller-scale research often does not make data available. The researchers, organisations and funders may not prioritise making the data available. In addition, research collects the data it needs, which may not be in the right format or structure to be useful as indicators outside that research project. We did not encounter research programmes that held data purposely in order to keep others from using it.	We encountered lack of understanding about the availability of data – which data were available to whom on what terms. Large government data sets have the reputation of being generally 'valuable' or 'useful', but individuals tend to have little direct experience of the IDI (Integrated Data Infrastructure), LEED (Linked Employer Employee Database) or LBD (Longitudinal Business Database). Government agencies are involved in long-term projects to harmonise and curate data. In the meanwhile, the data is not available. This is a timing issue.	Industry collects information that it does not make publicly available. The data can have commercial value, or can have privacy concerns. There also appears to be variation in the experience of researchers working with industry groups in terms of their willingness to make data available.
Not collected	Researchers tend to collect data for their own purposes. If other data would be useful to other stakeholders and end-users but is not currently collected, then there needs to be some mechanism to encourage its collection, as well as associated resources.	We encountered gaps in data availability for supporting OLW goals. For example, environmental data is not collected in a structured way that could be used to assess relative environmental performance of farms and rural communities. Additionally, some economic, social, cultural and environmental indicators that participants developed in theory could not be constructed with available data.	Industry tends to collect data that is useful for its own purposes. Data requires resources to collect and curate, and industry needs to be judicious in how it spends those resources.

Indicators can be used …

Despite the issues mentioned, indicators are useful and are being used. This observation was clear through the different projects in the IWG. Indicators are available and useful across stakeholders, end-users and geographic scales. For example, the community resilience work demonstrated that indicator based on Census data were useful in several ways. First, they provided information to community workshop participants about the economic, social, cultural and institutional dimensions of their communities. Even when they took issue with the indicator values, participants were still engaged with critically evaluating the information. Second, indicators were found to be somewhat useful in assessing the resilience of case study towns. Third, subsequent analysis has found that the resilience index developed from Census data and the individual indicators can be useful for establishing the relative resilience or vulnerability of rural Census Area Units in New Zealand.

Indicators were also useful at the farm and national scales. At the farm scale, researchers and land managers involved in NGS and the Sustainability Dashboard were using economic and environmental indicators to make management decisions and improve performance. At the national scale, the TSARA research showed that indicators can be linked to farm performance and aggregated to assess regional economic and environmental performance. Importantly, using indicators in land-use modelling allows researchers and policy-makers to understand the trade-offs involved in management decisions.

… but people need help using them

The IWG started its work by investigating indicators themselves, and developed its criteria for good indicators. We found that we returned again and again to this list. It was an important touchstone in our interactions with all our stakeholders. It was useful in workshops, discussions and reporting to have a few people who were focused mainly on indicators to work alongside other people focused on a particular issue, farm system or policy concern. By having people with that indicator lens, the IWG and PwC could challenge stakeholders to consider their information needs more closely: was the indicator valid? acceptable to other stakeholders? feasible to collect? In order to have good and useful information to assess land-use options over different temporal and geographic scales, an understanding of data and indicators is helpful.

The IWG provided additional guidance about using indicators. First, the stocktake conducted by the IWG, as well as the outreach and discussions over two-and-a-half years, exposed the PwC team to a lot of information about data and indicators in New Zealand. As a result, we were able to contribute to conversations about data availability and use. As reported to OLW, we contributed to discussions with Beef + Lamb; individual ministers; the Ministry of Business, Innovation and Employment; the Ministry for the Environment; the Ministry for Primary Industries; the New Zealand Institute of Primary Industry Management; Statistics NZ; The Treasury and cross-agency groups. A second piece of guidance concerned the effort needed to collect and curate data. As a proof-of-concept project, the IWG made a small dataset available from the community resilience research. The data was posted to data.govt.nz, with full permission and metadata. This work demonstrated that making data on indicators is possible, but requires specific and dedicated work.

If we keep doing things the same way, we will get the same results

This is the final report of the IWG, and the work is not expected to continue. As a result, the collection, curation and dissemination of data regarding New Zealand's land uses is likely to continue much as it has in the past. No single agency, organisation or entity has the knowledge, resources and mandate to lead the kinds of change that could improve the use of indicators for economic and environmental sustainability. Instead, existing incentives are likely to reproduce existing arrangements. Some useful data and indicators will continue to be available. As discussed above, stakeholder groups do have an understanding of what they need to know, and some of the data is available and is being used. Those indicators do already provide some indications about how land use in New Zealand can change to meet the goals of the Our Land and Water National Science Challenge. Nevertheless, a joined-up approach that produces harmonised data for collaboratively developed indicators available from a central source could provide a stronger evidence base for farmers and growers, communities, researchers and government.

Appendix A: Collaborators

The IWG involved a number of collaborators and stakeholders, including members of the Working Group and organisations that provided data, information and additional funding.

