Manaaki Whenua
Landcare Research

Perspectives on 'regenerative outcomes' and associated research needs: insights from consultation with participants in four sectors – arable, dairy, sheep & beef, and viticulture

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‘Think piece’ on Regenerative Agriculture in Aotearoa New Zealand: project overview and statement of purpose

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Find the full project overview, white paper and topic reports at

ourlandandwater.nz/regenag and www.landcareresearch.co.nz/publications/regenag

This report is one of a series of topic reports written as part of a ‘think piece’ project on Regenerative Agriculture (RA) in Aotearoa New Zealand (NZ). This think piece aims to provide a framework that can be used to develop a scientific evidence base and research questions specific to RA. It is the result of a large collaborative effort across the New Zealand agri-food system over the course of 6 months in 2020 that included representatives of the research community, farming industry bodies, farmers and RA practitioners, consultants, governmental organisations, and the social/environmental entrepreneurial sector.

The think piece outputs included this series of topic reports and a white paper providing a high-level summary of the context and main outcomes from each topic report. All topic reports have been peer-reviewed by at least one named topic expert and the relevant research portfolio leader within MWLR.

Foreword from the project leads

Regenerative Agriculture (RA) is emerging as a grassroot-led movement that extends far beyond the farmgate. Underpinning the movement is a vision of agriculture that regenerates the natural world while producing ‘nutrient-dense’ food and providing farmers with good livelihoods. There are a growing number of farmers, NGOs, governmental institutions, and big corporations backing RA as a solution to many of the systemic challenges faced by humanity, including climate change, food system disfunction, biodiversity loss and human health (to name a few). It has now become a movement. Momentum is building at all levels of the food supply and value chain. Now is an exciting time for scientists and practitioners to work together towards a better understanding of RA, and what benefits may or not arise from the adoption of RA in NZ.

RA’s definitions are fluid and numerous – and vary depending on places and cultures. The lack of a crystal-clear definition makes it a challenging study subject. RA is not a ‘thing’ that can be put in a clearly defined experimental box nor be dissected methodically. In a way, RA calls for a more prominent acknowledgement of the diversity and creativity that is characteristic of farming – a call for reclaiming farming not only as a skilled profession but

also as an art, constantly evolving and adapting, based on a multitude of theoretical and practical expertise.

RA research can similarly enact itself as a braided river of interlinked disciplines and knowledge types, spanning all aspects of health (planet, people, and economy) – where curiosity and open-mindedness prevail. The intent for this think piece was to explore and demonstrate what this braided river could look like in the context of a short-term (6 month) research project. It is with this intent that Sam Lang and Gwen Grelet have initially approached the many collaborators that contributed to this series of topic reports – for all bring their unique knowledge, expertise, values and worldviews or perspectives on the topic of RA.

How was the work stream of this think piece organised?

The project's structure was jointly designed by a project steering committee comprised of the two project leads (Dr Gwen Grelet[1] and Sam Lang[2]); a representative of the New Zealand Ministry for Primary Industries (Sustainable Food and Fibre Futures lead Jeremy Pos); OLW's Director (Dr Ken Taylor and then Dr Jenny Webster-Brown), chief scientist (Professor Rich McDowell), and Kaihāpai Māori (Naomi Aporo); NEXT's environmental director (Jan Hania); and MWLR's General Manager Science and knowledge translation (Graham Sevicke-Jones). OLW's science theme leader for the programme 'Incentives for change' (Dr Bill Kaye-Blake) oversaw the project from start to completion.

The work stream was modular and essentially inspired by theories underpinning agent-based modelling (Gilbert 2008) that have been developed to study coupled human and nature systems, by which the actions and interactions of multiple actors within a complex system are implicitly recognised as being autonomous, and characterised by unique traits (e.g. methodological approaches, world views, values, goals, etc.) while interacting with each other through prescribed rules (An 2012).

Multiple working groups were formed, each deliberately including a single type of actor (e.g. researchers and technical experts only or regenerative practitioners only) or as wide a variety of actors as possible (e.g. representatives of multiple professions within an agricultural sector). The groups were tasked with making specific contributions to the think piece. While the tasks performed by each group were prescribed by the project lead researchers, each group had a high level of autonomy in the manner it chose to assemble, operate, and deliver its contribution to the think piece. Typically, the groups deployed methods such as literature and website reviews, online focus groups, online workshops, thematic analyses, and iterative feedback between groups as time permitted (given the short duration of the project).

[1] Senior scientist at MWLR, with a background in soil ecology and plant ecophysiology - appointed as an un-paid member of Quorum Sense board of governors and part-time seconded to Toha Foundry while the think piece was being completed

[2] Sheep & beef farmer, independent social researcher, and project extension manager for Quorum Sense

Perspectives on 'regenerative outcomes' and associated research needs: insights from consultation with participants in four sectors – arable, dairy, sheep & beef, and viticulture

Contract Report: LC3954-5

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1 Introduction: study aims

This research conducted a series of sector-specific online working groups, complemented by survey questionnaires. Through these mixed quantitative and qualitative data collection processes, researchers elicited from participants:

- their views on what makes a farming system 'regenerative' (i.e. what outcomes does it achieve?)
- the relative importance of these different outcomes
- indicators that can be used to measure progress towards these outcomes
- what is currently working well and not well in New Zealand (NZ), and a comparison with international experiences
- where to focus future research.

This report presents these data.

Fifteen themes were identified from the data on what makes a system regenerative, covering not only on-farm activities and their impacts, but also the mindset of the farmers and the relationship between the farm, the landscape, and local communities. Participants from each sector then rated the relative importance of various dimensions of regenerative outcomes. We found that, across all sectors, pride in farming, making decisions based on long-term outcomes, increasing profitability and financial expertise, continuous improvement, and positioning NZ as a world leader in regenerative agriculture (RA) were collectively the highest rated of the outcomes.

Participants were then asked to identify whether, and if so how, they monitor key outcomes on their farm or in their business. This yielded a diverse set of potential indicators relevant to RA, ranging from the more conventional (such as water chemical testing) to monitoring happy lines in dairy cows.

Participants from all sectors were then asked what works well, what doesn't work well, and how NZ systems compare with overseas. Common to participants from all sectors on what is working well is a sense of NZ having a good reputation internationally, and that there is a market for produce from NZ. Participants across all sectors indicated that attention to the environment and, where relevant, to animal welfare, was positive, and highlighted the strong culture of continuous improvement, innovation, and collaboration.

In terms of what is not working well, common to participants from all sectors are concerns about water quality, and the intensive farming systems that focus on growth in production and not adding value to products. In a comparison with overseas, many of the participants considered that NZ systems perform at least as well as their overseas counterparts.

2 Methods

2.1 Data collection

Data was collected through mixed quantitative-qualitative online workshops. All workshops were conducted online using the Zoom video conferencing software (Archibald et al. 2019). The approach used in the workshop combines quantitative questionnaires with qualitative open-ended questionnaires and focus groups (Ward et al. 1991). There are many examples of these two methods working in a complimentary fashion, such as in studies of social marketing (Folch-Lyon and Trost 1981) and health research (Ashton et al. 2017) as well as in the adoption of precision farming techniques (Pedersen et al, 2004).

The decision to conduct the workshops online between June and August 2020 was influenced by the ongoing COVID-19 pandemic, which required NZ to enter a national quarantine lockdown between March and May of 2020, and again between August and September 2020 in the Auckland region. With ongoing restrictions on travel, the decision was made to conduct workshops online rather than in-person. Similar shifts of workshops from in-person to online during the pandemic have been reported by other researchers (Milovanović et al 2020; Hermans et al. 2021) and are currently implemented even in high profile initiatives (e.g. Global UN Food Systems Summit national dialogues).

Beyond the constraints posed by the pandemic, there are some benefits to conducting data collection online. One benefit is that it does not require participants to travel to and from a specific location to attend the workshops (Farnsworth and Boon 2010; Deakin and Wakefield 2014). This permitted the workshop organisers to connect farmers from different parts of the country together at the same time. Because farmer participants often live in remote rural areas, hosting workshops online also meant participants could attend from home, reducing the time they had to devote to the project.

We chose to use Zoom due to the specific advantages it holds over other online video conferencing platforms. One advantage is the ability to record and store workshops recordings without the need to use third-party software, something that is particularly important if you are collecting data on sensitive topics (Archibald et al. 2019) The real-time encryption of meetings, and the ability to back up recordings to the Cloud, are other advantages with using Zoom (Archibald et al. 2019).

Workshops are typically held either to generate new ideas, concepts, or to evaluate specific aspects of interest (Thoring et al. 2020). However, this project sought to generate both new knowledge on what participants think 'regenerative' outcomes means within a farming context, and then to subsequently devise indicators that can be used to measure progress towards these outcomes. The workshops were conducted as follows. We invited participants from four different primary sectors to a sequence of three online workshops. The sectors were arable farming (17 participants), dairy (15), sheep and beef (20), and viticulture (9). Participants were selected to represent a diversity of different occupations within their sector, such as growers, farmers, retailers, consultants, scientists, banking representatives, and local government staff. In the sheep and beef and dairy workshops, a veterinary expert was also invited to participate. Each workshop had a mix of farmers who self-identified as RA practitioners and others who did not identify as RA practitioners. All farmers and non-

salaried participants were compensated for their time and participation in the research via gift vouchers.

The three workshops were held in sequence. In the first workshop, researchers collected data about what participants thought made a farm system regenerative. To achieve this, researchers deployed two methods: (i) asking participants to fill in an open-ended online survey questionnaire (see Appendix 1) that were completed individually and, (ii) a short moderated discussion in break out rooms where participants discussed the rationale for their survey answers. The moderator's role was to ensure the participants discussed the environmental, economic, and social aspects of regenerative outcomes. Using this data, researchers noted the top 12 most commonly cited aspects of what 'regenerative' means.

In the second session, the participants were asked to examine those 12 aspects in more depth through a second open-ended questionnaire (see Appendix 2). Once again, this was followed by moderated discussion in break out rooms to explore these aspects in more depth.

In the third session, participants were invited to complete several additional questionnaires. The surveys were made available to participants outside the third time session, but scheduling dedicated time to completing the questionnaire was an efficient way to ensure most participants responded. See Table 1 below for a summary of the survey topics. Two types of survey were used in this final session: qualitative, open-ended questionnaires; and quantitative, Likert scale questionnaires.

Quantitative Likert scale questionnaires were used to collect quantitative data about participants' opinions on the relative importance of different topics. The Likert scale (Likert 1932) consists of a discrete number of choices per question among a sequence of bipolar adjectives, such as 'strongly disagree', 'disagree', 'no opinion', 'agree', and 'strongly agree'. The Likert scale can also use other bipolar sequences, ranging from 'not important' to 'extremely important'. The choices are presented to the respondents as an ordered list of mutually exclusive terms. Likert scales can have an odd number of levels to permit a neutral choice, or an uneven number of levels to force the respondent to make a directional choice (Heiberger and Robbins 2014). In this study, all but one quantitative survey included a Likert scale with an even number of levels, and deliberately did not permit a neutral choice. One survey allowed a neutral choice.

To understand what outcomes are most important for participants in each sector, we deployed five different Likert scale questionnaires (appendix 3). These questionnaires addressed the following topics: soil, business success, social well-being, mindset, and marketability of farm produce. Participants took a break between each survey to avoid bias introduced by question fatigue. Four surveys asked participants to choose an 'importance level' for each aspect of RA, and in one survey participants were asked to declare how truthful statements were.

Table 1. Summary of information on surveys used with sector working group participants

Aim of survey	*Survey type*	*When*	
To elicit participant views on what constitutes 'regenerative' outcomes for farming	2 qualitative, open-ended surveys	First and second online sessions	Appendix 1, 2
To elicit participant views on the relative importance of regenerative farming outcomes: soil, business success, social well-being, mindset, and marketability of farm produce	5 Likert scale quantitative surveys	Third online sessions	Appendix 3
To elicit participant experience on which on-farm/business outcomes are routinely measured and how?	1 qualitative, open-ended survey	Third online sessions	Appendix 4
To elicit participant views on what works well and not well in NZ within their agricultural sector, and how this compares with overseas	1 qualitative, open-ended survey	Third online sessions	Appendix 5
To elicit participant views on the relative importance of research topics in RA	1 Likert scale quantitative survey	Third online sessions	Appendix 6

2.2 Data analysis of qualitative, open-ended survey questions and verbal discussions

The researchers conducted a thematic analysis when coding the qualitative data (Braun and Clarke 2006). According to Braun and Clarke (2006), 'a theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set'. Thematic analysis is the process by which themes in qualitative data are identified. Because a theme represents a patterned response, it ought to be identified in more than one online session. However, because the analysis is qualitative, there is no prescribed percentage or amount of times a theme must be present for it to be coded as a theme. The theme aims to capture something important or interesting with respect to the topic(s) being researched.

In brief, researchers coded the data from the first round of online sessions into specific themes based on the question 'What makes farming regenerative?'. These themes were informed either by the research question or themes that emerged from the responses themselves (Braun and Clarke 2006; Fereday and Muir-Cochrane 2006). This mixed inductive–deductive coding approach permits the researchers to identify themes that they anticipated given the questions that were asked or themes that were not anticipated and were recognised solely from the data collected. Initially this coding was done by several different analysts for different sectors, who also developed individual topics or sub-themes for the sector data. Due to differences in the codes and topics, all data were recoded to a single set of broad themes by a single analyst. All the remaining qualitative data collected in the second and third online sessions were coded to these themes.

2.3 Data analysis of quantitative Likert scale survey questions

In the first four Likert surveys, participants were asked to indicate how they rated the importance of topics within particular outcomes: financial success of the farming business, access to market, soil health, social well-being, and mindset. In the fifth Likert survey, participants were asked to rate the veracity of statements pertaining to the marketability of NZ food and fibre produce. The choice of question asked within each Likert survey was determined based on the results of the preliminary analysis of the data collected during the first and second online session. In the last Likert survey, participants were asked to indicate how important they believed different research topics related to RA were for their sector; again, these research topics were derived for each sector by what was covered in their discussions in the first and second online sessions.

For the surveys asking participants to provide importance ratings, participants could choose between: 1 (not so important), 2 (quite important), 3 (very important), and 4 (extremely important). For the survey asking participants to provide veracity ratings, the choices were: 1 (not true), 2 (unsure), 3 (possibly), and 4 (yep, I agree).

Data were assessed (in 'Likert' and 'GGplot2' in the statistics package R-3.6.1) using the following:

1 Diverging stacked bar charts (Heiberger and Robbins 2014): data were plotted to contrast the proportion of responses of value 4 (extremely important) against all other responses (i.e. values 1, 2 and 3). This was to emphasise topics or outcomes that were considered most important to participants.

2 Heat maps: these maps showed the relative distribution of responses between the four possible choices based on a clustered heat map for each survey (Wilkinson and Friendly 2009). Rows were ordered based on similarities between questions.

3 Wind rose (Curtis 2007): wind roses are a graphical way of displaying both wind direction and wind speed. Here we used a similar concept, whereby we substituted 'topic' for 'direction' and 'relative proportion of responses given to each choice/value (e.g. 1, 2, 3, and 4)' for 'speed'. In doing so, the length of the bar emerging from the outer spoke around the circle was related to the relative proportion of respondents choosing the answer 4 (extremely important). The wind rose diagram was used to summarise all answers from all participants across all four sectors to all questions relating to the main themes identified in our thematic analysis.

To identify the priorities for future research, we selected the top nine priority research topics for each sector based on the relative proportion of participants marking them as 'extremely important'. For each sector, we then assigned a score to each topic: from 9 (top priority) to 1 (bottom priority). We then merged the four lists from the four sectors, making a total of 15 research topics. We then calculated the average priority score for each topic by summing all scores obtained individually for each sector and dividing this sum by the number of sectors that included it in its priority list. We then applied a weighting to the average score of each topic by increasing it by 20%, 15%, 10% or 5% depending on whether it was included in the list of 4, 3 ,2 or 1 sector working group, respectively. This weighting was to account for whether or not there was consensus across all sectors for each priority topic.

3 Results

3.1 What makes a system regenerative?

Participants were asked several open questions (Appendix 1) to elicit their views on what makes a system regenerative and what outcomes a system needs to achieve to be regenerative. Fifteen themes were identified from these questions (Table 2.). Figure 1. shows the proportion of times each theme was mentioned in the small focus group discussions or open-ended surveys during the first online sessions of each sector working group

It should be noted that a theme may have been given a high ranking if it was controversial or if it represented consensus, and so Figure 1. gives a sense of what people talked about most frequently. The contribution of RA to social well-being was the theme most mentioned by participants across the entire dataset (i.e. by all sector working groups), with soils the second most discussed theme. The latter reinforces the strong focus RA has on soil health (Schreefel et al. 2020). There was also a strong emphasis on access to market for the sheep & beef and arable sector participants, and on production, profitability & productivity for the viticulture sector participants.

