Kaitiaki Intelligence Platforms

Earth Quotient

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Meeting the Needs of the Assurance Sector: Informing the Kaitiaki Intelligence Platform Design

The Kaitiaki Intelligence Platforms (KIPs) project aims to position Māori at the forefront of cutting-edge remote environmental sensing in Aotearoa.

Leveraging the latest and emerging technologies, this project is designing a robust tech platform that will empower iwi to access real-time and precise information about the environmental condition of their rohe (territories). Furthermore, it will equip Māori farming collectives with the essential data to confidently manage their farms in alignment with their kaitiaki principles. Additionally, the platform will facilitate Māori farms in verifying their sustainable production to markets, regulators, and assurance bodies. Simultaneously, it will provide invaluable data to iwi for informed decision-making regarding their environmental management plans and policies.

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Introduction and context

The Kaitiaki Intelligence Platforms (KIPs) project is a Māori-led initiative to design an environmental sensing network (the Kaitiaki Intelligence Platform (KIP)) that can provide Māori governors and land managers with near real-time environmental intelligence. One use of this data is to aid Māori food producers in meeting the sustainability verification standards and environmental reporting requirements of markets, industry, and regulators – referred to collectively in this report as the 'assurance sector'. The environmental intelligence needs of this sector is explored in this report, and the extent to which the data they require may be autogenerated by a KIP. The purpose of the report is to create insights that may be used to inform the KIP design and automate reporting to the assurance sector.

The report provides background regarding the assurance sector before drilling down into specific indicators and metrics currently used, or under development, to verify/audit the environmental impacts of land management practices. The report also incorporates insights from 44 thought leaders that operate in the assurance sector – including regulatory agencies, accreditation bodies, assurance providers and retailers to determine their readiness for adopting new technologies to automate environmental reporting processes. It has a strong focus on the three priority areas for Māori and New Zealanders generally: carbon, water, and biodiversity. This report also defines the relevant indicators and metrics to be incorporated into a KIP design to meet assurance sector requirements, and outlines the next stages that are necessary to ensure acceptance of KIPs by the assurance sector.

Compared to other industry sectors, the assurance sector is often perceived as rather conservative and lagging in adopting new technologies and updating their modus operandi. In fact, many experts observe that the underlying assurance processes have not changed since the 1950s.

History of Field

The origins of assurance practices are found in ancient China, with subsequent developments in regions such as medieval Europe, where Guilds provided assurance and saw such practices adopted and adapted. With growing global trade, assurance practices focused on the development of standards and processes that made such trade more reliable and robust. During the industrial revolution, assurance practices supported the growth of mass production, ensuring consistency of processes and efficiency in production. Technological development and scientific discoveries were embedded into assurance practices over time. For example, in the 1930s, statistical techniques were introduced to improve the effectiveness of assurance processes. Ideas such as using sampling and statistical models to predict and prevent failure were central to assurance practice. After World War II (WWII) assurance practice broadened in scope, embracing the idea of 'systems thinking' with the focus shifting from management of individual processes to management of entire organisations. The scope also grew to encompass more domains: from manufacturing and a focus on quality to other domains such as environmental management and social responsibility. Since WWII there has also been a globally orchestrated effort to coordinate assurance practice, which led to the development of the assurance sector today. The contemporary assurance sector consists of a network of actors who develop standards, regulatory mechanisms, governance mechanisms, and auditing practice, and who coordinate their efforts across the globe to provide a 'quality infrastructure'.[1]

The environmental (or sustainability) domain has grown rapidly since the 1990s. First, international standards such as the International Standards Organisation (ISO) 14001 evolved alongside similar pathways as early quality assurance standards. These were industry driven, focusing on the development of process-based system indicators and largely using the same infrastructure as their quality predecessors. In the 1990s however, new entrants flooded the sustainability domain. Driven by gaps in international regulation (and global disenchantment with the environmental performance of multinational corporations), multi-stakeholder initiatives (MSI) emerged and developed their own assurance schemes. Examples include well-known schemes such as Forest Stewardship Council (FSC) in forestry, organic certification, Rainforest Alliance (a scheme for commodities), and Roundtable on Sustainable Palm Oil (RSPO) for palm oil, amongst many others. These assurance schemes have introduced several important innovations to the sector. For example, stakeholders have been invited to create standards and indicators as well as participate in governance of assurance schemes. A focus on impacts become central to the efforts of MSIs (at least the most advanced) and assurance providers started to collect fact-based evidence on these. MSIs also introduced more transparency in their operations. For example, audit reports started to be publicly available,

and impact reports are now shared with the general public and verified by third parties. MSIs also proved more flexibility in organising themselves and in the development of governance mechanisms. For example, the International Social and Environmental Accreditation and Labelling Alliance (ISEAL), an umbrella organisation for leading assurance providers in the sustainability domain, developed a series of standards and initiatives on governance, impact measurement, and verification of claims which were adopted by assurance providers.