Collaborators
Ministry for Primary Industries
AgResearch
AERU, Lincoln University
Rothamsted Research
Targets for Sustainable and Resilient Agriculture
Temperate Agriculture Network
University of Canterbury
Ministry for the Environment
Statistics NZ
DairyNZ
Beef + Lamb
New Zealand Institute of Primary Industry Management (NZIPIM)
People from communities and local government in Huntly, Te Kuiti, Taumarunui, Dannevirke, Masterton and Gore

People involved on the Working Group and in the research
Vicki Compton (MPI)
Bill Kaye-Blake (PwC)
Margaret Brown (AgR)
Caroline Saunders (AERU)
John Reid (UoC)
Jean le Roux (MfE)
Bruce Thorrold (DairyNZ)
Nick Beeby (BLNZ)
Ronaldo Vibart (AgR)
Penny Payne (AgR)
Jay Whitehead (AERU)
Matt Smith (PwC)
Ranui Ellison (PwC)
Kelly Stirrat (PwC)

Appendix B: Summary of research

Stocktake of existing indicator work: An initial assessment of the current level of indicator work.

Output	PwC. (2017). Our Land and Water National Science Challenge: stocktake of indicator projects. Lincoln: Our Land and Water, September.
Purpose	The report presents a stocktake of existing government, industry and research projects involving agri-environmental indicators. It identified the topics being covered and potential gaps.
Stakeholders	The report was an opportunity to involve the organisations who were participating in the IWG in collaborative information-sharing.
Approach	The following agencies were invited to contribute to the stocktake: • Ministry for Primary Industries • Ministry for the Environment • Lincoln University • AgResearch • Landcare Research • The Sustainability Dashboard • Beef+Lamb New Zealand • Dairy New Zealand.
Results	The report identified and described 28 projects or programmes that were involved in assembling indicators about agriculture and the environment. It provided the following information: • Name of project or programme • Description • Lead agency • Some key contact people • Project status • Indicator data collected • Data sources.

Setting the scene on indicators: Think piece and scene-setting report focused on defining and understanding indicators

Output

PwC. (2017). Signs to look for: criteria for developing and selecting fit for purpose indicators. Lincoln: Our Land and Water.

Purpose

The purpose was:

- to develop a definition of what an indicator is and what qualities make for the best and most useful indicators, which allows:
  - policy makers to measure effectiveness of policy
  - researchers to collect the data that is relevant to policymakers and land managers
- to create a definition that cuts across multiple disciplines and can be applied across the Challenge's work
- to develop criteria that express if an indicator is fit-for-purpose (good) for OLW.

Stakeholders

The report was secondary research as part of the internal development of the IWG.

Approach

The approach was a desktop literature review of academic and policy literature. The first task was to develop a definition of 'indicator' and gather the qualities and criteria of indicators. The next task was to isolate the most important criteria, given the role of indicators for OLW. Finally, an assessment was made of the trade-offs involved across the criteria.

Results

The report defined an indicator as 'a relevant variable that is measurable over time and/or space that provides information on larger phenomenon of interest and allows comparisons to be made'.

It found the following criteria for 'good' or 'fit for purpose' indicators:

1. Accepted by stakeholders
2. Valid
3. Clearly defined and standardised
4. Based on available or easily accessible data
5. Easily communicable
6. Performance-based.