Table 2. Themes identified from sector working groups on what makes a system regenerative

Social well-being	Long-term & te ao Māori culture/values
Soils	Air and climate change solutions
Integrated, circular systems	RA definition and evidence
Access to markets	Food quality and safety
Productivity and profitability	Animal welfare
Mindset	Resilience
Biodiversity	Farm integration in landscape
Waters	

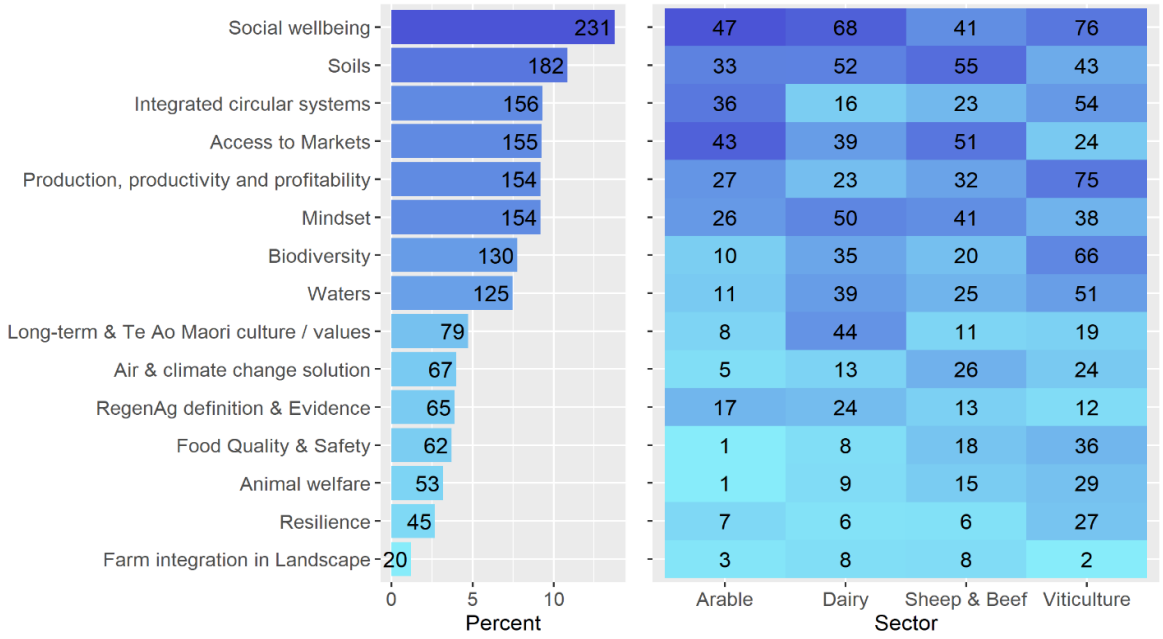

Figure 1. The number of times each theme was discussed by participants (*n* = 1,671). The bar chart (left) indicates the number of times that participants' conversation focused on each theme. The heat map (right) provides the number of times a theme was mentioned by sector. The shade of blue is directly proportional to data distribution among the 15 themes, either across the four sectors (bar chart) or within each sector (heat map).

Table 3. Identified themes and some explanations noted by participants for each theme

Theme	*Examples of participant descriptions of regenerative outcomes*
Social well-being	Good physical and mental health of farmers and employees. Enjoyment and fulfilment from work. Healthy food. Thriving rural communities and jobs. Urban and rural communities engaged with farming. Consumers connected to food.
Soils	Improved soil physical health (e.g. improved structure, organic matter levels, water holding capacity rooting depth, and decreased compaction and soil disturbance and erosion). Improved soil chemical health, increased soil carbon, total nitrogen, and increased nutrient cycling. Improved biological health (e.g. increased biological activity, more worms, more fungi). Increased soil resilience to floods and drought, relationship of soil health with biodiversity, plant function and animal function.
Integrated, circular systems	Farms managed as a system, recognising interconnections between on-farm practices and ecosystem health, and dependencies between environmental, animal, social, cultural, and economic dimensions. Tight nutrient cycles resulting in fewer nutrient inputs and losses and reducing imported and non-renewable inputs. The stocking intensity of the farm is no more than can be supported from the surrounding area all year around. Organic matter recycling (e.g. through composting and farm wastes reconceived as resources, e.g. for organic matter, nutrients, energy). Mixed systems, such as animals integrated into crop or vineyard.
Access to markets	Greater emphasis on local: local customers, profits kept local, supporting local communities and businesses. NZ RA has a strong brand, a compelling and evidenced story and NZers are proud of the way the food and fibre are produced. Regenerative produce should command a premium. Payments received for other values/services produced on farm, such as ecosystems services and carbon sequestration. High trust relationship with financial sector and financial sector valuing multiple values, not just economic. Some participants highlighted a tension between producing a premium product and the ethos of healthy food being available to all. Other participants questioned whether regenerative principles should underpin all of NZ agriculture, or just certified 'regenerative' farms.
Productivity & profitability	Whole-of-system productivity measures used. Less impact for unit of yield. Profitable while internalising externalities and paying living wage and maintaining good conditions for employees. Businesses are not just for profit, and profitability is balanced with quality of life. Profits shared at all stages of the value chain. Businesses moving away from commodity markets. Multiple sources of income. Financial freedom to experiment.
Mindset	Work with nature for holistic outcomes, not trying to control nature and not just for production. Proud and happy to be a regenerative farmer. Curious, open-minded, experimental with a drive towards continual improvement underpinned by learning and adaptation. Confident to take responsibility for the farm's impacts, to make decisions for now and the future, and with a sense of empowerment. Collaborative with peers and connected to community. Observed desired shift in mindset towards RA, where farming expertise is valued, and there is a high trust relationship between farmers and regulators that also allows for experimentation.
Biodiversity	All parts of the farming environment are biodiverse (e.g. microbial, insects, plants, birds, genetics, and in soils). Taonga species and native biodiversity are protected. There is structural and functional biodiversity. Regenerative farmers consider biodiversity beyond the farm boundaries and support biodiversity at landscape and ecosystem scales. Diversity considered more generally, such as moving from monocultures to polycultures and strategic use of trees in the landscape.

Theme	*Examples of participant descriptions of regenerative outcomes*
Waters	Reduced contaminant loss from farm. Planting critical source areas and gullies. Improved water quality and ecological health in waterways. Stock out of waterways and improved wintering of stock. More efficient use of water on farm.
Long-term & te ao Māori culture/values	Long-term outcomes inform planning and goal setting. Future needs recognised and accounted for. Next generations have a connection with the land. Next generations want to farm and can farm profitably. Farming for environmental outcomes. Stewardship demonstrated to the public. Improved mauri of the land and water. Respect for cultural values and those values protected. Taonga acknowledged and protected.
Air and climate change solutions	Improved air quality. Reduced greenhouse gas emissions. Reduced methane emissions through grazing practices and reduced animal nitrogen intake. Sequestration and deep storage of carbon in soils. Measuring and monitoring in place.
RA definition and Evidence	Regenerative farming claims need to be verified and practices audited. Outcome measures as opposed to input measures suggested as a way to build evidence but allowing flexibility in practice. Ongoing monitoring and evaluation processes in place. Differing views on how to define RA, from black-and-white definition that is easy to certify and provide the evidence needed to secure a premium, through to the continuous improvement nature of RA, which means that the definition should be more about the journey, or the trend. How do we know at what point on the journey we become regenerative? Outcome measures as opposed to input measures were suggested as a way to build evidence, while allowing flexibility in practice. Some arable farmers noted that going fully regenerative is more difficult for arable systems, and that pastoral systems may have more to gain from regenerative practices.
Food quality & safety	High-quality, verifiably nutrient-dense foods. Reduced or no chemical usage, leading to verifiably residue-free foods. Although participants from all sectors thought reduced chemical usage was an important outcome of regenerative farming, some in the arable and viticulture sectors indicated the challenges of managing resistance and producing clean seed lines without agrochemicals and suggested that the emphasis should be on different inputs, not no inputs, such as exploration of alternatives to chemical biocides.
Animal welfare	Year-round high standards of animal health and welfare, including good nutrition, good husbandry, good disease surveillance, resulting in reduced disease and mortality rates. “Not pushing animals so hard”. Diverse swards used provide the opportunity for stock to “self-medicate”. Decreased need for chemical and therapeutic treatments as health and welfare increase.
Resilience	Ecological and economic resilience. Ability to deal with change, especially systems and crops that can cope with extreme weather. Resilience is considered not only at an individual farm level but at multiple farm levels.
Farm integration in landscape	Farming in the context of the landscape, such as planting out critical source areas and fragile land, maintaining ecological corridors or regenerating natural landscape functions. Integrated catchment management with others farms and catchment communities. Collective management of landscape-scale concerns such as cross-contamination of clean seed lines from biodiverse cover crop mixes.

3.2 Relative importance of regenerative outcomes and veracity of market-related statements

The themes describing the outcomes of RA identified are quite broad in what they cover (Table 4). The next part of the research tried to ascertain the relative importance of different topics in those broad outcomes. For each outcome area, questions were tailored to each sector based on data collected in the first online session. Participants were asked to indicate how highly they rated the importance of different topics related to the financial success of the farming business, soil health, social well-being and mindset. The relative distribution of responses from 1 (not so important) to 4 (extremely important) (see Figure 2., Figure 4., Figure 5., Figure 6.). Participants were also asked to rate the veracity of statements in relation to the marketability of NZ food and fibre products produced. The relative distribution of their answers from 1 (not true) to 4 (yep, I agree) is shown in Figure 3..

The results are shown as heat maps, with each sector × question × answer represented by a square. The colour shade of the squares indicates the relative proportion of participants choosing a particular answer for a particular question, by sector. The total number of participants in each sector is not corrected for, so these data have been used to show where there is a strong consensus within and across sectors.

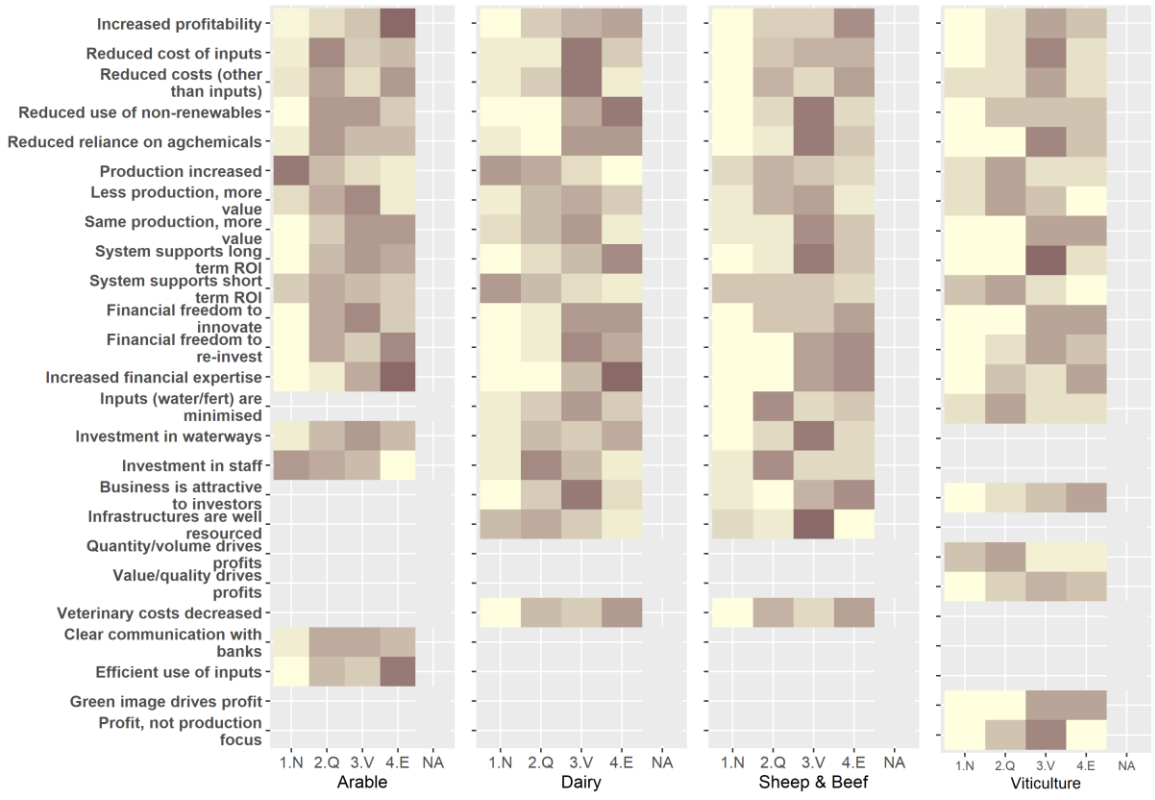

Figure 2. Importance ratings by participants from each sector to 25 different topics pertaining to the financial success of the farming business. The relative distribution of participant ratings is indicated by the colour intensity, from 1 (not so important/yellow) to 4 (extremely important/dark brown). Some topics were not relevant for some sectors and the squares were left blank (i.e. grey). ROI – Return on investment.

Increased profitability was noted as extremely important for many participants. However, the pathway to increased profitability was via maintaining the production of produce with higher value rather than via increasing production. Participants also saw an increase in their own financial expertise as extremely important. While the reduced reliance on agrichemicals and non-renewable resources was seen as extremely important for most sectors, this wasn't driven solely by the desire to decrease input costs (agrichemicals or other costs). Participants valued the financial freedom to innovate and to re-invest in RA, as well as their systems being able to provide a good return in investment over the long term.

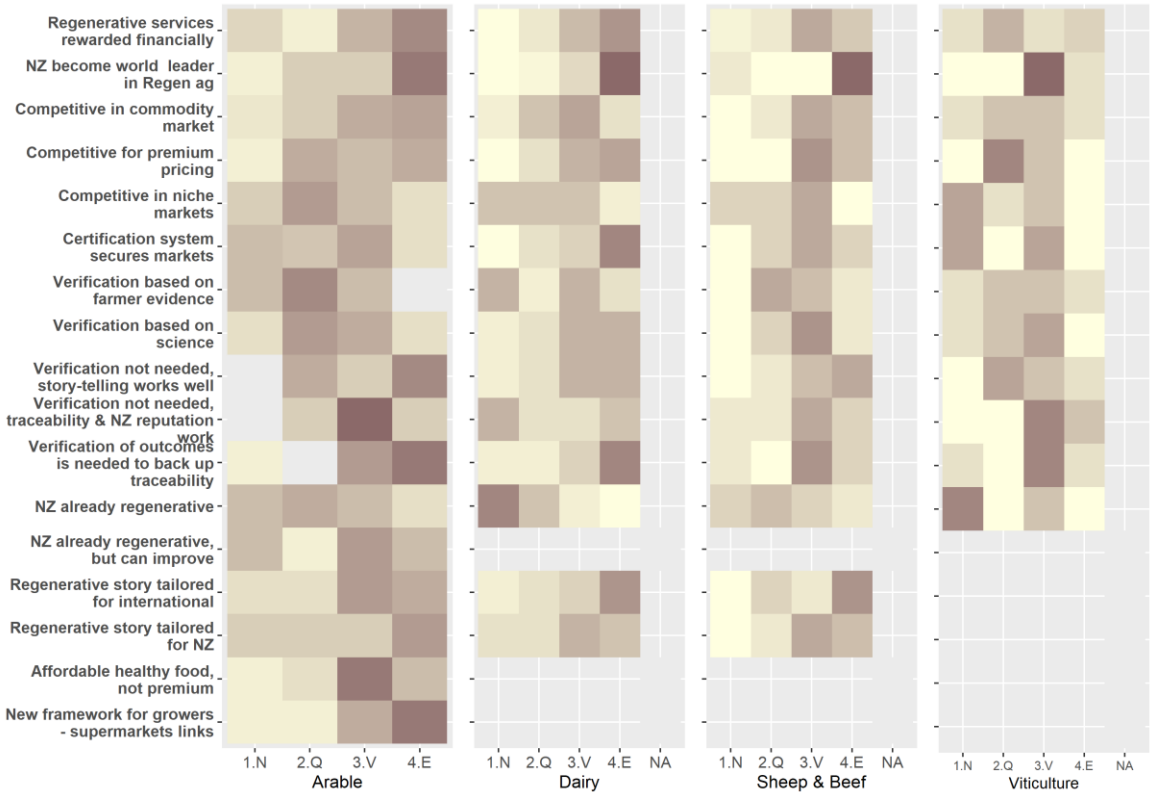

Figure 3. Veracity ratings given by participants from each sector to 17 different topics pertaining to markets. The relative distribution of participant ratings is indicated by the colour intensity, from 1 (not true/yellow) to 4 (yep, I agree/dark brown). Some topics were not relevant for some sectors and the squares were left blank (i.e. grey).