Other organisations with a traditional oversight role for financial auditing are expanding their activity to also include oversight of non-financial environmental and sustainability auditing and assurance. The External Reporting Board (XRB) is an independent Crown Entity and the legislated New Zealand organisation that develops and issues reporting standards on accounting, climate, audit, and assurance for entities across the private, public, and not-for profit sectors. These define what and how entities must report to meet regulatory requirements. The New Zealand Auditing and Assurance Standards Board (NZAuASB) has delegated authority from the XRB Board to develop, adopt, and issue auditing and assurance standards, including professional and ethical standards for assurance practitioners.[2] The XRB Au1 standard is the overarching standard issued by the XRB covering the application of audit and assurance standards, including Non-Financial Assurance Engagement Standards (NFAES). XRB NFAES include ISAE NZ 3000, updated in 2022 (which aligns with the IAASB International Standard on Assurance Engagements 3000).

Compared to other industry sectors, the assurance sector is often perceived as rather conservative and lagging in adopting new technologies and updating their *modus operandi*. In fact, many experts observe that the underlying assurance processes have not changed since the 1950s.[3] Such inertia could be explained in part by the complexity and global interconnections of key actors in the sector. For example, harmonisation processes require time for negotiation, consensus building, and adoption across the entire global economy to ensure that trust is sustained in the integrity of assurance processes. MSIs and private schemes tend to be leaner, yet even in this domain changes take time.

There are several global organisations governing the sector, with ISO, International Electrotechnical Commission (IEC), and International Accreditation Forum (IAF) among the most important. These three are instrumental in setting the standards and guiding documents for the sector. For example, ISO standards for audit processes, certification bodies, testing laboratories, and inspection bodies are used across the globe to monitor actors in the assurance sector. IAF is also instrumental in introducing guidance for the sector. In 2017 IAF developed the first guidance document for remote audits and assessment and the use of Information and Communications Technology (ICT) – considered to be a key document in setting the scene for the sector during the pandemic. Notably, private actors such as MSIs also rely on these organisations in their governance and operations.

Consistent with current trends, the assurance sector is primary focused on the digitalisation (that is, the conversion of analogue processes into ICT processes) of their service. The COVID-19 pandemic was an import milestone. Although previously rather reluctant to adopting progressive approaches for assurance, during the pandemic the assurance sector witnessed a rapid uptake of ICT technologies. This trend continues, and the sector is building up its capability to adopt more advanced technologies such as drones, satellites, remote sensors, robots, and wearable technologies.[4] The sector is also increasingly focusing on social responsibility, which includes issues such as worker conditions (child labour, modern slavery) and equitable distribution of profits in supply chains. Alongside the adoption of social responsibility, the current debate also centres on who should 'control' the assurance sector. Governments across the globe are increasingly proactive in their due diligence against modern slavery, a domain previously associated with MSIs. At the same time, private firms are increasingly focused on the development of in-house assurance systems – shying away from MSIs and Non-Government Organisation (NGO) based standards (a trend apparent, for example, in the context of regenerative farming). Alongside digitalisation (and changes in ownership and governance), the assurance sector is also trying to address growing cynicism about the actual impact of assurance, accusations of greenwashing, and frustration with the bureaucratisation of assurance practices and their ever-increasing cost. The time is ripe to rethink and redesign assurance processes.

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1. UNIDO. (2020). Advancing Conformity Assessment for the New Digital Age. Vienna, Austria: UNIDO, Department of Digitalization, Technology, and Innovation (DTI).
2. https://www.xrb.govt.nz/standards/assurance-standards/how-we-set-our-standards/audit-and-assurance-standard-board/
3. Herding, W., & Fischer, S. (2015). Smart Data: An Exploration of Technology Innovations for Sustainability Standards Systems. London: the ISEAL Alliance.
4. Castka, P., & Searcy, C. (2023). Audits and COVID-19: A paradigm shift in the making. *Business Horizons, 66*(1), 5-
5. New Zealand Institute of Economic Research. (2017). Examining the way IANZ supports the New Zealand economy. NZIER.
6. Swann, G.M.P. (2010). The Economics of Standardization: An Update, Report for the UK Department of Business, Innovation and Skills (BIS). Innovative Economics Limited.