Key graphic or table

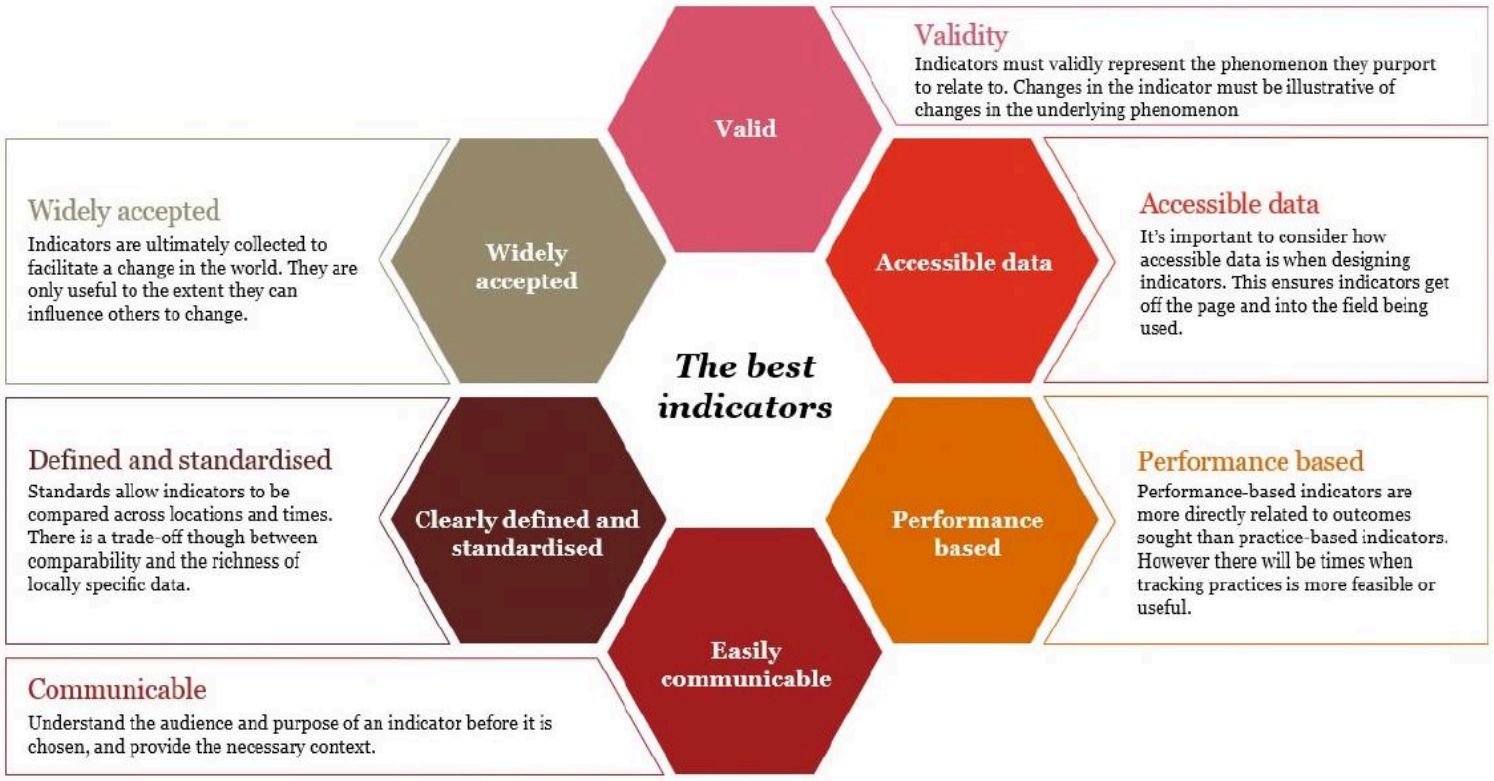

Figure 1. The six criteria for good indicators

Indicators of SDG 2: Zero Hunger: An assessment of possible indicators for SDG 2: Zero Hunger from New Zealand's perspective, and the possibility of backcasting for achieving it

Output

Vibart, R., Smith, M.J., Kaye-Blake, W., Brown, M., Stirrat, K.A., & Mackay, A. (2017). Targets for sustainable and resilient agriculture (TSARA): a New Zealand perspective (Report no. RE450/2017/048). Palmerston North: AgResearch Limited.

Purpose

This report presented the first stage in AgResearch's contribution to the TSARA research programme. It was a review of the data required for the TSARA modelling and the feasibility of populating the model with New Zealand data. The first objective of this report was to assess the feasibility of adding New Zealand's geospatial and biophysical data on farm typologies and agri-environmental zones (AEZs) to the larger TSARA programme. The second objective was to investigate the potential indicators that could be used to track progress on SDGs.

Targets for sustainable and resilient agriculture (TSARA) is a European research programme that is investigating land uses and changes to land uses, their potential to support progress towards the United Nations (UN) Sustainable Development Goals (SDG) and pathways from the current situation to defined future end states.

Stakeholders

The report used both primary and secondary research. A workshop was held that included representatives from government, the primary industry and research organisations. The modelling stage involved working with Rothamsted Research in the UK.

Approach

The research had two streams. The first stream focused on the Rothamsted Research land use model. Data was parameterised in order to feed it into model for New Zealand conditions. One set of data was for farming activities and land uses, specifically for cropping in Canterbury. A set group of data includes the natural resources of New Zealand according to a number of agri-environmental zones (AEZ), mimicking the modelling approach taken by the TSARA programme. The model was then used to estimate efficient frontiers for agricultural production.

The second stream involved consultation with government, industry and research to develop indicators relevant for Targets 2.4 and 2.5 for the Zero Hunger Goal. The approach was workshop, with subsequent assessment of indicators against the criteria for good indicators.

Results

The research demonstrated the feasibility of re-parameterising the Rothamsted Research model with data from New Zealand to estimate trade-offs amongst production

and environmental indicators. It also developed a list of potential indicators relevant to SDG 2: Zero Hunger.

Key graphic or table

Table 16. Feasibility summary of New Zealand SDG indicators identified.

SDG target element	Feasible, small effort	Feasible, greater effort	Infeasible to collect or link to farm types
2.4A — Increasing productivity and production	Index of exports	Yield per unit area of land Value of food exports Locally produced food consumed in NZ Land owner priorities	
2.4B — Maintaining ecosystems and improving soil		Change in land use intensity Water quality	Soil health metrics Ecosystem health
2.4C — Strengthening adaptation	Land area impacted by climate events Calorie/emission ratio of exported food	Production losses caused by extreme weather Land use diversity	Vulnerability of infrastructure to risk events
2.5A — Maintaining genetic diversity		Diversity of food consumed in rural communities	Percentage of genetic material in plant banks Measure of organism biodiversity Species on endangered list
2.5B — Promoting access to genetic resources		Social licence perception/awareness Percentage of freshwater management zones with targets considering baseline traditional knowledge	

Further indicators for SDGs: Development of further indicators for SDGs incorporating additional Goals and Targets, alongside modelling of Canterbury crop farming

Output

Vibart, R., Stirrat, K.A., Kaye-Blake, W., Smith, M.J., & Brown, M. (2018). Targets for Sustainable and Resilient Agriculture (TSARA): indicators and modelling for the Sustainable Development Goals (Report no. RE450/2018/045). Palmerston North: AgResearch Limited.