There is considerable debate currently on what constitutes RA. Our study was not designed to capture the views of participants on what RA is. Rather, we intended to capture their views on what regenerative outcomes might look like to them. With this in mind, the questions asked in this survey (Figure 3.) were designed to capture the participants' perspectives on the potential for NZ to market its produce on a market interested in regenerative produce. Participants across sectors thought that NZ could become a world leader in RA (Figure 3.). However, there was no clear consensus on whether participants thought this might be achieved by being more competitive in commodity markets, or by premium or niche markets specifically interested in produce from RA. Very few participants in any sector believed NZ agriculture was already regenerative; most participants responded 'neutral' or declared this statement to be false.

There are discussions emerging in the RA sector about a new approach to certification and verification, one that moves away from a set of standards and certifying body to one that is based much more on a transparent relationship between producers and consumers, including greater traceability (Baer and Penelope 2020). These discussions set some of the context for the choice of questions asked in this survey (Figure 3.), and the responses to the questions about certification and verification for RA.

There was little consensus across participants from the sectors that a certification system secures market access. Only participants in the dairy sector agreed for the majority that a certification system secures niche market. There was some agreement across participants from three of the sectors that verification (of on-farm 'regenerative outcomes') was not necessary, and that a system of consumer assurance could be based on traceability (and transparency). Participants across the sectors thought that verification of the outcomes of regenerative farming was an important part of creating transparency between the producers and consumers. Interestingly, across all sectors, participants did not all agree on whether verification of regenerative outcomes should be done by scientists or by farmers themselves, nor that story-telling could substitute for verification.

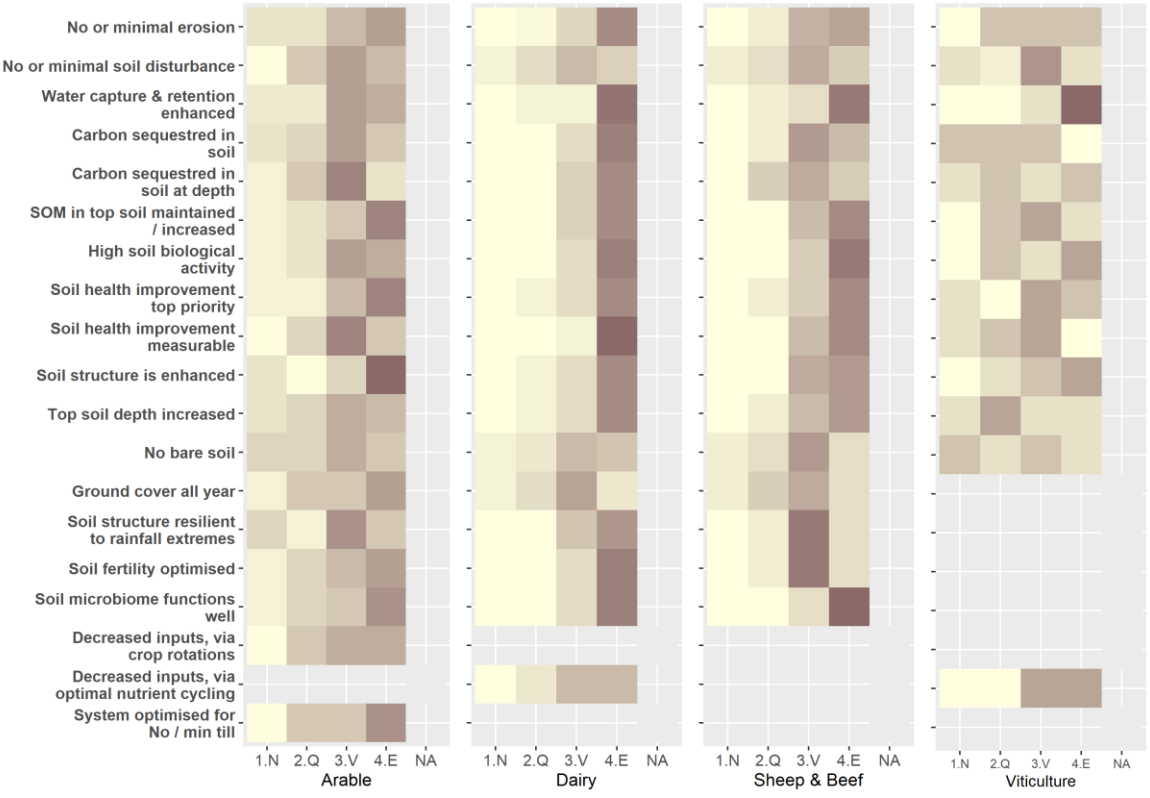

Figure 4. Importance ratings by participants from each sector to 25 different topics pertaining to the soil health. The relative distribution of participant ratings is indicated by the colour intensity, from 1 (not so important/yellow) to 4 (extremely important/dark brown). Some topics were not relevant for some sectors and the squares were left blank (i.e. grey).

Minimising or eliminating erosion and increasing soil structure was considered extremely important by participants across all four sectors (Figure 4.). However, there was no clear

consensus, in terms of importance, on the three pathways included in the survey – leaving no soil bare, having ground cover all year round, or eliminating or reducing disturbance – to achieve these outcomes. Soil biological activity and good functioning of the soil microbiome were generally rated as extremely important.

In terms of soil carbon sequestration, only dairy sector participants rated it as extremely important. Viticulture participants differed from those in other sectors in they did not rate soil organic carbon as extremely important, either increased soil depth or more soil organic matter in the top soil. This is expected due to the relationship between soil organic matter and water-holding capacity, and the known impacts of water-holding capacity on wine quality (Fayolle et al. 2019).

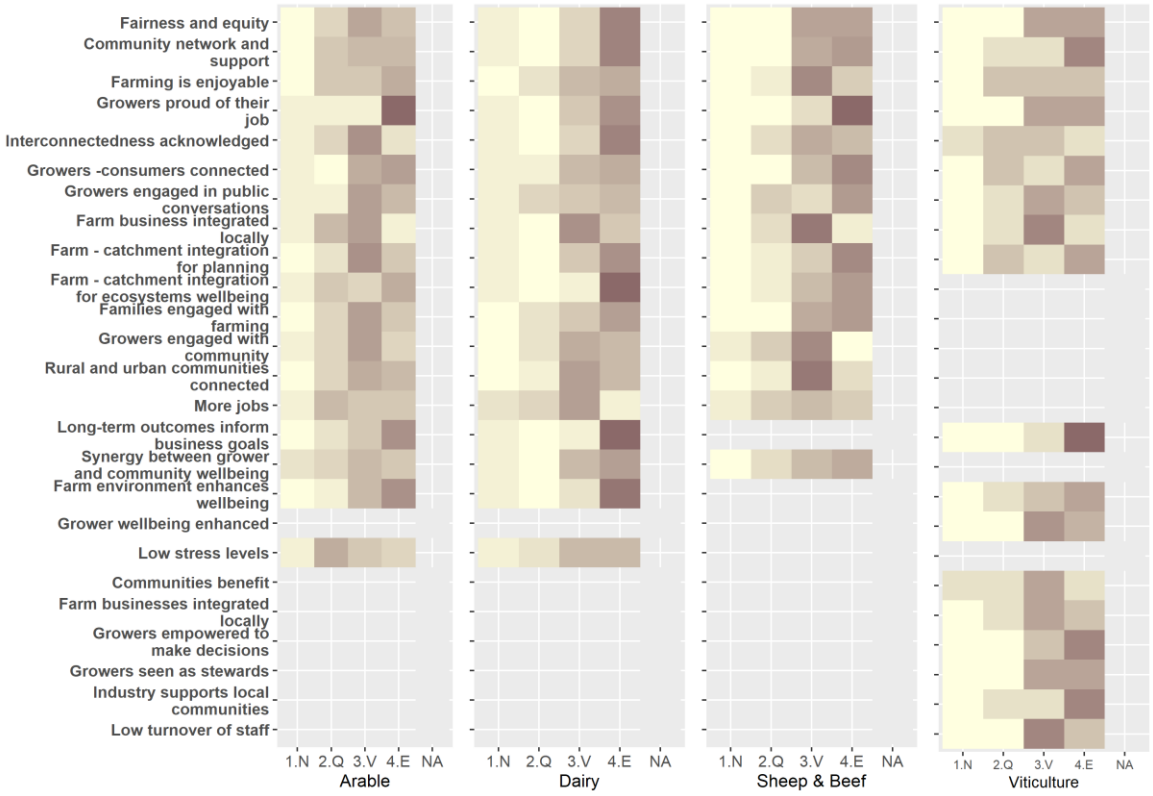

Figure 5. Importance ratings by participants from each sector to 25 different topics pertaining to the social well-being**. The relative distribution of participant ratings is indicated by the colour intensity, from 1 (not so important/yellow) to 4 (extremely important/dark brown). Some topics were not relevant for some sectors and the squares were left blank (i.e. grey).**

Participants across all sectors noted the importance of farmers and growers feeling proud of their jobs (Figure 5.). A valued outcome by participants from all sectors was the connection between farmers and their local community, whether it be farm businesses being integrated locally, or farmers engaged with and supporting local communities. The connection of the farm to their wider catchment was also considered important for achieving ecosystem well-being.

Long-term outcomes informing business goals and a farm environment that enhances well-being were considered important outcomes by participants from the arable, dairy and viticulture sectors.

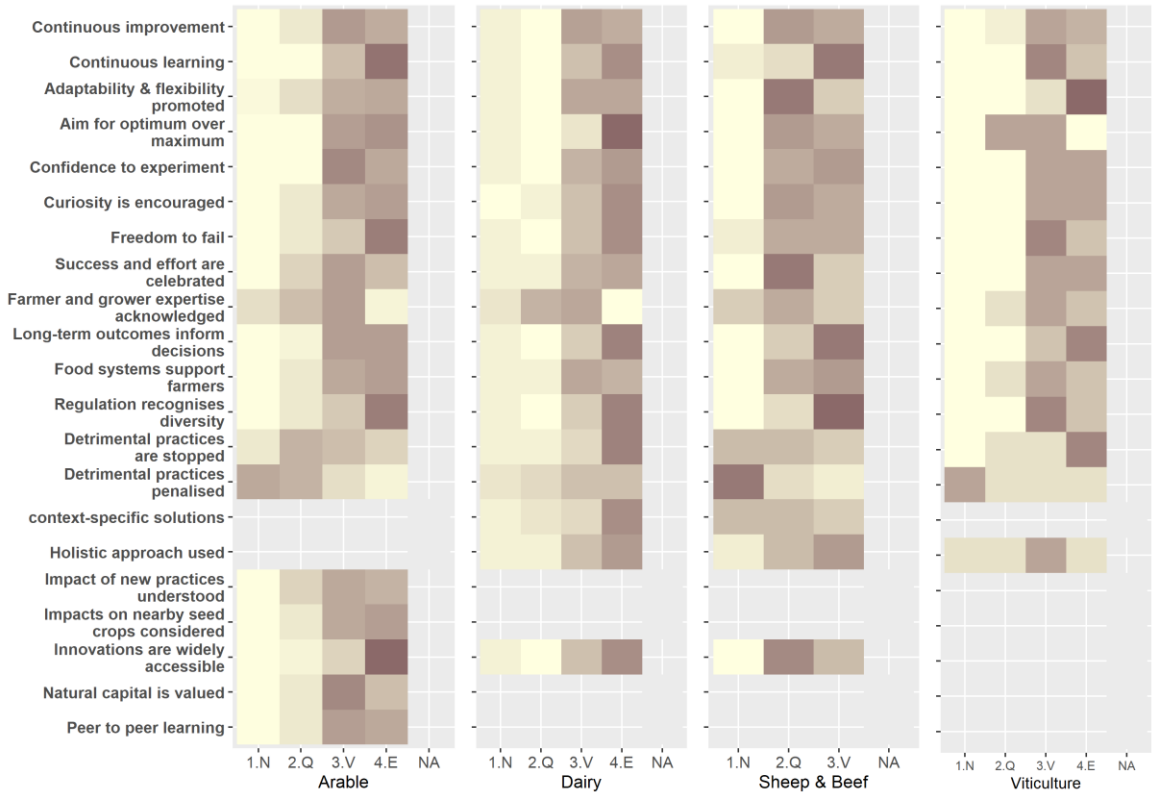

Figure 6. Importance ratings by participants from each sector to 25 different topics pertaining to mindset**. The relative distribution of participant ratings is indicated by the colour intensity, from 1 (not so important/yellow) to 4 (extremely important/dark brown). Some topics were not relevant for some sectors and the squares were left blank (i.e. grey).**

The culture of experimentation, along with curiosity, freedom to fail, adaptability and flexibility, was considered an important outcome by participants across sectors (Figure 6.), underpinned by a commitment to continuous learning. This culture suggests a journey-like characteristic of RA, and one where effort as well as successes are celebrated.

While most participants believed that stopping management practices that are detrimental (e.g. the environment) is important, they also considered that the mechanism to do that should not be by penalising these practitioners, and that if regulation was used then the diversity of farming operations should be recognised.

Of the three sectors asked, arable, beef & sheep, and dairy, the accessibility of innovations was considered an important outcome for participants. Also considered important by most participants (particularly those from the dairy sector) was achieving optimal rather than maximal production.

Figure 7. brings together the main topics that displayed a clear pattern in Figure 2. to Figure 6., through either a clear consensus among all participants of all sectors (n = 61), or,

on the contrary, a lack of consensus. Pride in farming, making decisions based on longer-term outcomes, increasing profitability and financial expertise, continuous learning, and positioning NZ as a world leader in RA were topics considered extremely important by participants. Given participants did not consider NZ to already be regenerative, their aspiration for NZ to become a world leader in RA implies a willingness to create the type of rapid and meaningful change that would be needed to achieve this leadership. Figure 7. also indicates that participants have a high demand for outcome verification to support traceability requirements (see explanation above for 'traceability' as a means to connect producers to consumers).

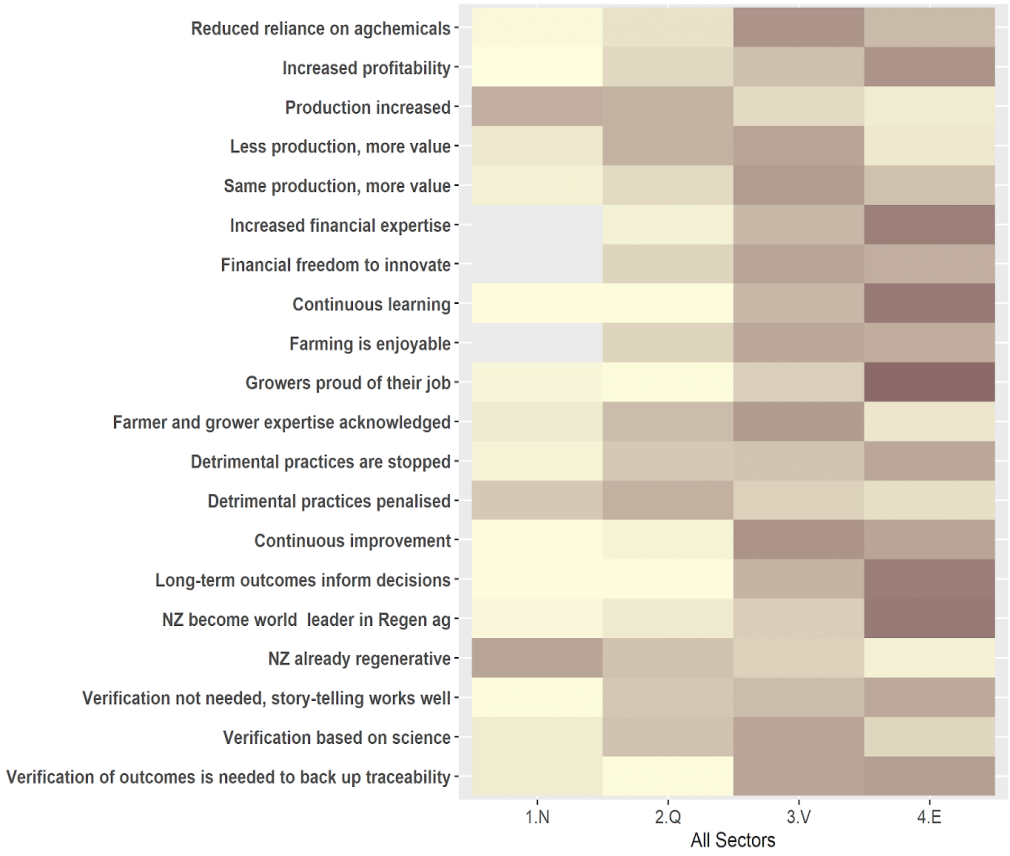

Figure 7. Importance/veracity ratings by participants across all four sectors, given to 20 key topics pertaining to financial success, soil health, social well-being, mindset and markets. The relative distribution of participants' answers was between choice 1 (not so important / not true /yellow), and 4 (extremely important / yep, I agree / dark brown). Some topics had no responses and were left blank (i.e. grey).