Literature Review

Background to the assurance sector

The New Zealand conformity assessment system plays a significant role in international trade and the NZ economy. This impact is illustrated through the activity of IANZ, one of New Zealand's two accreditation bodies. IANZ supports production in sectors that employ over 357,700 workers, accounting for 17% of all employment in New Zealand. Through its accreditation activities, IANZ also plays a valuable role in supporting New Zealand's exports. The total value of these IANZ-facilitated exports was $27.6 billion in the year to June 2016, or 56.5% of New Zealand's total merchandise exports.[5] IANZ supports industries that produce $35.8 billion of GDP. Economic modelling demonstrates that IANZ secures a $4.5 billion export premium for accredited exporters. Global studies such as the UK report on the value of conformity assessment argue that conformity assessment delivers an average of 8% price premium over non-accredited products.[6] This finding provides an indication of the additional value generated by conformity assessment of the type IANZ delivers, though the premium could be considerably higher in New Zealand given the country's reliance on primary exports that need accreditation.

The assurance sector consists of a complex network of actors, including conformity assessment bodies (CABs) such as certification, testing, and inspection bodies, accreditation bodies (of which each country has one or more), the companies subject to audit and inspection, and others such as governments or NGOs.[7] Each actor has a specific role in the system. For example, accreditation bodies monitor conformity assessment bodies to establish that their services (such as audits or laboratory testing) are conducted consistently and in line with requirements. Conformity assessment bodies determine whether products, processes, systems, and people meet requirements.[8]

The assurance sector can be divided into two main domains: voluntary and mandatory. Each domain has its specifics (who determines standards and indicators, and how), but at the same time, the two domains are interlinked. Voluntary standards are used to provide assurance for regulatory purposes. For instance, Synlait's Lead with Pride (a private voluntary assurance system) is used to satisfy compliance criteria for Environment Canterbury (ECan) requirements for a Farm Environment Plan.[9]

Figure 1 (p12) provides an overview of how assurance is provided in the voluntary domain (i.e., industry) and the regulatory domain (i.e., government), and the process used for assurance for customers:

7. Reber, K. (1999). A combination of accreditation and certification in an evolving process at EMPA: A management system to meet ISO 9001, ISO 14001 and EN 45001. Accreditation and Quality Assurance, 4(4), 156-157; Castka, P. (2013). Audit and Certification: what do users expect? Canberra, Australia: Joint Accreditation System of Australia and New Zealand.

8. UNIDO. (2020). Advancing Conformity Assessment for the New Digital Age. Vienna, Austria: UNIDO, Department of Digitalization, Technology, and Innovation (DTI).

9. To facilitate this, Lead with Pride, has been accredited to the ISO 17065 by JAS-NAZ (Accreditation body) as well as approved by Ecan https://www.ecan.govt.nz/your-region/farmers-hub/fep/fep-audits/

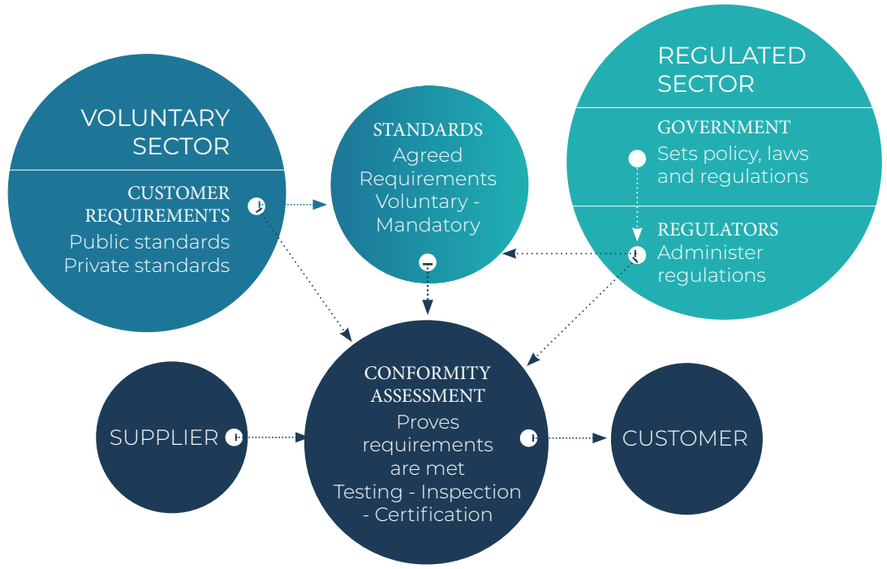


Figure 1. Relationships between voluntary and regulatory sectors and standards[10]