Purpose

The objective of the report was to describe an expanded set of indicators for measuring achievement of the SDGs and show how they could be incorporated into the land-use model that is part of the Targets for Sustainable and Resilient Agriculture (TSARA) programme.

TSARA is a European research programme that is investigating how different land uses can support progress towards achieving Goal 2 of the United Nations (UN) Sustainable Development Goals (SDGs): Zero Hunger. The purpose of this report was to provide an update on the progress made in FY18 towards AgResearch's contribution to the TSARA research. It is a follow-up to the report on the first stage of this research.

This work was funded by the AgResearch Resilient Rural Communities (RRC) programme as part of the TSARA programme.

Stakeholders

A workshop included 25 representatives from government agencies, including Department of Internal Affairs, Department of Conservation, Greater Wellington Regional Council, Ministry for the Environment, Ministry for Primary Industries, Statistics New Zealand and Te Puni Kokiri.

Approach

In one research stream, researchers held a half-day workshop to develop indicators for seven Targets linked to five Goals. A second research stream incorporated data on Canterbury arable agriculture into the Rothamsted Research land-use model to investigate the relationships between pairs of output variables.

Results

Workshop participants identified a long list of potential indicators that would be useful and meaningful. Subsequently, they assessed selected indicators against the criteria for good indicators.

The modelling demonstrated the ability to use New Zealand data in the model, and to show trade-offs between environmental and economic indicators.

Key graphic or table

Table 3. Potentially fit-for-purpose indicators

Target	Indicator
2.3	Gender equality pay measure
2.3	Increase in four capitals stock (financial, social, natural, human)
6.4 and 6.6	E.coli measured in fresh water
6.4 and 6.6	Amount of nitrogen, phosphorus and sediment in rivers and fresh water
8.4	Gross National Income (GNI)
14.1	Environmental reporting series, coastal and estuarine water quality
14.1	Environmental reporting series, heavy metal load in sediment
15.1 and 15.3	Environmental reporting series, soil moisture and drought
15.1 and 15.3	Percentage change in land that is suitable for crop production
15.1 and 15.3	Environmental reporting series, land cover

Key graphic or table

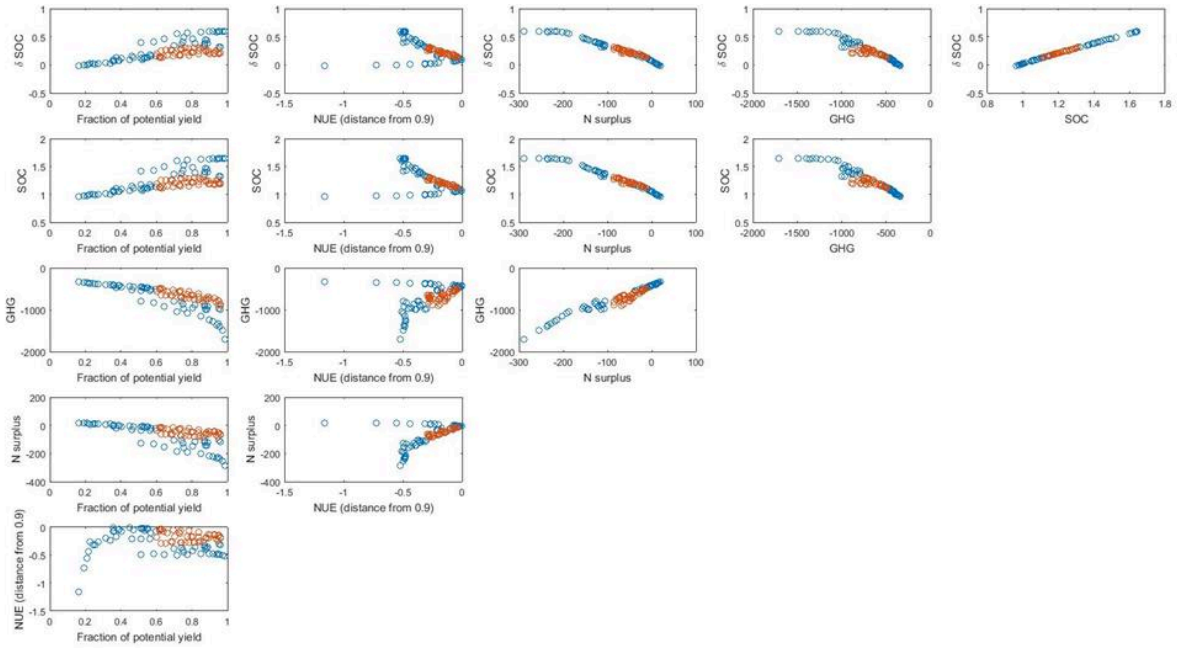

Figure 4. Different panels showing pairwise trade-offs between two variables (trade-offs are calculated for all variables together behind the scenes). All data points shown are on the frontier of all variables investigated [fraction of potential yield, changes in SOC (δ SOC), SOC, GHG (N_2O) emissions, N surplus, and N utilisation efficiency (NUE)]. Note: For any given panel, red points satisfy the following criteria: i) between 0.6 and 1.0 of potential yield, ii) annual N surplus <100 kg N ha^{-1}, iii) NUE between 0.5 and 0.9.