4 Indicators

So far we have captured what aspects of regenerative farm systems are important for participants from each sector. To enable further research in RA that will have relevance to people across those four sectors, we asked participants whether they routinely measured any of the outcomes outlined in Figure 2. through Figure 6., and if so, how they measured them. We particularly sought to capture participants' insights about observational indicators not typically captured by biophysical science research programmes, as well as other sector-specific indicators.

Table 4 below summarises indicators that are actively monitored by participants. The indicators are shown by sector, and by topic area.

Table 4. Indicators used by participants in each sector for the topic areas discussed by each sector working group (Figure 1.)

Outcomes	*Indicators / measures of outcomes*			
	Arable	*Dairy*	*Sheep & beef*	*Viticulture*
Soil fertility	Lab soil testing, deep nitrogen testing, visual soil assessment	Soil tests, Kinsey test, visual assessment, Olsen phosphorus, soil micro- and macro-minerals, soil moisture, soil organic matter, soil carbon, soil food web tests, fungi:bacteria ratios, earthworm numbers, herbage testing, fast dung cycling, soil electrical conductivity (EC), colour, smell, texture (gloss or mat), visual assessment of soil structural issues, plant species growing as an indicator of fertility, width of grass leaf, visual signs in plants of mineral deficiency	Lab soil tests (sometimes fertiliser company, sometimes independent), herbage tests, visual soil assessment	Soil tests, visual soil assessment, hot-water carbon, food web and microbial tests,
Soil biological activity	Visual assessment, plant tests, Brix, earthworm activity, decomposition rate, soil carbon and organic matter tests	Visual soil assessment, soil food web assessment, dung recycling, plant health, CO_2 soil emissions, soil carbon, water-holding capacity, aggregate stability, Brix, pasture litter decomposition rate, visual assessment of rhizosphere	Soil smell, worm counts, general health of soil	
Pasture feed quality (beef/sheep, arable, dairy)/ grape quality (viticulture)	Lab feed quality tests, carbohydrate:protein ratio, animal weight gain, animal health, animal performance, plant tests, Brix, visual assessment	Herbage test, Brix, animal health (dung quality and consistency), stock performance, Near Infra-red (NIR) analysis of pasture and feed, visual assessment of pasture, milk yield and % pasture harvested, look and taste of plant, meat and milk, milk composition, mineralisable energy, test silage, legume content, % green leaf	Visual assessment, eye and animal performance, observation, Brix, maturity and mix of pasture species in relation to stock class, ground cover and species diversity, herbage testing, visual assessment against standard plant values	Observations in field, Brix, pH, flavour, acids, sugars, aroma, disease resistance/incidence, health of canopy, colour, disease, wine sensory session with winemakers, wine flavour

Outcomes	*Indicators / measures of outcomes* *Arable*	*Dairy*	*Sheep & beef*	*Viticulture*
Crop health and performance (arable) / health and stock performance (beef/sheep)	Animal weight gain, crop yield, lab plant tests, milling grain test, pre-sowing soil tests, visual assessment, germination test, vigour tests on seed crops	Stock behaviour (e.g. alert, walking well, producing well), coat condition, blood test, milk volume and quality, prevalence of animal health issues, reproduction outcomes, weight gain, rate of lameness, mastitis, pneumonia, scours; retention of foetal membranes, calving issues, retained membranes, death rate, gut fill, rumen pH, liver testing, happy lines, Body Mass Index (BMI) rest periods and rumen activity (cow manager tags), antibiotic usage, % day lying down, chewing cud number/minute, urine nitrogen, milk urea nitrogen, size of vet bill, cow age	Observation, faecal egg count, weight gain and rate, kill sheet, condition score, observing behaviour, animal health tests if required, blood tests, shiny coats, bright eyes, no runny faeces, pregnancy rates	
Biodiversity	Visual assessment of beneficial insects, visual soil assessment	Visual soil assessment, soil food web assessment, dung recycling, plant health, CO_2 soil emissions, soil carbon, water-holding capacity, aggregate stability, Brix, pasture litter decomposition rate, visual assessment of rhizosphere	Sustainability goals, amount of bare soils, infiltration test, visual pasture diversity, birdlife, flora, animals, soil tests, herbage tests, blood tests, vulnerable areas protected, reduced weeds	Soil DNA, ecosystem sampling in vineyards, lab and field tests of soil health as a proxy for soil biodiversity, plant and insect diversity (visual and quantitative)
Leaching	Estimate using Overseer, moisture probes, nitrogen budgets, deep nitrogen testing, flux meters, water testing of tile drainage and on-farm watercourses	Nutrient budgeting, visual, assessment of milk urea, soil physical profile observation, measure soil carbon, total nitrogen, water-holding capacity and infiltration rates, test tile drainage and streams	Monitor proximal waterways, soil compaction, nutrient budgets, adherence to soil health principles, match nutrient supply with demand	Suction cups
Health of on-farm waterways	Water clarity, weed growth, dissolved oxygen, eel numbers, instinctive, water testing of tile drainage and on-farm watercourses	Water clarity, dissolved nutrients, fish survey, algae, invertebrates, plant growth, macrophytes, fish numbers, habitat, discoloration of runoff during rainfall	Test waterways (lab testing or using SHMAK kit), monitor visual clarity of runoff, test aquatic life, completion of fencing	Water quality testing, invertebrates, visual inspection of drains

Outcomes	*Indicators / measures of outcomes* *Arable*	*Dairy*	*Sheep & beef*	*Viticulture*
Health of Water leaving the farm	Water clarity, weed growth, dissolved oxygen, eel numbers, instinctive, water testing of tile drainage and on farm watercourses	Water clarity, dissolved nutrients, macrophytes, fish numbers, habitat, discolouration of runoff during rainfall algae, invertebrates,	Clarity of runoff, drink it, testing	
Economic success	Quarterly financial reporting, annual profit (with respect to value of land), production and other KPI benchmarking, individual crop gross margins, ability to reinvest, ability to expand and improve	Farm working expenses vs profits, return on investment to shareholders, benchmarking, DairyBase, return on investment (ROI), net profit, profit/ha, forecasting, budgeting, happy bank manager, good family income, ability to reinvest, positive feedback, long-term supplies	Financial accounts, benchmarking, continuous improvement, ability to service debt, EBITA/ha, profit/kg meat, return on investment, bank balance, good relationship with bank manager, profit/ha, FEW as a % of gross farm income, profit/stock unit	EBIT, long-term yield data, standard accounts, profit/ha, resilience in difficult years, margins
Economic forecast	Budgeting (from rough calculations to detailed budgets), monitoring farm enterprises and adjusting cost plans, monitoring gross margins before, during and after season	Budgeting, scenario budgeting, forecasting, horizon scanning, scenario budgeting, prioritise expenses based on their ability to generate new income, condition of stock and ground cover	Budgeting, market outlooks	Budget, sales targets
Employees' well-being	Regular surveys, regular meetings, direct questions, wife talks to partner, annual performance reviews	Manager observation, communication conversations, staff turnover, regular meetings, staff productivity	Regular communication and conversations, annual review, sustainable sourcing guidelines (to ensure all in food chain are being paid fairly), high residence rate	Annual reviews, regular contact, independent surveys, staff turnover, staff morale (singing and laughing at work)
Waste recycling efficiency	Don't assess but recycle everything possible, use schemes on offer (e.g. Agrecovery)	Tidiness of farm, plastic audit, residence time of waste, use of recycling services		

Outcomes	*Indicators / measures of outcomes* *Arable*	*Dairy*	*Sheep & beef*	*Viticulture*
Resource use efficiency	Sustainability reporting and tracking, irrigator testing and calibration (bucket test), use of moisture probes, water scheduling, nutrient budgeting	Water meters, fertiliser spreading records, cost efficiency, profitability compared with other farmers, production, nutrient budgets, DairyBase, energy, waste, soil function, infiltration rate, soil organic matter, growing season length		Careful budgeting and monitoring of costs, footprinting and eco-efficiency studies, inputs over time carefully monitored, visual soil moisture check and turn off irrigation when substantial rain is due, visual checking of vines
Whole-of-systems farm well-being	Progress towards sustainability commitments, improved fertility, improved soil health, yield, consistency and staff turnover, condition of soil, pasture, crops, and animal health	Environmental, financial, human health, animal welfare and social measures, intuition, soil testing, soil carbon, more production with fewer inputs, enjoyment, healthy animals, soil fertility, staff retention, soil testing, water testing, milk production, profitability, happiness, happy bank manager, sense of pride about farm, landscape function, community resources and services	Return of natural flora and fauna, progress towards sustainability commitments, soil carbon, adherence to soil health principles, visual observations of land, water, stock, happy stock and happy staff, visual soil condition	Vine health, low virus incidence, low grapevine trunk disease incidence, pest and disease incidence, vine productivity, yields, income, quality appearance of canopy fruit quality, pruning wood quality, footprinting and eco-efficiency, visually interesting, returns/ha, efficiency ($/labour/time/stress)

4.1 Self-reflection: What works in New Zealand, what doesn't, and comparison with overseas: perspectives from the sector working groups

4.1.1 What is working well

NZ having a good reputation internationally and a market existing for NZ produce were common themes across all sector working groups. Attention to the environment and, where relevant, to animal welfare was positive for all participants, as was a culture of continuous improvement, innovation, and collaboration. Other specific points that participants from different sectors noted as working well in NZ are listed here.

Arable:

- open-mindedness of farmers to try new things, willingness to share and strong desire for continuous improvement
- scale of uptake of new practices (e.g. widespread use of efficient or precision water, fertiliser and chemical practices and large-scale adoption of reduced tillage practices)
- NZ arable systems are technically advanced
- integration of stock within the farm system and the diversity of crops grown
- trusted supplier of high-quality and safe products, especially seed
- high-quality and supportive research organisations and a current government keen to support sustainable outcomes.

Beef and sheep:

- weather is favourable
- grass-fed systems and the grazing practices used
- attention to environmental and biodiversity protection and animal welfare
- production of high-quality food, and a strong market for grass-fed produce
- NZ has a strong cultural attachment to pastoral sheep and beef farming
- good culture of networking and sharing, farmer disposition towards continuous improvement and adopting new practices.

Dairy:

- grass-fed systems and grazing practices, quality and diversity of pastures, efficiency of conversion of pasture to milk, and potential of organic sector
- large amounts of data available, on-farm, from the milk factory and from milk companies; good animal tracking data and genetics data
- good genetic stock
- widespread fencing of waterways
- attention to animal health
- proactive approach of industry with innovative farming leaders
- ability to gain access to the industry is high, with small investments and large opportunities, and access to credit
- image is good internationally.

Viticulture:

- NZ blessed with natural capital assets that confer terroir
- a strong NZ, and especially Marlborough, brand
- industry has made good use of niche markets
- good support for the growers and the industry, through Sustainable Wine NZ programme and NZ Winegrowers
- a strong desire to improve sustainability from an already low environmental footprint
- growers are improving their practice over time.

4.1.2 What is not working well

Participants from all sectors raised concerns about water quality and the intensive farming systems that focus on increasing production rather value-added products. Other specific points that participants from different sectors noted as not working well in NZ are listed here.

Arable:

- poor ecological performance on arable farms
- poor management of bare soils and soils not being resilient to extreme weather events
- no easy and reliable way to measure soil biological health
- insufficient attention to social and cultural impacts of farming
- regulatory burden
- poor visibility, recognition, and influence of NZ arable industry in NZ
- increasing amount of dairy grazing occurring on land suitable for arable farming
- insufficient investment on-farm in non-market values, and concerns over future profitability with low prices and high cost of land
- insufficient collaboration or collectivisation to optimise industry for national benefit
- evangelical feel of the NZ regenerative farming movement.

Beef & sheep:

- lack of leadership and collaboration in the industry, and not thinking systemically enough about how to tackle challenges facing industry
- a disconnect between research and farming practice, inadequate soil and social research, and research not focused on solving future problems
- overgrazing, winter grazing, accelerated rates of runoff and erosion and insufficient sequestration of carbon in soils
- future profitability concerns and an over-reliance on non-renewable resources
- lack of biodiversity supported by systems
- industry isn't appealing enough to attract newcomers: the burden of regulation is too high, and there is inadequate engagement with young people and consumers.

Dairy:

- dairy feeding practices including winter grazing
- lack of knowledge on animal nutrition by many farmers
- low nutritional value of stock feed and of milk
- use of monoculture pasture
- too much growth and intensification of dairy farming, resulting in large landscape-scale conversion to dairy, with governing agencies not adequately managing the impacts of this land-use change
- future profitability concerns
- intensive system dependent on external inputs and finite non-renewable resources, and current systems not internalising current externalities
- lack of open-mindedness by DairyNZ regarding RA
- banking approaches to dairy in terms of a limited scope of what banks value when lending
- lack of connection between producers and consumers

Viticulture:

- pest and disease management, reliance on chemical fungicides, and the pressure to have a tidy vineyard leading to a 'kill everything' mindset
- high dependence on non-renewable inputs
- vine longevity
- insufficient controls at borders for preventing biosecurity incursions
- single varieties, single clone and few rootstocks make systems vulnerable (e.g. monoculture in Marlborough)
- too dependent on overseas labour.

4.1.3 Comparison with overseas

Participants from the beef & sheep sector believe NZ systems perform better than overseas systems, although some acknowledged there isn't the evidence to back up this statement. The reasons for this statement were:

- the extensive grass-fed, low-input systems with minimal routine use of animal health products
- multiple stock types on a single farm
- market not driven by subsidy
- the farmers' sense of stewardship and willingness to use science and technology.

Participants from the arable sector thought NZ systems performed at least as well as, or better than, overseas systems. This was due to:

- favourable environmental conditions (weather, soils, water)
- no long history of soil degradation

- diverse cropping rotations integrated with livestock
- good market access in many parts of the world
- willingness to try novel crops
- some added value, rather than only being commodity driven
- great farmers with deep connections to the land and a sense of stewardship.

Participants from the viticulture sector did not know overseas systems well enough to make a comparison, although they noted that the quality of the product compares well with other New World wines, and that the NZ image is important to all in the industry and needs protecting.

Dairy participants gave a mixed response, with some thinking NZ systems outperform overseas and some thinking they do not. In terms of performing better, the reasons noted were:

- high efficiency
- lower-intensity farm systems
- use of grass-based system, with a high proportion of feed grown on the farm
- the use of legume-grass pastures
- a benign climate
- good infrastructure.

Some participants believed the lower-intensity farm systems perform better than overseas systems, but not the intensive systems. Those that did not consider NZ systems perform better than overseas systems cited the fact that the systems in NZ are driven by quantity not quality, and there is more variability in farm performance within NZ than between the average NZ and overseas system.

4.2 Research investment

This section outlines, on a sector basis, the relative importance of research investment in topics aligned to specific outcomes derived from RA.

A Likert scale survey design was used with four importance ratings: not so important (1), quite important (2), very important (3), and extremely important (4). The questions were designed to capture the range of topics discussed by each sector working group in their first and second online sessions. In the survey questionnaire (Appendix 6), some questions on potential research topics were common to all, and some questions were specific to participants from individual sectors. Similar questions were grouped together to display the results.

The relative importance of research topics from participants for each of the four sectors is shown in Figure 8. to Figure 11.. For participants from the dairy, sheep & beef, and arable sectors, 'impacts on water' was rated the most important research topic. Arable and viticulture participants rated research into the long-term viability of systems as very important. Sheep & beef and viticulture rated research into food quality and safety as very important, and dairy and beef & sheep rated research into animal welfare as very important.