Development of standards and indicators

The various actors also participate in the development of standards and indicators. Standards are documents, established by consensus and approved by a recognised body, that provide (for common and repeated use) rules, guidelines, and characteristics for activities or their results, aimed at achieving the optimum degree of order in a given context. Standards can be developed by various actors: committees at recognised standardisation bodies (e.g., ISO or IAF), industry associations (e.g., New Zealand Farm Assurance (NZFAP)), regulators (e.g., New Zealand Freshwater farm management program) or private actors (e.g., Starbucks' CAFÉ Program or Synlait's Lead with Pride).

An Indicator provides evidence that a condition exists or that certain results have or have not been achieved. Indicators can be either quantitative or qualitative, and are not created equal, providing different evidence depending on type. The assurance sector uses a hierarchy of indicators outlined in Figure 2 (p13).

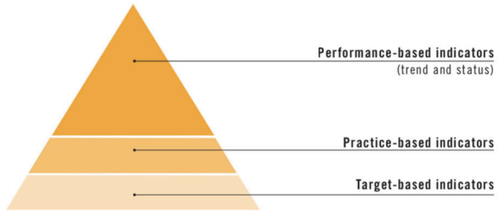
Conformity assessment in the assurance sector

Conformity assessment is the process used to prove that the requirements of standards are met. The assurance sector relies primarily on in-person audits and *in situ* collection of data. Some data collection is managed by firms using monitoring. For example, farmers use sensors on farms to monitor water quality. Still, onsite inspections are used to verify the data and approve farm management practices. The audit process typically involves a visit by an auditor, with the frequency of audit often determined by the risk profile of the operator and their previous audit results.[12] Auditors review evidence for

10. Russ M, et al. (2009) Environmental Assurances Research Report. Prepared for Ministry of Agriculture and Fisheries.

11. Food and Agriculture Organization of the United Nations. (2014). Sustainability Assessment of Food and Agriculture Systems (SAFA) Guidelines Version 3.0. ISBN 978-92-5-108485-4 (print), E-ISBN 978-92-5-108486-1 (PDF). https://www.fao.org/3/i3957e/i3957e.pdf

12. Arvanitoyannis, I. S., Samourelis, K., & Kotsanopoulos, K. V. (2016). A critical analysis of ISO audits results. *British Food Journal, 118*(9), 2126-2139. The following document by International Accreditation Forum (IAF) provides more insight into conceptualizing of risk: IAF. (2015). Determination of Audit Time of Quality and Environmental Management Systems. IAF MD 5:2015. International Accreditation Forum.



- **Performance-based indicators, also called results-oriented or outcome indicators.** Performance based indicators are focused on the results of compliance with an objective and can measure the performance of an operation, identify trends and communicate results.
- **Practice-based indicators, also called prescriptive or process indicators.** These indicators prescribe that the necessary tools and systems be in place to ensure best practices. These indicators are process, rather than outcome-oriented. For example, these indicators assume that having health and safety management systems in place leads to better management of health and safety issues. The cause-effect between a given practice and a result is however never precise.
- **Target-based indicators.** These indicators focus on whether the operation has plans, policies or monitoring, with targets and ratings based on steps towards implementing them .

Figure 2. Hierarchy of indicators[11]

compliance with assurance programme requirements, which are typically defined in a standard and reported by the firm being audited. It should be noted that audits differ from surveillance. An audit involves examination and analysis as well as monitoring and observation. However, surveillance only involves monitoring and observation and although it can provide information in support of an audit process, it cannot typically replace it. The audit may identify issues that need to be addressed by the operator (corrective actions), with the response time possibly varying depending on the criticality of the issue.[13] An assessment of compliance is provided – this can range from a simple pass/fail to a score or risk-based assessment.[14] Some assurance programmes require demonstration of continuous improvement by the firm being audited.