Indicators of market access risk: Assessment of the possibility of using indicators to inform decisions about market access risk

Output

Kaye-Blake, W., Stirrat, K., Smith, M., & Ellison, R.A. (2019). Assembling indicators of market access risks for food exports. Lincoln: Our Land and Water.

Purpose

The work investigated the market trends identified in the Drivers project in Our Land and Water to evaluate possible indicators for assessing those trends. By identifying and measuring indicators for particular drivers, policymakers and industry groups can anticipate international consumer and market trends and adjust production approaches and marketing efforts appropriately.

Stakeholders

The work was secondary research that did not involve stakeholders. Policymakers and industry groups, as well as individual producers, are potential stakeholders.

Approach

This research sought existing sources of data that allowed cross-section and time-series investigation of the size of consumer concern. This approach was chosen in order to explore a method for efficiently understanding the relative importance of consumer issues without conducting primary research

This research focused on seven drivers deemed most relevant to international market access. Under the economic theme, those drivers were food safety and carbon trading schemes. Under the environmental theme, the drivers were food miles or local food (locavore), climate change, and water quality. Finally, the social theme included the drivers' ethics/fair trade and animal health and welfare.

Results

The research produced several findings:

- There is little consistency across markets: different drivers are important in different places.
- Climate change and carbon prices are relatively important, although not in all markets.
- A one-size-fits-all approach may not be appropriate for creating a marketing narrative for New Zealand exports.
- This research also demonstrates the difficulty of producing a holistic quantitative view of future export drivers.

Key graphic or table

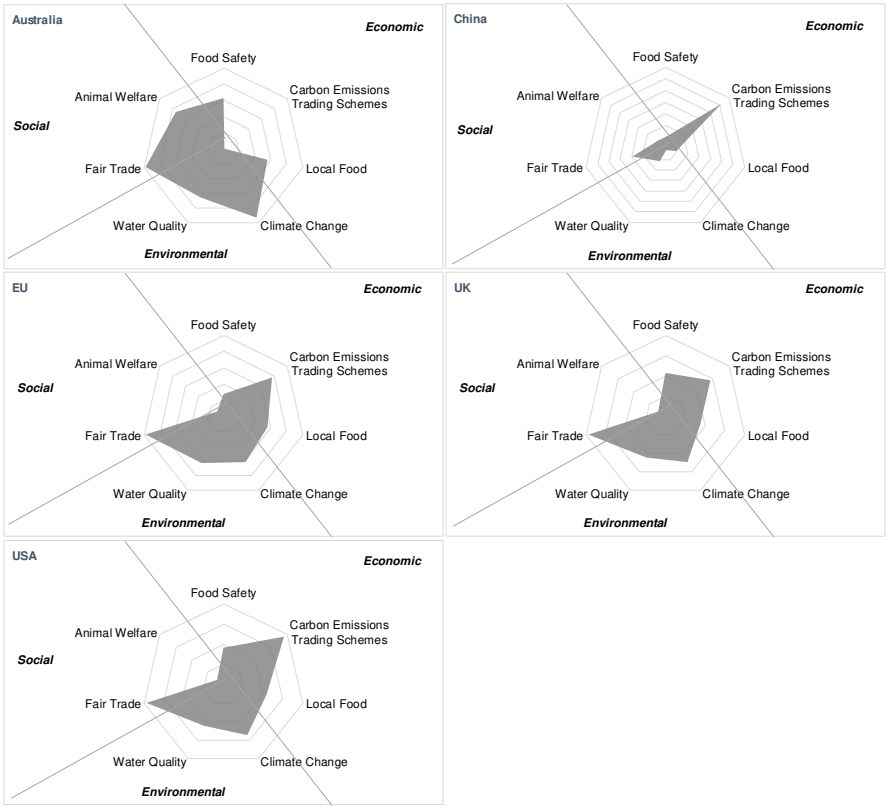

Figure 3. Relative change in indicators for each overseas market

Initial work on resilience indicators: Comparison of external indicators of resilience against community-based ratings of their own resilience

Output

Kaye-Blake, W., Stirrat, K., Smith, M., & Fielke, S. (2017). Testing indicators of resilience for rural communities (Report no. RE450/2017/056). Lincoln: AgResearch Limited.

Kaye-Blake, W., Stirrat, K., Smith, M., & Fielke, S. (2019). Testing indicators of resilience for rural communities. *Rural Society*. DOI 10.1080/10371656.2019.1658285.

Purpose

This work investigated three questions:

1. Is it possible to provide empirical measures of resilience to inform agricultural policy?
2. Can official statistics serve as a useful proxy for self-reported resilience?
3. Which aspects of resilience most strongly influence community perceptions of overall resilience?

Stakeholders

Primary research was conducted for four rural towns in New Zealand (Huntly, Te Kūiti, Taumarunui and Dannevirke). Secondary research was conducted through analysis of data from the 2013 New Zealand Census.

Approach

The research conducted community workshop in four rural towns to investigate how they viewed their own towns and their resilience across five dimensions: social, economic, cultural, environmental and institutional. It also gathered indicator data from the Census, based on a review of the literature about potential indicators of resilience. The two sets of data – from the workshops and the Census – were analysed and compared.