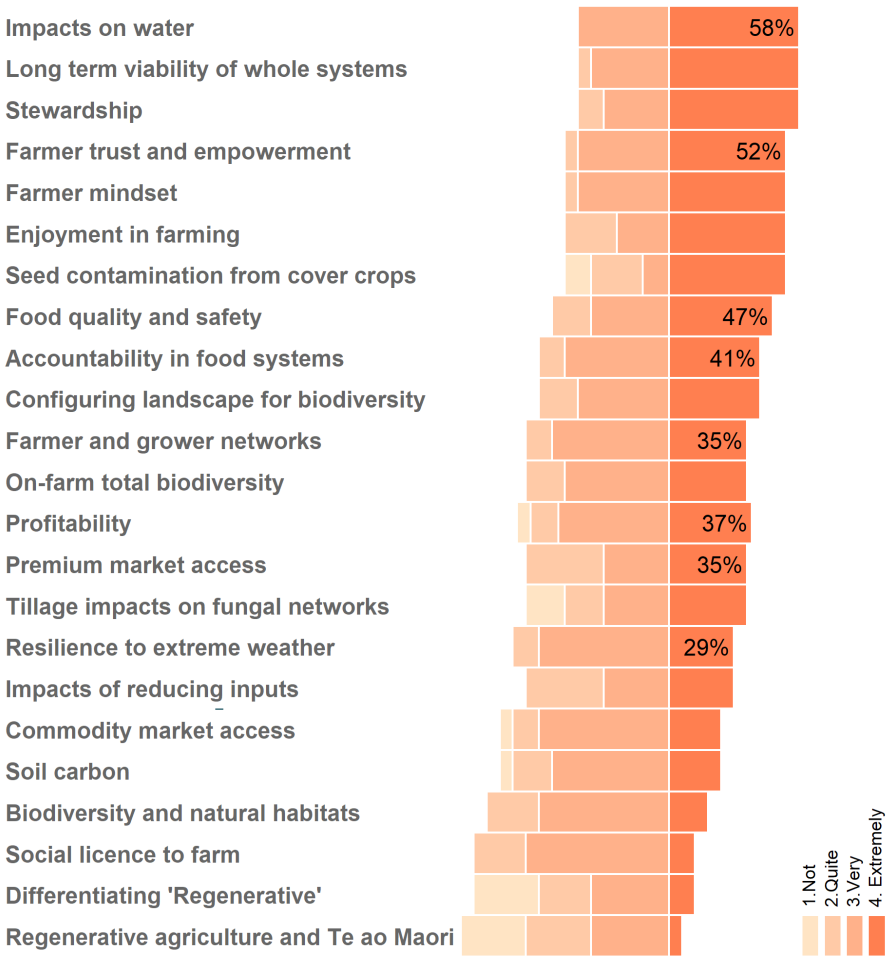

Figure 8. Importance given to 23 potential research topics by participants from the arable **sector. The relative number of participants choosing between 1 (not so important) and 4 (extremely important) is indicated by the length of the bar taking the colour allocated to each choice (indicated in the legend). Bars are stacked so that the relative number of responses taking the value 4 are to the right of a single vertical bar. Percentage values on some bars indicate the proportion of participants from that sector choosing the value 4 as their answer.**

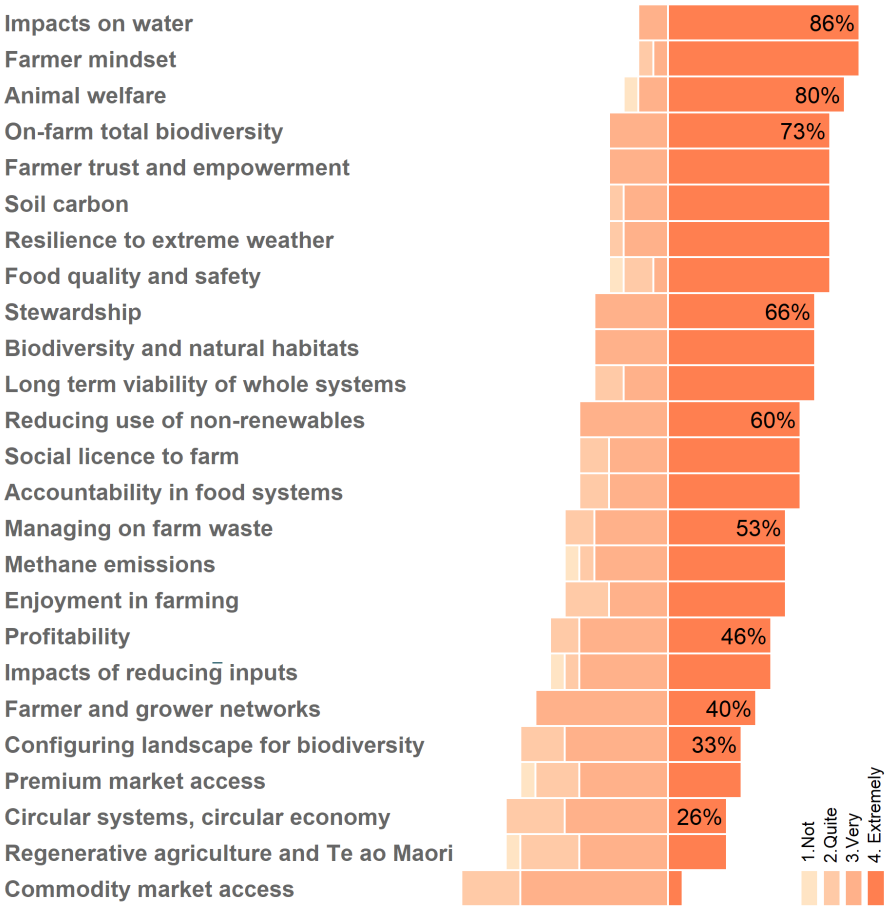

Figure 9. Importance given to 25 potential research topics by participants from the dairy sector. The relative number of participants choosing 1 (not so important), 2 (quite important), 3, (very important) or 4 (extremely important) is indicated by the length of the bar taking the colour allocated to each choice (indicated in the legend). Bars are stacked so that the relative number of responses taking the value 4 are to the right of a single vertical bar. Percentage values on some bars indicate the proportion of participants from that sector choosing the value 4 as their answer.

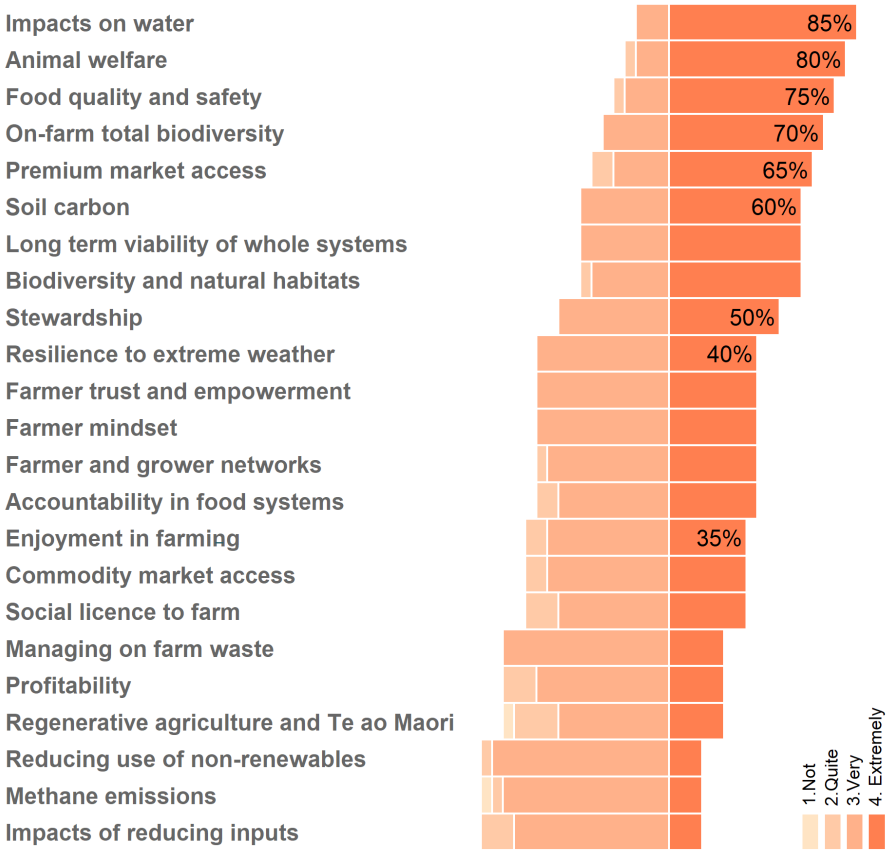

Figure 10. Importance given to 25 potential research topics by participants from the sheep & beef sector. The relative number of participants choosing 1 (not so important), 2 (quite important), 3 (very important) or 4 (extremely important) is indicated by the length of the bar taking the colour allocated to each choice (indicated in the legend). Bars are stacked so that the relative number of responses taking the value 4 are to the right of a single vertical bar. Percentage values on some bars indicate the proportion of participants from that sector choosing the value 4 as their answer.

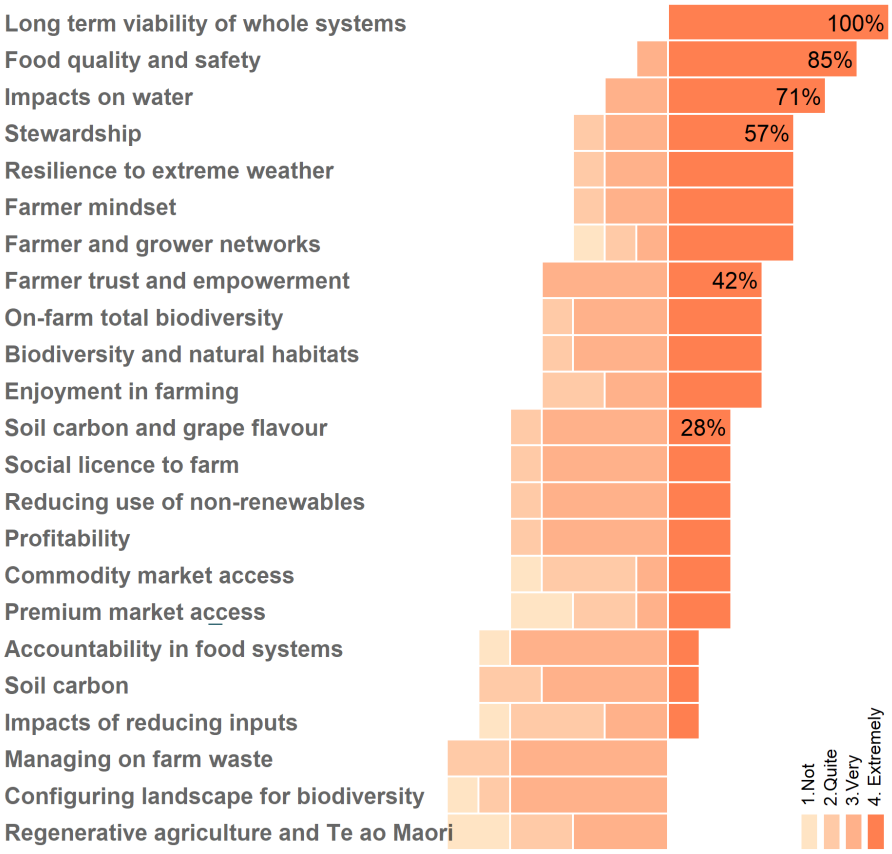

Figure 11. Importance given to 25 potential research topics by participants from the viticulture sector. The relative number of participants choosing 1 (not so important), 2 (quite important), 3 (very important) or 4 (extremely important) is indicated by the length of the bar taking the colour allocated to each choice (indicated in the legend). Bars are stacked so that the relative number of responses taking the value 4 are to the right of a single vertical bar. Percentage values on some bars indicate the proportion of participants from that sector choosing the value 4 as their answer.

Figure 12. brings together the relative distribution of importance ratings for different topics of research across all participants (n = 61) from the four sectors, and groups them into broad research areas: economy and access to markets, environment, food quality, social and farmer well-being, and integrated circular systems. The wind rose indicates those topics considered most important to research by participants across all sectors. Note that three questions were sector-specific to the arable (n = 17) and viticulture (n = 9) sectors, and these are marked with an asterisk in Figure 5..

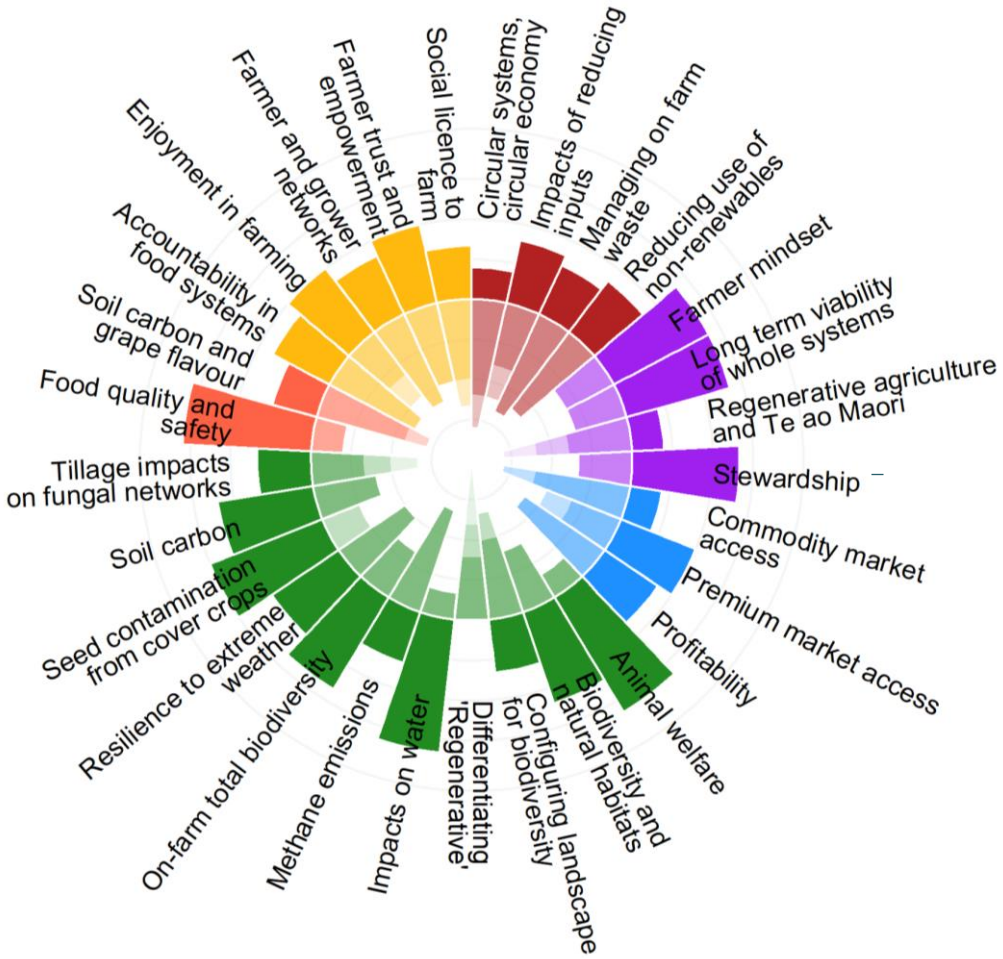

Figure 12. Importance ratings from participants in all four sectors on 29 potential research topics. There were 60 participants included in this study. The relative number of participants choosing between 1 (not so important, light shades) and 4 (extremely important, darker shades) is indicated by the length of the bar. All bars were arranged such that the relative number of participants choosing the highest rating (extremely important) is displayed on the outside of the white circle. Topics were grouped by broad topic categories: economy and access to markets (blue), environment (green), food quality (orange/light-red), social and farmer well-being (yellow), integrated circular systems (dark red).

4.2.1 Prioritisation of research needs

The topics of research that were rated the most important *across all sectors* were identified and ranked according to consensus of the rating across participants form the four sectors. A weighting was applied to account for consensus or lack of consensus across all four groups of participants. This resulted in the following prioritised list of future research areas in RA:

- impact of RA on freshwater
- impact of RA on food quality and safety
- relationship between RA and farmer empowerment and mindset
- long-term viability of whole systems and stewardship (impact of reducing inputs, long-term resilience to financial and climate change, next generation legacy, etc.)