Results

The research produced several findings:

- Collecting resilience indicators directly from community members was feasible.
- It was possible to have empirical measures of resilience, both from community and central government sources.
- Some indicators produced a better fit with community resilience ratings than others, so that some official statistics could be used as proxies for self-reported resilience.
- Communities tended to emphasise different aspects of resilience, depending on local circumstances and workshop participants.

Key graphic or table

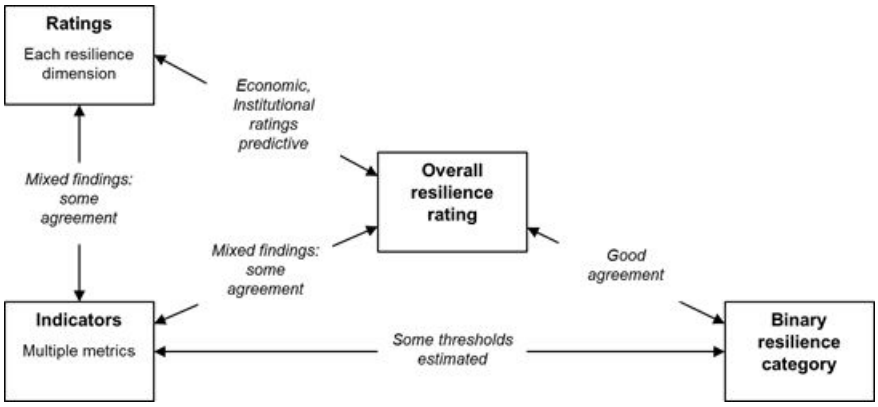

Figure comparing the community resilience Ratings with Indicators from official statistics, and noting the level of agreement between pairs of data types.

Continued work on community resilience: More assessment of the use of indicators for understanding community resilience

Output	Payne, P. R., Kaye-Blake, W. H., Stirrat, K. A., Ellison, R. A., Smith, M. J., & Brown, M. (2019). Identifying resilience dimensions and thresholds: evidence from four rural communities in New Zealand. *Resilience*, *7*(2), 149-171.
Purpose	The work tested the relationships between official statistics and expert judgments about community resilience against the results of community workshops. The purpose was to provide a larger sample size and better statistical results than the initial study.
Stakeholders	Primary research was conducted for four rural towns in New Zealand (Huntly, Te Kūiti, Taumarunui and Dannevirke). Secondary research was conducted through analysis of data from the 2013 New Zealand Census.
Approach	An additional four workshops were conducted in four rural towns to investigate their judgments about their own resilience. Their resilience Ratings were compared to Indicators based on official data.
Results	The research produced several findings: • Indicators of resilience were not significantly related to the Ratings from community members. • Expert judgment did not agree with community Ratings. • Some evidence was found that community members judged the different dimensions of resilience in a compensatory way: more of one dimension could make up for less of another.

Key graphic or table

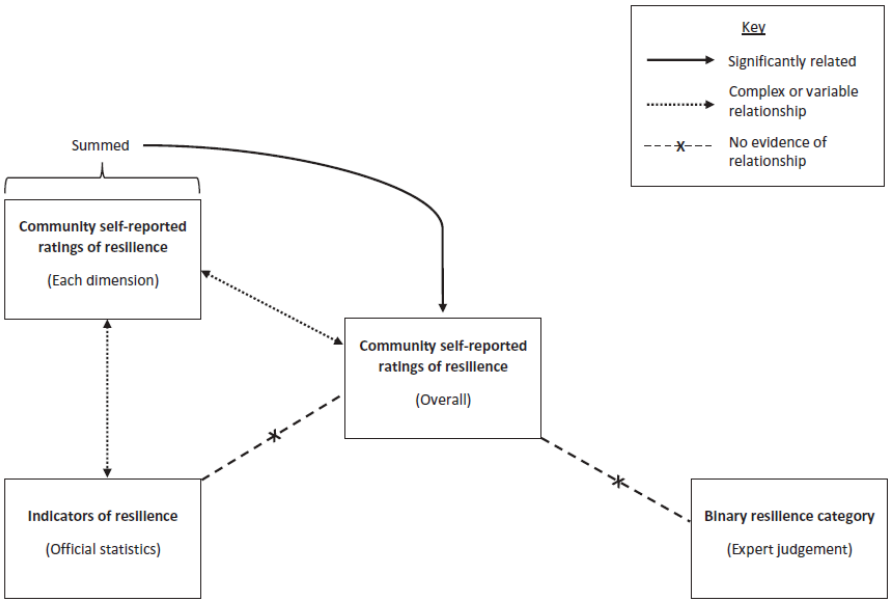

Figure 3. The significance of relationships between key variables examined in this research.

Resilience indicators for rural towns: A test of indicators of resilience across 308 rural towns, which resulted in an estimate of a resilience index

Output

PwC. 2019. Resilience indicators for rural New Zealand towns: statistical analysis. Lincoln: AgResearch Limited and Our Land and Water.

Purpose

The main purpose of this report was to conduct quantitative analysis that would complement case studies conducted in 2017, 2018 and 2019. The aim was to collect data on rural areas, based on the existing resilience research, and analyse it for useful patterns.

This work was funded by the AgResearch Resilient Rural Communities (RRC) programme.

Stakeholders

This research did not involve stakeholders. The analysis was focused on secondary research. Potential stakeholders include rural communities and central and local government, who could use the information produced.