- impact of RA on animal welfare
- on-farm total biodiversity under RA
- soil carbon in regenerative farming systems, particularly pastoral systems
- impact of RA on farm and landscape resilience to extreme weather
- accountability in food systems
- impact of RA on NZ's access to premium and niche markets
- role of RA in configuring the farm and landscape for native biodiversity
- seed contaminations (arable) from multispecies crops and pastures
- relationship between farmer support and learning network
- profitability of RA farming systems
- role of RA for increasing enjoyment in farming.

5 References

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Appendix 1. Survey questionnaire 1: Aspects of farming systems that makes them 'regenerative'

Participants were invited to respond to the following questions in an online Google document. The facilitator asked these questions verbally.

"What makes farming systems regenerative in your opinion, for particular aspects of your sector. What does a regenerative farming system look like to you for a given outcome? What should a farming system achieve or deliver in your opinion for it to be regenerative in this particular aspect?

If you do not know what regenerative agriculture is, please base your answers on what the word means to you.

Other ways to think about this question are: What does success for this particular aspect of farming look like for your sector / at farm level? What does failure look like? What's working now? What isn't and should be working for the system to be regenerative?"

Appendix 2. Survey questionnaire 2: Aspects of farming systems that makes them 'regenerative' – in detail

Participants were divided into small groups to discuss themes that had been identified by their sector in their first online session (Table 5). Prior to discussions, participants were invited to record their initial thoughts on the in-depth topics with respect to regenerative agriculture in an online Google document. This was to capture initial thoughts on these topics that might not have been covered in the subsequent discussion due to time constraints.

Table 5. Discussion topics identified from data collected during the second online sessions of each sector working group

Sub-group	*Arable*	*Beef and sheep*	*Dairy*	*Viti-culture*
1	Public perception maintained/improved licence to operate/Farmers Trusted Enjoying farming/feeling good/ curious mindset/ Stewardship (as an intrinsic outcome)	Healthy Soils Water cycle & clean waterways: pollution, filtration, storage and irrigation, resilience	Healthy Soils Water cycle & healthy waterways	
2	Lower input requirement/reduced chemical use/Reduction in the use of unnecessary fertilisers and pesticides Healthy food/ Healthier people	Biodiversity of Flora/Fauna - exotic versus native, diverse pastures, tree plantings. bees/birds/microbes Carbon sequestration / soil carbon (GHGs/SOC) - SOC increase, CH4 decrease, Tree planting, NxO decrease	Monocultures/low diversity versus Biodiversity Carbon sequestration / GHG	
3	Healthy Soils/ greater soil health Water cycle & clean waterways	Licence to Operate & trust/respect regained - trust, pride in farming, practices negatively impacting wellbeings eliminated, negative impacts reversed / mitigated, respect for food Thriving WHOLE ecosystems & Overall wellbeing (management 4that promotes wellbeing in soils, p5lants, animals, humans, bu6sinesses, communities)	Licence to Operate & trust/respect regained for farmers Social & environmental responsibility at all level of food system (including farmers and distribution chain)	

Sub-group	*Arable*	*Beef and sheep*	*Dairy*	*Viti-culture*
4	Journey of improvement across a spectrum/ non-prescriptive flexibility/ Continuous improvement Farmers influencing other farmers to improve practices (more effective than regulation)/ Detrimental practices stopped	Economic value-add - branded products, verifiable claims of improved nutritional / medicinal properties / positive environmental impacts (i.e. C sequestration), need for transparency? Verification of benefits necessary? NZ specific? Threat of greenwashing? On farm profits / profitability - examining the value add of costs, monetary assessment of co-benefits, how to calculate the true financial gains of regen farms if multiple co-benefits generated (direct reward for co-benefits or future reward if co-benefits lead to resilience or higher competitively in the future)	Economic value-add (co-benefits?) & branding a 'point of difference' for NZ Milk (commodity/premium?) story-telling versus real on-farm data	
5	Carbon sequestration / climate change solution/greater resilience Biodiversity	Connected communities and Iwi: peer-to-peer, respect and collaboration with Iwi, urban to rural divide decreased or eliminated Resilience and next generation legacies / farmer stewardship / resilience for thriving future	circular bioeconomy: shorter supply and value chains, waste handling & recycling, elimination of unsustainable extractions of resources (includes winter feeding)	
6	Market / branding / Premium / Niche + Market access/Marketing story/Responsive to consumer Demand Improved costs/inputs margins/improved profits/Profitable farmers	Context-specific solutions / locality / Diversification of on-farm solutions (not one size fits all) Mindset: continuous improvement & learning, whole system approach valuing all aspects (i.e. profit without sacrifice), thrive to thrive	Wellbeing - mental health Profit for farmers	

Appendix 3. Survey questionnaire 3: relative importance of 'regenerative' outcomes (pertaining to soil, business success, social wellbeing and mindset) or 'statement' (pertaining to marketability of farm produce)

Questions are listed as asked to the participants word for word for each sector. Questions were tailored for each sector, i.e. the word "farmer" was used in the pastoral sectors, but the word "grower" was used in the viticulture sector. For analyses, each question was coded against a unified "outcome" / "statement" across all four all sector, unless the question was sector specific. The code used is listed in the column "outcome" / "statement". The sector to which the question was asked is listed in the third column.

Survey: Healthy Soils

Explanation provided to the participants: "Please indicate below how highly you rate these outcomes for soil health. 1 = NOT so important; 2 = QUITE important; 3= VERY important; 4 = EXTREMELY important".

Question	*Outcome*	*Sector*
Carbon is sequestered in soil	Carbon sequestered in soil	SheepBeef
Carbon is sequestered in soil	Carbon sequestered in soil	Dairy
Carbon is sequestered in soil	Carbon sequestered in soil	Arable
Carbon is sequestered in soil	Carbon sequestered in soil	Viticulture
Carbon is sequestered at depth (in sub-soil or deeper)	Carbon sequestered in soil at depth	SheepBeef
Carbon is sequestered at depth (in sub-soil or deeper)	Carbon sequestered in soil at depth	Dairy
Carbon is sequestered at depth (in sub-soil or deeper)	Carbon sequestered in soil at depth	Arable
Carbon is sequestered at depth (in sub-soil or deeper)	Carbon sequestered in soil at depth	Viticulture
Strategic crop rotations reduce external mineral inputs	Decreased inputs, via crop rotations	Arable
Nutrient cycling in soil enables reductions in external mineral inputs	Decreased inputs, via optimal nutrient cycling	Viticulture
Ground cover is maintained over winter	Ground cover all year	Arable
no negative impact of winter feeding on ground cover	Ground cover all year	SheepBeef
no negative impact of winter feeding on ground cover	Ground cover all year	Dairy
High biological activity in soils	High soil biological activity	SheepBeef
High biological activity in soils	High soil biological activity	Dairy
High biological activity in soils	High soil biological activity	Arable
High biological activity in soils	High soil biological activity	Viticulture

Question	*Outcome*	*Sector*
No bare soil	No bare soil	SheepBeef
No bare soil	No bare soil	Dairy
No bare soil	No bare soil	Arable
No bare soil	No bare soil	Viticulture
Erosion is reduced or eliminated	No or minimal erosion	SheepBeef
Erosion is reduced or eliminated	No or minimal erosion	Dairy
Erosion is reduced or eliminated	No or minimal erosion	Viticulture
No top soil losses	No or minimal erosion	SheepBeef
No top soil losses	No or minimal erosion	Dairy
Top soil losses via wind erosion are minimised	No or minimal erosion	Arable
Water erosion of soil is minimised	No or minimal erosion	Arable
No or minimal chemical soil disturbance events	No or minimal soil disturbance	Viticulture
No or minimal physical soil disturbance events	No or minimal soil disturbance	Viticulture
No or minimal soil disturbance	No or minimal soil disturbance	SheepBeef
No or minimal soil disturbance	No or minimal soil disturbance	Dairy
No or minimal soil disturbance	No or minimal soil disturbance	Arable
Cycling of mineral in soils enable weaning off / reducing external mineral inputs	Decreased inputs, via optimal nutrient cycling	Dairy
Soil fertility is optimised	Soil fertility optimised	SheepBeef
Soil fertility is optimised	Soil fertility optimised	Dairy
Soil fertility is optimised	Soil fertility optimised	Arable
Soil health improvement are measurable	Soil health improvement measurable	SheepBeef
Soil health improvement are measurable	Soil health improvement measurable	Dairy
Soil health improvement are measurable	Soil health improvement measurable	Viticulture
Soil health improvement is measurable	Soil health improvement measurable	Arable
Improving soil health is a key focus of management	Soil health improvement top priority	SheepBeef
Improving soil health is a key focus of management	Soil health improvement top priority	Dairy
Improving soil health is a key focus of management	Soil health improvement top priority	Arable
improving soil health is a key focus of management	Soil health improvement top priority	Viticulture
Soil microbiome functions well	Soil microbiome functions well	SheepBeef
Soil microbiome functions well	Soil microbiome functions well	Dairy
Soil microbiome functions well	Soil microbiome functions well	Arable
Soil structure is enhanced	Soil structure is enhanced	SheepBeef
Soil structure is enhanced	Soil structure is enhanced	Dairy
Soil structure is enhanced	Soil structure is enhanced	Arable
Soil structure is enhanced	Soil structure is enhanced	Viticulture
Soil structure is maintained in drought / flood events	Soil structure resilient to rainfall extremes	SheepBeef

Question	*Outcome*	*Sector*
Soil structure is maintained in drought / flood events	Soil structure resilient to rainfall extremes	Dairy
Soil structure is maintained in drought / flood events	Soil structure resilient to rainfall extremes	Arable
Soil organic matter concentration is maintained or increased in top soil	SOM in top soil maintained / increased	SheepBeef
Soil organic matter concentration is maintained or increased in top soil	SOM in top soil maintained / increased	Dairy
Soil organic matter concentration is maintained or increased in top soil	SOM in top soil maintained / increased	Viticulture
Soil organic matter is maintained or increased in top soil	SOM in top soil maintained / increased	Arable
New issues from adopting no or reduced tillage are anticipated and prepared for (e.g. slugs and residue management issues)	System optimised for No / min till	Arable
Functional soil depth is increased (building top soil)	Top soil depth increased	Arable
Soil depth is increased (building top soil)	Top soil depth increased	SheepBeef
Soil depth is increased (building top soil)	Top soil depth increased	Dairy
Soil depth is increased (building top soil)	Top soil depth increased	Viticulture
Soil water retention is enhanced/ optimised	Water capture & retention enhanced	Arable
Water capture / infiltration is optimised	Water capture & retention enhanced	SheepBeef
Water capture / infiltration is optimised	Water capture & retention enhanced	Dairy
WATER capture / infiltration is optimised	Water capture & retention enhanced	Viticulture
Water infiltration is optimised	Water capture & retention enhanced	Arable

Survey: Financial success

Explanation provided to the participants: "Please indicate below how highly you rate these outcomes in terms of economic performance of the farming business. 1 = NOT so important; 2 = QUITE important; 3= VERY important; 4 = EXTREMELY important".

Question	*Outcome*	*Sector*
investment in fences is proportionally high	Infrastructures are well resourced	Dairy
investment in fences is proportionally high	Infrastructures are well resourced	SheepBeef
Farming business / property is highly valued and attractive to investors	Business is attractive to investors	Dairy
Farming business / property is highly valued and attractive to investors	Business is attractive to investors	SheepBeef
Vineyard business / property is highly valued and attractive to investors	Business is attractive to investors	Viticulture
Farmers can demonstrate to banks they are on track to meeting forecasts	Clear communication with banks	Arable

Question	*Outcome*	*Sector*
Inputs are chosen / designed to better utilise what's already in the soil.	Efficient use of inputs	Arable
Farmers have the financial freedom to invest in innovative trials	Financial freedom to innovate	Arable
Farmers have the financial freedom to invest in innovative trials	Financial freedom to innovate	Dairy
Farmers have the financial freedom to invest in innovative trials	Financial freedom to innovate	SheepBeef
Winegrowers have the financial freedom to invest in innovative trials	Financial freedom to innovate	Viticulture
Farmers have the financial freedom to re-invest in farm capital	Financial freedom to re-invest	Arable
Farmers have the financial freedom to re-invest in farm capital	Financial freedom to re-invest	Dairy
Farmers have the financial freedom to re-invest in farm capital	Financial freedom to re-invest	SheepBeef
Winegrowers have the financial freedom to re-invest in vineyard capital	Financial freedom to re-invest	Viticulture
'Green image' of the NZ wine industry is a driver of profit	Green image drives profit	Viticulture
Farmers have the power and knowledge required to optimise expenditure and types of inputs	Increased financial expertise	Arable
Farmers have the power and knowledge required to optimise expenditure and types of inputs	Increased financial expertise	Dairy
Farmers have the power and knowledge required to optimise expenditure and types of inputs	Increased financial expertise	SheepBeef
Growers have the power and knowledge required to optimise expenditure	Increased financial expertise	Viticulture
Profit margins are increased	Increased profitability	Arable
Profit per hectare is increased	Increased profitability	Arable
Profit margins are increased	Increased profitability	Dairy
Profit per hectare is increased	Increased profitability	Dairy
Profit margins are increased	Increased profitability	SheepBeef
Profit per unit land area is increased	Increased profitability	SheepBeef
Profit per hectare is increased	Increased profitability	Viticulture
Profit margins are increased	Increased profitability	Viticulture
Phosphorus inputs are minimised	Inputs (water/fert) are minimised	Dairy
Phosphorus inputs are minimised	Inputs (water/fert) are minimised	SheepBeef
Fertigation inputs are minimised	Inputs (water/fert) are minimised	Viticulture
Investment in labour cost is proportionally high (compared to investment in inputs, for example)	Investment in staff	Arable
Investment in labour cost is proportionally high (compared to investment in inputs, for example)	Investment in staff	Dairy

Question	*Outcome*	*Sector*
Investment in labour cost is proportionally high (compared to investment in inputs, for example)	Investment in staff	SheepBeef
Investment in management of waterways is proportionally high	Investment in waterways	Arable
investment in management of waterways is proportionally high	Investment in waterways	Dairy
investment in management of waterways is proportionally high	Investment in waterways	SheepBeef
Production per hectare is decreased, profit per hectare is increased	Less production, more value	Arable
Production per hectare is decreased, profit per hectare is increased	Less production, more value	Dairy
Production per unit land area is decreased, profit per unit land area is increased	Less production, more value	SheepBeef
Production per hectare is decreased, profit per hectare is increased	Less production, more value	Viticulture
Production per hectare is increased	Production increased	Arable
Production per hectare is increased	Production increased	Dairy
Production per unit land area is increased	Production increased	SheepBeef
Production per hectare is increased	Production increased	Viticulture
Wine industry business model structured for profit over yield	Profit, not production focus	Viticulture
Export volume is a driver of profit	Quantity/volume drives profits	Viticulture
Wine quantity is a driver of profit	Quantity/volume drives profits	Viticulture
Input costs are decreased	Reduced cost of inputs	Arable
Input costs are decreased	Reduced cost of inputs	Dairy
Input costs are decreased	Reduced cost of inputs	SheepBeef
Input costs are decreased	Reduced cost of inputs	Viticulture
Compliance costs are reduced	Reduced costs (other than inputs)	Arable
Farm working expenses are decreased	Reduced costs (other than inputs)	Arable
Farm working expenses are decreased	Reduced costs (other than inputs)	Dairy
Farm expenditures are decreased	Reduced costs (other than inputs)	SheepBeef
Vineyard working expenses are decreased	Reduced costs (other than inputs)	Viticulture
Reliance on chemical inputs is decreased or minimised	Reduced reliance on agchemicals	Arable
Reliance on chemical inputs is decreased or eliminated	Reduced reliance on agchemicals	Dairy
Reliance on chemical inputs is decreased or eliminated	Reduced reliance on agchemicals	SheepBeef
Reliance on chemical inputs is decreased or eliminated	Reduced reliance on agchemicals	SheepBeef

Question	*Outcome*	*Sector*
Reliance on chemical inputs is decreased or eliminated	Reduced reliance on agchemicals	Viticulture
Reliance on non-renewable resources is decreased or minimised	Reduced use of non-renewables	Arable
Reliance on non-renewable resources is decreased or eliminated	Reduced use of non-renewables	Dairy
Reliance on non-renewable resources is decreased or eliminated	Reduced use of non-renewables	SheepBeef
Reliance on non-renewable resources is decreased or eliminated	Reduced use of non-renewables	Viticulture
Production per hectare is maintained, profit per hectare is increased	Same production, more value	Arable
Production per hectare is maintained, profit per hectare is increased	Same production, more value	Dairy
Production per unit land area is maintained, profit per unit land area is increased	Same production, more value	SheepBeef
Production per hectare is maintained, profit per hectare is increased	Same production, more value	Viticulture
Inputs are chosen / designed to provide high return on investment in the medium to long term	System supports long term ROI	Arable
Inputs are chosen / designed to provide high return on investment in the medium to long term	System supports long term ROI	Dairy
Inputs are chosen / designed to provide high return on investment in the medium to long term	System supports long term ROI	SheepBeef
Inputs are chosen / designed to provide high return on investment in the medium to long term	System supports long term ROI	Viticulture
Inputs are chosen / designed to provide high return on investment in the same financial year	System supports short term ROI	Arable
Inputs are chosen / designed to provide high return on investment in the same financial year	System supports short term ROI	Dairy
Inputs are chosen / designed to provide high return on investment in the same financial year	System supports short term ROI	SheepBeef
Inputs are chosen / designed to provide high return on investment in the same financial year	System supports short term ROI	Viticulture
Export value is a driver of profit	Value/quality drives profits	Viticulture
Wine quality is a driver of profit	Value/quality drives profits	Viticulture
Veterinary bills per animal are decreased	Veterinary costs decreased	Dairy
Veterinary bills per animal are decreased	Veterinary costs decreased	SheepBeef

Survey: Social well-being

Explanation provided to the participants: "Please indicate below how highly you rate these outcomes in terms of economic performance of the farming business. 1 = NOT so important; 2 = QUITE important; 3= VERY important; 4 = EXTREMELY important".