Approach

Researchers obtained data from the 2013 New Zealand Census for 308 Area Units to develop indicators for the social, economic and cultural dimensions of resilience. Based on prior resilience framework research, 15 indicators were identified.

The indicators were analysed using statistical analysis for patterns that would suggest whether community resilience can be identified or determined based solely on official statistics. Statistical analysis included:

- Descriptive statistics
- Correlation analysis
- Principal Component Analysis.

Results

The analysis found high levels of correlation between most pairs of indicators, while there were some pairs with little correlation. The correlations suggested that there were consistent patterns that held across the resilience dimensions.

Principal Component Analysis produced a single component or trend that explained about one-half of the variation in the dataset. This finding suggested that Areas Units could be ordered from less resilient to more resilient. It also suggested that the ranking would miss some variations in the experience of people living in rural communities.

The report suggested that official statistics can provide a simple indication of resilience for rural communities in New Zealand, but this indication will not capture the full experience of these communities.

Key graphic or table

Table 8 Selected scores for CAUs based on the first principal component

CAU name	Score	CAU name	Score
Lowest scores – 1st to 10th			
Murupara	-0.586	Hokianga North	-0.325
Moerewa	-0.457	Levin South	-0.288
East Cape	-0.451	Kaitaia West	-0.286
Kaikohe	-0.417	Wairoa	-0.263
Cape Runaway	-0.382	Kawakawa	-0.263
Middle scores – 150th to 159th			
Nireaha-Tiraumea	0.280	Masterton West	0.284
Norsewood-Herbertville	0.280	Pohonui-Porewa	0.286
Oamaru South	0.281	Te Waewae	0.287
Geraldine	0.282	Papatawa	0.289
Richmond Heights	0.282	Rakaia	0.290
Highest scores – 299th to 308th			
Rapaura	0.564	Wanaka	0.627
Sunshine Bay	0.567	Kelvin Heights	0.705
Arrowtown	0.579	Wakatipu Basin	0.714
Queenstown Hill	0.605	Arthurs Point	0.859
Hawea	0.627	Lake Hayes South	0.951

Indicators in the Sustainability Dashboard: Use of indicators in the New Zealand Sustainability Dashboard (NZSD) research programme and lessons from the work

Output

Whitehead, J. & PwC. (2018). Indicators in the New Zealand Sustainability Dashboard: an overview of their structure and application. Lincoln: Our Land and Water.

Purpose

This report focuses on the use of sustainability indicators within the NZSD. It describes the structure of specific industry dashboards, giving particular attention to how each dashboard utilises sustainability indicators, and assesses the feasibility of incorporating new indicators into each dashboard.

The New Zealand Sustainability Dashboard (NZSD) began in 2012 as a research project funded by the Ministry of Business, Innovation and Employment (MBIE). 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.

Stakeholders

This project was secondary research and did not include stakeholders.

Approach

The approach was to summarise the different dashboards developed by NZSD and compare and contrast their development and indicators. The report assessed the indicators against the criteria for good indicators. Finally, the report also assessed the possibility of including additional indicators into the dashboards.

Results

The review of NZSD provided a few key lessons:

- There is scope for expanding the dashboards to include additional indicators, so the dashboard would be a feasible vehicle for communicating more information within the primary sector.
- The indicators in the dashboards were generally fit-for-purpose. There is some tension between the acceptability of indicators and their accuracy, because some indicators may be complex even though they are accurate.
- The NZSD programme was able to make progress on a collection of dashboards, each focused on a specific industry in the primary sector. There was less support for a single, cross-industry dashboard.