Question	*Outcome*	*Sector*
Growers feel supported by their community	Community network and support	Viticulture
Strong & supportive community network	Community network and support	Arable
Strong & supportive community network	Community network and support	Dairy
Strong& supportive community network	Community network and support	SheepBeef
Fair and equitable practices	Fairness and equity	Arable
Fair and equitable practices	Fairness and equity	Dairy
Fair and equitable practices	Fairness and equity	SheepBeef
Fair and equitable values	Fairness and equity	Arable
Fair and equitable values	Fairness and equity	Dairy
Fair and equitable values	Fairness and equity	SheepBeef
Fair and equitable values and practices	Fairness and equity	Viticulture
Farmers & families positively engage with farming activities	Families engaged with farming	Arable
Farmers & families positively engage with farming activities	Families engaged with farming	Dairy
Farmers & families positively engage with farming activities	Families engaged with farming	SheepBeef
There is a positive feedback loop between the farm ecosystem and the catchment ecosystem	Farm - catchment integration for ecosystems wellbeing	Arable
There is a positive feedback loop between the farm ecosystem and the catchment ecosystem	Farm - catchment integration for ecosystems wellbeing	Dairy
There is a positive feedback loop between the farm ecosystem and the catchment ecosystem	Farm - catchment integration for ecosystems wellbeing	SheepBeef
Farm goal setting takes into account catchment and regional objectives	Farm - catchment integration for planning	Arable
Farm goal setting takes into account catchment and regional objectives	Farm - catchment integration for planning	Dairy
Farm goal setting takes into account catchment and regional objectives.	Farm - catchment integration for planning	SheepBeef
Vineyard goal setting takes into account catchment and regional objectives	Farm - catchment integration for planning	Viticulture
Farm businesses are integrated in local communities	Farm business integrated locally	Arable
Farm businesses are integrated in local communities	Farm business integrated locally	Dairy
Farm businesses are integrated in local communities	Farm business integrated locally	SheepBeef

Question	*Outcome*	*Sector*
Wine and vineyard businesses are integrated in local communities	Farm business integrated locally	Viticulture
The wine industry supports stable local economy	Farm businesses integrated locally	Viticulture
The farm environment is of high quality and enhances wellbeing of people working there	Farm environment enhances wellbeing	Arable
The farm environment is of high quality and enhances wellbeing of people working there	Farm environment enhances wellbeing	Dairy
The vineyard environment is of high quality and enhances wellbeing of people working there	Farm environment enhances wellbeing	Viticulture
Farming is fun	Farming is enjoyable	Arable
Farming is fun	Farming is enjoyable	Dairy
Farming is fun	Farming is enjoyable	SheepBeef
Grape growing is fun	Farming is enjoyable	Viticulture
Innovation and uptake of management practices consider or enhance the wellbeing of the grower	Grower wellbeing enhanced	Viticulture
Winegrower mental & physical health and wellbeing is enhanced through their work	Grower wellbeing enhanced	Viticulture
Grower wellbeing benefits the community and vice	Grower-community mutual benefit	Viticulture
Farmers and consumers are connected	Growers -consumers connected	Arable
Farmers and consumers are connected	Growers -consumers connected	Dairy
Farmers and consumers are connected	Growers -consumers connected	SheepBeef
Winegrowers and consumers are connected	Growers -consumers connected	Viticulture
Growers feel empowered to make their own decisions for their vineyard	Growers empowered to make decisions	Viticulture
Farmers are engaged in public conversations	Growers engaged in public conversations	Arable
Farmers are engaged in public conversations	Growers engaged in public conversations	Dairy
Farmers are engaged in public conversations	Growers engaged in public conversations	SheepBeef
Growers are engaged with their community and / or in public conversations	Growers engaged in public conversations	Viticulture
The farm is engaged with its community	Growers engaged with community	Arable
The farm is engaged with its community	Growers engaged with community	Dairy
The farm is engaged with its community	Growers engaged with community	SheepBeef
Farmers feel good about their job & business	Growers proud of their job	Arable
Farmers feel good about their job & business	Growers proud of their job	Dairy
Farmers feel good about their job & business	Growers proud of their job	SheepBeef
Growers feel good about their job & business	Growers proud of their job	Viticulture
Kaitiakitanga: winegrowers are seen as guardians of the land	Growers seen as stewards	Viticulture
The wine industry supports vibrant rural communities	Industry supports local communities	Viticulture
Interconnectedness is acknowledged	Interconnectedness acknowledged	Arable

Question	*Outcome*	*Sector*
Interconnectedness is acknowledged	Interconnectedness acknowledged	Dairy
Interconnectedness is acknowledged	Interconnectedness acknowledged	SheepBeef
Whenua Ora, Kai Ora, Wai Ora, Tangata Ora: Interconnectedness is acknowledged	Interconnectedness acknowledged	Viticulture
Farm goal setting takes into account long-term outcomes	Long-term outcomes inform business goals	Arable
Farm goal setting takes into account long-term outcomes	Long-term outcomes inform business goals	Dairy
Vineyard goal setting takes into account long-term outcomes	Long-term outcomes inform business goals	Viticulture
Stress levels are Low	Low stress levels	Arable
Stress levels are Low	Low stress levels	Dairy
Good staff retention i.e. low turnover of staff	Low turnover of staff	Viticulture
More jobs in farming	More jobs	Arable
More jobs in farming	More jobs	Dairy
More jobs in farming	More jobs	SheepBeef
Rural and urban communities are connected	Rural and urban communities connected	Arable
Rural and urban communities are connected	Rural and urban communities connected	Dairy
Rural and urban communities are connected	Rural and urban communities connected	SheepBeef
There is a positive feedback loop between farmer wellbeing and community wellbeing	Synergy between grower and community wellbeing	Dairy
There is a positive feedback loop between farmer wellbeing and community wellbeing	Synergy between grower and community wellbeing	Arable
There is a positive feedback loop between farmer wellbeing and community wellbeing	Synergy between grower and community wellbeing	SheepBeef

Survey: Mindset

Explanation provided to the participants: "Please indicate below how highly you rate these outcomes in terms of economic performance of the farming business. 1 = NOT so important; 2 = QUITE important; 3= VERY important; 4 = EXTREMELY important".

Question	*Outcome*	*Sector*
Adaptability to change is improved	Adaptability & flexibility promoted	Arable
Adaptability to change is improved	Adaptability & flexibility promoted	Dairy
Adaptability to change is improved	Adaptability & flexibility promoted	SheepBeef
Non prescriptive flexibility is endorsed	Adaptability & flexibility promoted	Arable
Winegrowers have the ability to change and adapt	Adaptability & flexibility promoted	Viticulture
Management promotes optimum instead of maximum	Aim for optimum over maximum	Dairy
Management promotes optimum instead of maximum	Aim for optimum over maximum	SheepBeef
Management promotes optimum instead of maximum	Aim for optimum over maximum	Viticulture

Question	*Outcome*	*Sector*
Management promotes optimum rather than maximum	Aim for optimum over maximum	Arable
Farmers have the confidence to learn and try new things	Confidence to experiment	Arable
Farmers have the confidence to learn and try new things	Confidence to experiment	Dairy
Farmers have the confidence to learn and try new things	Confidence to experiment	SheepBeef
Growers have the confidence to learn and try new things	Confidence to experiment	Viticulture
Context matters	context-specific solutions	Dairy
Context matters	context-specific solutions	SheepBeef
Commitment & responsibility to improve at all levels	Continuous improvement	Arable
Commitment & responsibility to improve at all levels	Continuous improvement	Dairy
Commitment & responsibility to improve at all levels	Continuous improvement	SheepBeef
Commitment & responsibility to improve at all levels	Continuous improvement	Viticulture
Continuous improvement of both soil and above ground needed	Continuous improvement	Arable
Mindset of continuous improvement is adopted at all levels	Continuous improvement	Arable
Mindset of continuous improvement is adopted at all levels	Continuous improvement	Dairy
Mindset of continuous improvement is adopted at all levels	Continuous improvement	SheepBeef
Mindset of continuous improvement is adopted at all levels	Continuous improvement	Viticulture
Learning is continuous	Continuous learning	Arable
Learning is continuous	Continuous learning	Dairy
Learning is continuous	Continuous learning	SheepBeef
Learning is continuous	Continuous learning	Viticulture
Curiosity is encouraged	Curiosity is encouraged	Arable
Curiosity is encouraged	Curiosity is encouraged	Dairy
Curiosity is encouraged	Curiosity is encouraged	SheepBeef
Curiosity is encouraged	Curiosity is encouraged	Viticulture
Detrimental practices are stopped	Detrimental practices are stopped	Arable
Detrimental practices are stopped	Detrimental practices are stopped	Dairy
Detrimental practices are stopped	Detrimental practices are stopped	SheepBeef
Detrimental practices are stopped	Detrimental practices are stopped	Viticulture
Detrimental practices are subject to penalties	Detrimental practices penalised	Arable
Detrimental practices are subject to penalties	Detrimental practices penalised	Dairy
Detrimental practices are subject to penalties	Detrimental practices penalised	SheepBeef
Detrimental practices are subject to penalties	Detrimental practices penalised	Viticulture
Farmers know best: their knowledge is priority	Farmer and grower expertise acknowledged	Arable

Question	*Outcome*	*Sector*
Farmers know best: their knowledge is priority	Farmer and grower expertise acknowledged	Dairy
Farmers know best: their knowledge is priority	Farmer and grower expertise acknowledged	SheepBeef
Winegrowers know best - empowered and informed decision making.	Farmer and grower expertise acknowledged	Viticulture
Support to farmers from both supply and value chains	Food systems support farmers	Arable
Support to farmers from both supply and value chains	Food systems support farmers	Dairy
Support to farmers from both supply and value chains	Food systems support farmers	SheepBeef
SUPPORT to farmers from both supply and value chains	Food systems support farmers	Viticulture
Freedom to fail as part of learning	Freedom to fail	Arable
Freedom to fail as part of learning	Freedom to fail	Dairy
Freedom to fail as part of learning	Freedom to fail	SheepBeef
Freedom to fail is accepted as part of learning	Freedom to fail	Viticulture
A whole system view of wine growing is adopted by all	Holistic approach used	Viticulture
Whole system view of farming is adopted by all	Holistic approach used	Dairy
Whole system view of farming is adopted by all	Holistic approach used	SheepBeef
Understanding that new practices can lead to new issues	Impact of new practices understood	Arable
Decisions take into account land-use around the farm and the potential for contamination when choosing cover crop species mixes	Impacts on nearby seed crops considered	Arable
Innovation is accessible to all	Innovations are widely accessible	Arable
Innovation is accessible to all	Innovations are widely accessible	Dairy
Innovation is accessible to all	Innovations are widely accessible	SheepBeef
Decisions also take into account long-term outcomes	Long-term outcomes inform decisions	Arable
Decisions also take into account long-term outcomes	Long-term outcomes inform decisions	Dairy
Decisions also take into account long-term outcomes	Long-term outcomes inform decisions	SheepBeef
Decisions take into account longterm outcomes	Long-term outcomes inform decisions	Viticulture
Natural capital is valued	Natural capital is valued	Arable
Peer to peer learning	Peer to peer learning	Arable
Farming and its regulations is not a one-size-fits-all	Regulation recognises diversity	Arable
Farming and its regulations is not a one-size-fits-all	Regulation recognises diversity	Dairy
Farming and its regulations is not a one-size-fits-all	Regulation recognises diversity	SheepBeef
Wine growing and its regulations are NOT a one-size-fits-all	Regulation recognises diversity	Viticulture
Successes and efforts are celebrated	Success and effort are celebrated	Arable
Successes and efforts are celebrated	Success and effort are celebrated	Dairy
Successes and efforts are celebrated	Success and effort are celebrated	SheepBeef
Successes and efforts are celebrated	Success and effort are celebrated	Viticulture

Survey: Market

Explanation provided to the participants: "Please indicate below how true these statements are in your opinion: 1 = NOT true, 2 = UNSURE, 3 = POSSIBLY true, 4 = Yep, I AGREE".

Question	*Statement*	*Sector*
Affordable healthy food for all sectors of society is more important than a premium	Affordable healthy food, not premium	Arable
A certification system for "regenerative" NZ produce is essential to create a fast / reliable pathway to market	Certification system secures markets	Arable
A certification system for "regenerative" NZ produce is essential to create a fast / reliable pathway to market	Certification system secures markets	Dairy
A certification system for "regenerative" NZ produce is essential to create a fast / reliable pathway to market	Certification system secures markets	SheepBeef
A certification system for "regenerative" NZ produce is essential to create a fast / reliable pathway to market	Certification system secures markets	Viticulture
A certification system for "regenerative" NZ produce is not possible if non prescriptive flexibility is the aim	Certification system secures markets	Arable
Farm produce from "regenerative systems" can secure a premium	Competitive for premium pricing	Arable
Farm produce from "regenerative systems" can secure a premium	Competitive for premium pricing	Dairy
Farm produce from "regenerative systems" can secure a premium	Competitive for premium pricing	SheepBeef
Wine from "regenerative systems" can secure a premium	Competitive for premium pricing	Viticulture
Consumers who say they want products with a better environmental footprint will still buy the cheapest options on the shelf	Competitive in commodity market	Arable
Farm produce from "regenerative systems" can be highly competitive in a commodity market (better quality, more consistent supply chain)	Competitive in commodity market	Arable
Farm produce from "regenerative systems" can be highly competitive in a commodity market (better quality, more consistent supply chain)	Competitive in commodity market	Dairy
Farm produce from "regenerative systems" can be highly competitive in a commodity market (better quality, more consistent supply chain)	Competitive in commodity market	SheepBeef
Wine from "regenerative systems" can be highly competitive in a commodity market (better quality, more consistent supply chain)	Competitive in commodity market	Viticulture
Farm produce from "regenerative systems" can be highly competitive in a niche market only	Competitive in niche markets	Arable
Farm produce from "regenerative systems" can be highly competitive in a niche market only	Competitive in niche markets	Dairy
Farm produce from "regenerative systems" can be highly competitive in a niche market only	Competitive in niche markets	SheepBeef
Wine from "regenerative systems" can be highly competitive in a niche market only	Competitive in niche markets	Viticulture