Key graphic or table

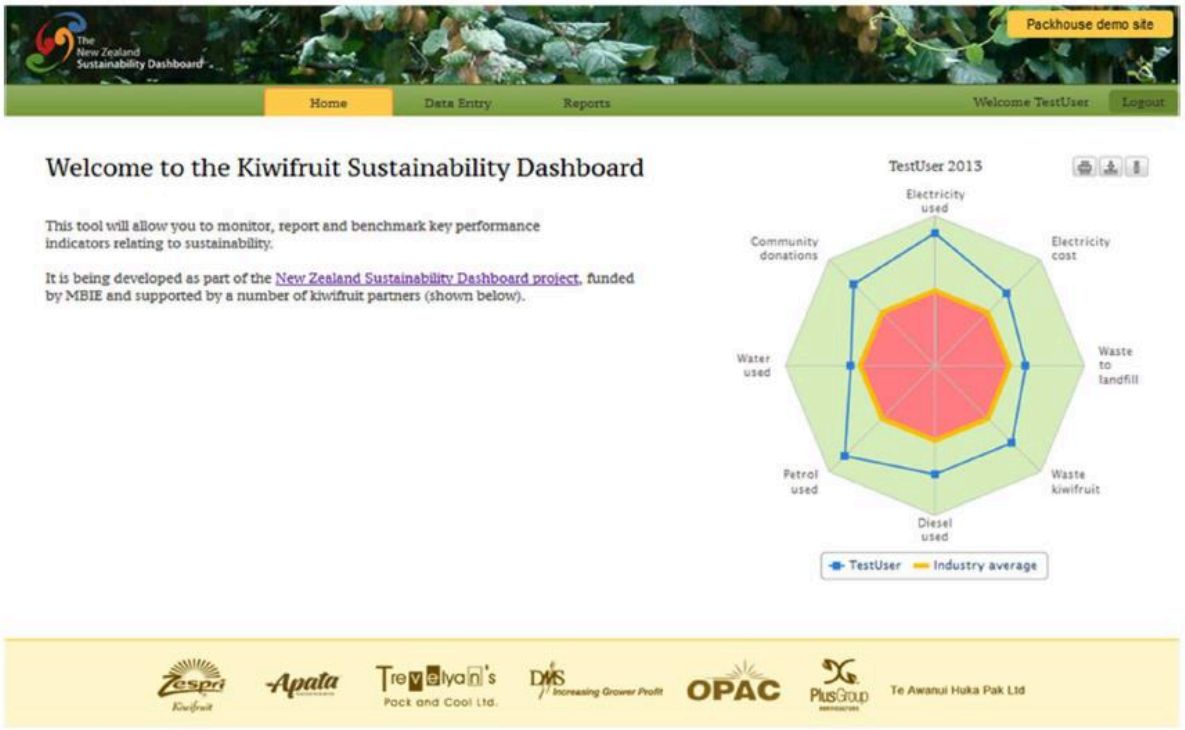

Figure 8 Indicator performance benchmarking using a spider chart

Next Generation Systems: An exploration of indicators needed to assess the performance of new models for the primary sector

Output	PwC. 2019. Indicators for the future: lessons from Next Generation Systems. Lincoln: Our Land and Water.
Purpose	The purpose of the project was to work with the OLW-funded Next Generation Systems (NGS) programme to investigate indicators for high-performing farms as determined by rural entrepreneurs. Identifying high-performing farms and investigating them is the work of NGS. The Indicator Working Group (IWG) was working with researchers in NGS to draw out what they have learned about indicators and put it in the context of the whole IWG programme of work.
Stakeholders	PwC worked with five lead researchers from the NGS programme.
Approach	A structured workshop with five lead researchers from NGS produced a long list of potential indicators that covered many aspects of primary production, including people, ecosystems, production, infrastructure and change over time, as well as links to surrounding communities and to value chains. They also prioritised indicators during the workshop, and indicators were subsequently further assessed against the IWG criteria for good indicators.
Results	The report provided a long list of potential indicators. A short list of prioritised indicators that are relevant for farming systems included: • Dollar-value indicators – Profits, EBIT, production per hectare and per unit of input, and variability / volatility of revenue of earnings • Connectivity indicators – Business connections and networks, local money flows, and indirect and induced impacts • Water quality indicators – Macroinvertebrate community structure, swimmability and contaminants.

Key graphic or table

Table 2 Selected indicators and their evaluation

Indicator	Is it valid?	Is it accessible?	Is it performance-based?	Is it easily communicated?	Is it well defined?	Is it widely accepted?
Dollars – Profit Dollars – EBIT Dollars – per ha Dollars – per unit Dollars – variability/volatility	Yes – partly valid, along with diversity and social impacts	Yes	Yes – but is only one aspect	Yes	Yes – it is the indicator of choice for some industries. Question of cash flow vs returns	Yes
Business connections Business networks Social Network Analysis Local money flows Indirect and induced impacts	Diversity of portfolio of business	Yes, or may be – but not necessarily publicly available	They could be performance-based, such as a requirement that 50% of connections are women	Yes	Not clear on what is good or bad	Not for some stakeholders
Water – macroinvertebrate community structure	Yes – with some discussion on swimmability	MICS is not often measured	All three measure outcomes, especially MICS	Yes	Yes	Gold standard
Water – swimmability		Maybe – by looking at notices	Human-centred	Yes	Rubbery	Yes-ish, but not enough
Water – contaminants		–	Not the whole story	Yes	Level are unclear	Widely

Appendix C: Restrictions

This report has been prepared solely for the purposes stated herein and should not be relied upon for any other purpose. We accept no liability to any party should it be used for any purpose other than that for which it was prepared.

To the fullest extent permitted by law, PwC accepts no duty of care to any third party in connection with the provision of this report and/or any related information or explanation (together, the “Information”). Accordingly, regardless of the form of action, whether in contract, tort (including without limitation, negligence) or otherwise, and to the extent permitted by applicable law, PwC accepts no liability of any kind to any third party and disclaims all responsibility for the consequences of any third party acting or refraining to act in reliance on the Information.

We have not independently verified the accuracy of information provided to us, and have not conducted any form of audit in respect of the organisation for which work is completed. Accordingly, we express no opinion on the reliability, accuracy, or completeness of the information provided to us and upon which we have relied.

The statements and opinions expressed herein have been made in good faith, and on the basis that all information relied upon is true and accurate in all material respects, and not misleading by reason of omission or otherwise.

The statements and opinions expressed in this report are based on information available as at the date of the report.

We reserve the right, but will be under no obligation, to review or amend our report, if any additional information, which was in existence on the date of this report was not brought to our attention, or subsequently comes to light.

This report is issued pursuant to the terms and conditions set out in our contract with the Our Land and Water National Science Challenge (via AgResearch) received 4 July 2017.

“Without data, you’re just another person with an opinion.”

W. Edwards Deming