Question	*Statement*	*Sector*
Relationship between supermarkets and farmers requires a new framework	New framework for growers - supermarkets links	Arable
NZ arable systems are already "regenerative"	NZ already regenerative	Arable
NZ dairy systems are already "regenerative"	NZ already regenerative	Dairy
NZ sheep & beef systems are already "regenerative"	NZ already regenerative	SheepBeef
NZ viticulture systems are already "regenerative"	NZ already regenerative	Viticulture
NZ arable systems are already "regenerative" but there is room for improvement	NZ already regenerative, but can improve	Arable
NZ has the capacity to become world leader in "regenerative" arable produce	NZ become world leader in Regen ag	Arable
NZ has the capacity to become world leader in "regenerative" dairy produce	NZ become world leader in Regen ag	Dairy
NZ has the capacity to become world leader in "regenerative" farm produce	NZ become world leader in Regen ag	SheepBeef
NZ has the capacity to become world leader in arable produce with exceptional nutritional properties	NZ become world leader in Regen ag	Arable
NZ has the capacity to become world leader in dairy produce with exceptional nutritional properties	NZ become world leader in Regen ag	Dairy
NZ has the capacity to become world leader in regenerative wine production	NZ become world leader in Regen ag	Viticulture
"regenerative farming systems" produce other services that could be rewarded financially directly (e.g. carbon credits)	Regenerative services rewarded financially	Arable
"regenerative farming systems" produce other services that could be rewarded financially directly (e.g. carbon credits)	Regenerative services rewarded financially	Dairy
"regenerative farming systems" produce other services that could be rewarded financially directly (e.g. carbon credits)	Regenerative services rewarded financially	SheepBeef
"Regenerative farming systems" produce other services that could be rewarded financially directly (e.g. carbon credits)	Regenerative services rewarded financially	Viticulture
"regenerative farming systems" produce other services that could be rewarded financially indirectly (e.g. lower tax)	Regenerative services rewarded financially	Arable
"regenerative farming systems" produce other services that could be rewarded financially indirectly (e.g. lower tax)	Regenerative services rewarded financially	Dairy
"regenerative farming systems" produce other services that could be rewarded financially indirectly (e.g. lower tax)	Regenerative services rewarded financially	SheepBeef
"Regenerative farming systems" produce other services that could be REWARDED financially INDIRECTLY (e.g. lower tax)	Regenerative services rewarded financially	Viticulture
Story-telling / branding of "regenerative" NZ farm produce are tailored to International markets	Regenerative story tailored for international	Dairy

Question	*Statement*	*Sector*
Story-telling / branding of "regenerative" NZ farm produce are tailored to International markets	Regenerative story tailored for international	SheepBeef
Story-telling / branding of "regenerative" NZ farm produce is tailored to International markets	Regenerative story tailored for international	Arable
Story-telling / branding of "regenerative" NZ farm produce are tailored to domestic markets	Regenerative story tailored for NZ	Dairy
Story-telling / branding of "regenerative" NZ farm produce are tailored to domestic markets	Regenerative story tailored for NZ	SheepBeef
Story-telling / branding of "regenerative" NZ farm produce is tailored to domestic markets	Regenerative story tailored for NZ	Arable
Story-telling about "regenerative" NZ systems requires minimum verification as long as there is plenty farmer-led evidence available	Verification based on farmer evidence	Dairy
Story-telling about "regenerative" NZ systems requires minimum verification as long as there is plenty farmer-led evidence available	Verification based on farmer evidence	SheepBeef
Story-telling about "regenerative" NZ systems requires minimum verification as long as there is plenty farmer-led evidence available	Verification based on farmer evidence	Viticulture
Story-telling about "regenerative" NZ systems requires minimum verification as long as there is plenty farmer-led evidence available	Verification based on farmer evidence	Arable
Story-telling about "regenerative" NZ systems requires rigorous verification using scientific quantitative methods in order to provide market advantage	Verification based on science	Viticulture
Story-telling about "regenerative" NZ systems requires rigorous verification using scientific quantitative methods in order to provide market advantage	Verification based on science	Arable
Story-telling about "regenerative" NZ systems requires rigorous verification using scientific quantitative methods in order to provide market advantage	Verification based on science	Dairy
Story-telling about "regenerative" NZ systems requires rigorous verification using scientific quantitative methods in order to provide market advantage	Verification based on science	SheepBeef
Story-telling about "regenerative" NZ systems is compelling and provides access to premium / niche market	Verification not needed, story-telling works well	Arable
Story-telling about "regenerative" NZ systems is compelling and provides access to premium / niche market	Verification not needed, story-telling works well	Dairy
Story-telling about "regenerative" NZ systems is compelling and provides access to premium / niche market	Verification not needed, story-telling works well	SheepBeef
Story-telling about "regenerative" NZ systems is compelling and provides access to premium / niche market	Verification not needed, story-telling works well	Viticulture

Question	*Statement*	*Sector*
The ability to trace farm produce to its producer can provide market advantage (provenance) , because of NZ "green" reputation (no need for additional verification)	Verification not needed, traceability & NZ reputation work	Arable
The ability to trace farm produce to its producer can provide market advantage (provenance) , because of NZ "green" reputation (no need for additional verification)	Verification not needed, traceability & NZ reputation work	Dairy
The ability to trace farm produce to its producer can provide market advantage (provenance) , because of NZ "green" reputation (no need for additional verification)	Verification not needed, traceability & NZ reputation work	SheepBeef
The ability to trace wine to the vineyard can provide market advantage (provenance) , because of NZ's "green" reputation.	Verification not needed, traceability & NZ reputation work	Viticulture
The ability to trace farm produce to its producer can provide market advantage (provenance), but only if the producer can demonstrate particular desired outcomes (e.g. protection of biodiversity / C sequestration in soils..)	Verification of outcomes is needed to back up traceability	Arable
The ability to trace farm produce to its producer can provide market advantage (provenance), but only if the producer can demonstrate particular desired outcomes (e.g. protection of biodiversity / C sequestration in soils..)	Verification of outcomes is needed to back up traceability	Dairy
The ability to trace farm produce to its producer can provide market advantage (provenance), but only if the producer can demonstrate particular desired outcomes (e.g. protection of biodiversity / C sequestration in soils..)	Verification of outcomes is needed to back up traceability	SheepBeef
The ability to trace wine back to the vineyard can provide market advantage (provenance), but only if the producer can demonstrate particular desired outcomes (e.g. protection of biodiversity / C sequestration in soils..)	Verification of outcomes is needed to back up traceability	Viticulture

Appendix 4. Survey questionnaire 4: indicators of outcomes

In order to ascertain the indicators people used to monitor different aspects of their farm system and farm business, participants were invited to respond to the following questions in an online Google document:

- Do you regularly assess or measure soil fertility? If so, how?
- Do you assess / measure soil biological activity? If so, how?
- Do you assess or measure whether pasture quality is good quality feed? If so, how?
- If applicable: How do you assess / measure the health and performance of your crops? What observations do you make? Do you use any lab-based measures?
- Do you assess / measure whether your system protects / enhances biodiversity? If so, how?
- How do you assess how much / whether there is leaching from the soils of your property?
- How do you assess / measure the health of the waterways on your farm (if any)?
- How do you assess the quality / health of the water leaving your farm?
- How do you assess whether your business is economically successful?
- How do you forecast whether your business will be profitable this year?
- How do you assess whether your employees are happy when they work on your farm? (if any)
- How do you assess how efficiently you recycle waste?
- How do you assess how efficiently you use external resources (water, etc..)?
- Overall, do you have ways of assessing / measuring the wellbeing of your farm (as a whole ecosystem)? If so, please can you write a few words about that?

Appendix 5. Survey questionnaire 5: What works and what doesn't, and how does NZ compare with overseas

Participant from all sectors were invited to respond to the following questions (targeted towards their sector) in an online Google document:

- In your opinion, what is working well in NZ (arable/Beef and sheep/dairy/viticulture) systems and can remain the same?
- In your opinion, do NZ (arable/Beef and sheep/dairy/viticulture) systems perform better than overseas systems? please explain
- In your opinion, what is not working well in NZ (arable/Beef and sheep/dairy/viticulture) systems? i.e. what issues need to be resolved? these can be environmental, economic or social / cultural

Appendix 6. Survey questionnaire 6: What are key research needs

To complete a survey entitled "Research / Data priorities", participants were asked:

Please indicate below how important you see these topics to be assessed in the context of regenerative agriculture, for your sector – selecting one answer amongst 1 (not so important), 2 (quite important), 3 (very important) and 4 (extremely important).

Below a the list of questions asked, along with the corresponding research area code used to analyse the data, and the broad research theme used to colour code the windrose data plot.

Question	*Research Area*	*Sector*	*Broad research theme*
A circular economy in the diary sector is organised - whereby multiple farms complement each other with their produce	Circular systems, circular economy	Dairy	Circularity
Long-term effects of reducing above ground inputs on soil fertility and yields	Impacts of reducing inputs	Arable	Circularity
Low dependency of external mineral input (fertilisers and mineral	Impacts of reducing inputs	Dairy	Circularity
Low dependency of external mineral input (fertilisers and mineral	Impacts of reducing inputs	SheepBeef	Circularity
Low dependency of external mineral input (fertilisers and mineral	Impacts of reducing inputs	Viticulture	Circularity
Low dependency on external mineral inputs (fertilisers)	Impacts of reducing inputs	Arable	Circularity
Reducing chemical inputs whilst maintaining clean seed lines	Impacts of reducing inputs	Arable	Circularity
Repercussions of reducing chemical inputs are understood	Impacts of reducing inputs	Arable	Circularity
Closing the loops: Waste is handled responsibly and recycled	Managing on farm waste	Dairy	Circularity
Closing the loops: Waste is handled responsibly and recycled	Managing on farm waste	SheepBeef	Circularity
Closing the loops: Waste is handled responsibly and recycled	Managing on farm waste	Viticulture	Circularity
Use of non-renewable resources is minimised	Reducing use of non-renewables	Dairy	Circularity
Use of non-renewable resources is minimised	Reducing use of non-renewables	Dairy	Circularity
Use of non-renewable resources is minimised	Reducing use of non-renewables	SheepBeef	Circularity
Use of non-renewable resources is minimised	Reducing use of non-renewables	Viticulture	Circularity
Mindset of continuous improvement	Farmer mindset	Arable	Culture & Values
Mindset of continuous improvement	Farmer mindset	Dairy	Culture & Values

Question	*Research Area*	*Sector*	*Broad research theme*
Mindset of continuous improvement	Farmer mindset	SheepBeef	Culture & Values
Mindset of continuous improvement	Farmer mindset	Viticulture	Culture & Values
Ability to leave positive legacy to next generation	Long term viability of whole systems	Arable	Culture & Values
Ability to leave positive legacy to next generation	Long term viability of whole systems	Dairy	Culture & Values
Ability to leave positive legacy to next generation	Long term viability of whole systems	SheepBeef	Culture & Values
Ability to leave positive legacy to next generation	Long term viability of whole systems	Viticulture	Culture & Values
Te Ao Māori is acknowledged and promoted	Regenerative agriculture and Te ao Maori	Arable	Culture & Values
Te Ao Māori is acknowledged and promoted	Regenerative agriculture and Te ao Maori	Dairy	Culture & Values
Te Ao Māori is acknowledged and promoted	Regenerative agriculture and Te ao Maori	SheepBeef	Culture & Values
Te Ao Māori is acknowledged and promoted	Regenerative agriculture and Te ao Maori	Viticulture	Culture & Values
High standards: stewardship of the land	Stewardship	Arable	Culture & Values
high standards: stewardship of the land	Stewardship	Dairy	Culture & Values
high standards: stewardship of the land	Stewardship	SheepBeef	Culture & Values
Kaitiakitanga: High standards in stewardship of the land	Stewardship	Viticulture	Culture & Values
Ability to secure commodity market based on added environmental	Commodity market access	Dairy	Economy
Ability to secure commodity market based on added environmental	Commodity market access	SheepBeef	Economy
Ability to secure commodity market based on added environmental	Commodity market access	Viticulture	Economy
Ability to secure commodity markets based on added environmental accountability	Commodity market access	Arable	Economy
Ability to secure niche / premium markets	Premium market access	Arable	Economy
Ability to secure niche / premium markets	Premium market access	Dairy	Economy
Ability to secure niche / premium markets	Premium market access	SheepBeef	Economy
Ability to secure niche / premium markets	Premium market access	Viticulture	Economy
High profitability & profit margins & returns on investments	Profitability	Arable	Economy
High profitability & profit margins & returns on investments	Profitability	Dairy	Economy

Question	*Research Area*	*Sector*	*Broad research theme*
High profitability & profit margins & returns on investments	Profitability	SheepBeef	Economy
High profitability & profit margins & returns on investments	Profitability	Viticulture	Economy
High standards: animal welfare	Animal welfare	Dairy	Environment
High standards: animal welfare	Animal welfare	SheepBeef	Environment
Biodiversity, and natural habitats are protected and enhanced	Biodiversity and natural habitats	Arable	Environment
Biodiversity, and natural habitats are protected and enhanced	Biodiversity and natural habitats	Dairy	Environment
Biodiversity, and natural habitats are protected and enhanced	Biodiversity and natural habitats	Viticulture	Environment
Biodiversity, native, is protected and enhanced	Biodiversity and natural habitats	SheepBeef	Environment
Biodiversity: landscape configuration is optimised to support ecosystem services	Configuring landscape for biodiversity	Arable	Environment
Biodiversity: landscape configuration is optimised to support native species	Configuring landscape for biodiversity	Dairy	Environment
Biodiversity: landscape configuration is optimised to support native species	Configuring landscape for biodiversity	Viticulture	Environment
At what point along the spectrum does a system shift from being mitigative to regenerative.	Differentiating 'Regenerative'	Arable	Environment
High standards: healthy waters	Impacts on water	Arable	Environment
High standards: healthy waters	Impacts on water	Dairy	Environment
High standards: healthy waters	Impacts on water	SheepBeef	Environment
High standards: healthy waters	Impacts on water	Viticulture	Environment
Solution to climate change: lower methane emission	Methane emissions	Dairy	Environment
Solution to climate change: lower methane emission	Methane emissions	SheepBeef	Environment
Biodiversity in the vineyard is high and supports the performance of the vineyard	On-farm total biodiversity	Viticulture	Environment
Biodiversity on-farm is high	On-farm total biodiversity	Arable	Environment
Biodiversity on-farm is high	On-farm total biodiversity	Dairy	Environment
Biodiversity on-farm is high	On-farm total biodiversity	SheepBeef	Environment
High resilience to drought / flood	Resilience to extreme weather	Arable	Environment
High Resilience to drought / flood	Resilience to extreme weather	Dairy	Environment

Question	*Research Area*	*Sector*	*Broad research theme*
High Resilience to drought / flood	Resilience to extreme weather	SheepBeef	Environment
High resilience to drought / flood	Resilience to extreme weather	Viticulture	Environment
Contamination of near-by seed lines from cover crop mixes	Seed contamination from cover crops	Arable	Environment
Solution to climate change: carbon sequestration	Soil carbon	Arable	Environment
Solution to climate change: carbon sequestration	Soil carbon	Dairy	Environment
Solution to climate change: carbon sequestration	Soil carbon	SheepBeef	Environment
Solution to climate change: carbon sequestration	Soil carbon	Viticulture	Environment
If stop/starting tillage - how long is the recovery time for fungal networks after they have been disrupted?	Tillage impacts on fungal networks	Arable	Environment
High quality food & safe food	Food quality and safety	Arable	Food Quality
High quality food & safe food	Food quality and safety	Dairy	Food Quality
High quality food & safe food	Food quality and safety	SheepBeef	Food Quality
High quality food & safe food	Food quality and safety	Viticulture	Food Quality
Soil health can be optimised to increase soil carbon and improve / maintain grape quality / flavours	Soil carbon and grape flavour	Viticulture	Food Quality
Farmers, value & supply chains, regulators take responsibility and are all accountable	Accountability in food systems	Arable	Society
Farmers, value & supply chains, regulators take responsibility and are all accountable	Accountability in food systems	Dairy	Society
Farmers, value & supply chains, regulators take responsibility and are all accountable	Accountability in food systems	SheepBeef	Society
Growers, value & supply chains, regulators take responsibility and are all accountable	Accountability in food systems	Viticulture	Society
Farming is fun	Enjoyment in farming	Arable	Society
Farming is fun	Enjoyment in farming	Dairy	Society
Farming is fun	Enjoyment in farming	SheepBeef	Society
Grape growing is fun	Enjoyment in farming	Viticulture	Society
Strong support network for farmers by farmers	Farmer and grower networks	Arable	Society
Strong support network for farmers by farmers	Farmer and grower networks	Dairy	Society
Strong support network for farmers by farmers	Farmer and grower networks	SheepBeef	Society

Question	*Research Area*	*Sector*	*Broad research theme*
Strong support network for growers by growers	Farmer and grower networks	Viticulture	Society
Farmers feels empowered and trusted	Farmer trust and empowerment	Arable	Society
Farmers feels empowered and trusted	Farmer trust and empowerment	Dairy	Society
Farmers feels empowered and trusted	Farmer trust and empowerment	SheepBeef	Society
Growers feels empowered and trusted	Farmer trust and empowerment	Viticulture	Society
Social licence to farm	Social licence to farm	Arable	Society
Social licence to farm	Social licence to farm	Dairy	Society
Social licence to farm	Social licence to farm	SheepBeef	Society
Social licence to grow grapes	Social licence to farm	Viticulture	Society