During the COVID-19 pandemic, remote audits gained prominence. Remote audits focus on replicating existing processes using ICT (Teams/ZOOM/Webex) in combination with cameras and phones.[15] The assurance sector has learnt a lot from the rapid introduction of remote audits during the pandemic, with an overarching lesson that a blended approach (mixing in situ and remote audits) is the next natural step in the provision of assurance services. This blended approach is often labelled a 'hybrid audit'.[16]

Additional factors impacting the integrity of conformity assessment verification include how often audits are conducted (typically annually), who undertakes the audit (3rd, 2nd, or 1st party), and the use of announced audits. Also important is the audit's scope – for example, whether production processes as well as the performance/ impacts of farming systems are audited; whether interviews are undertaken with workers; whether external stakeholders are consulted; the qualification, training, and independence of auditors; and the level of compliance to standard requirements and recommendations.

13. IAF. (2009). IAF Mandatory Document for Duration of QMS and EMS Audits. IAF MD 5: 2009, 18. International Accreditation Forum.

14. Busch (2011) provides a useful taxonomy of standards based on pass-fail and risk-based assessment approaches. See Busch, L. (2011). Standards. Recipes for Reality. Boston: The MIT Press.

15. See for example: Castka, P., Zhao, X., Bremer, P., Wood, L., & Mirosa, M. (2021). Remote auditing and assessment during the COVID-19 pandemic in New Zealand and China. Learnings from the food industry and guidance for the future. Wellington, New Zealand: A report for New Zealand China Food Protection Network (NZCFPN), and Koch, C., Asna Ashari, P., Mirtsch, M., Blind, K., & Castka, P. (2022). Impact of the COVID-19 pandemic on accredited conformity assessment bodies: insights from a multinational study. Accreditation and Quality Assurance, 27(5), 275-288.

16. UNIDO. (2022). Remote Conformity Assessment in a Digital World. Opportunities, challenges, and implications for developing countries. Vienna, Austria: United Nations Industrial Development Organization.

Demand for assurance services

The literature commonly describes three institutional forces that drive demand for assurance services: coercive, normative, and mimetic.[17]

- Coercive forces: Organisations often have no choice and must comply with the requirements and standards. There are multiple reasons for and manifestations of coercion, such as:
  - Standards and conformity assessment are part of international trade and trade agreements, and organisations that do not comply are excluded from the trade;[18]
  - Governments (national, regional) impose regulatory compliance, such as farm management regulations – demanded by central or regional government,[19] or due diligence legislation;[20]
  - Private (and powerful) actors impose standards and certification upon elements of their supply chains such as processors and markets (for example Zespri, Fonterra, or retailers such as Countdown).
- Normative forces: Institutions in the assurance sector institutionalise certain practices (how things should be done) and establish their right and legitimacy to monitor others.
- Mimetic forces: Organisations often monitor their external operating environment and imitate the actions of others at the location or in their industry sector. Organisations may benchmark themselves against the exemplars in their domains – if such an organisation seeks assurance services, others in their markets will follow this lead.

Determining the value of assurance services

Market access and regulatory compliance both provide value to customers. From these two perspectives, the assurance sector provides a basic licence to operate to organisations that would otherwise be excluded from the marketplace. However, the assurance sector also serves organisations that look to *enhance* the value of their products and service. To enhance value, assurance providers need to offer services that exceed the basic levels.

'Value enhancement' assurance services have many forms. Provision of such services requires the collection of precise and timely data of the kind valued by customers and/or consumers. These services include the following illustrative examples:

- Verification of unique (and hidden) attributes – this includes certification of indigenous products, handcrafted products, or products produced through unique processes or reflecting cultural values and traditions. Examples include organic certification, the Māori organic certification scheme Hua Parakore, and certification of artisan products.[21]
- Verification of environmental claims – the growing number of assurance claims means new mechanisms are being developed to differentiate them. For example, ISEAL has developed methodologies to verify environmental claims. Their initiative involved an independent review to support the translation of evidence-based, scientifically-grounded information into business-ready information.[22]
- Verification of assets – the assurance sector is also involved in verification of assets, such as carbon sinks for the emissions trading market. The AgriBusiness Group is working with farmers to assess the potential of farms to obtain carbon credits for regenerating native forests and assist them in entering the New Zealand Emissions Trading Scheme (ETS).[23] The use of drones to map and assess the suitability of forest to meet ETS requirements has significantly increased the efficiency of undertaking these tasks.[24]
- Investors and Environmental, Social, Governance (ESG) reporting – data is also being sought to provide assurance to investors about the environmental credentials of firms. For example, Sustainable Agriculture and Finance Initiative (SAFI) or ESG reporting.[25]

Challenges faced by the assurance sector

The assurance sector has been subject to increasing criticism and challenged on multiple (often fundamental) issues central to the provision of assurance services, including inconsistent assurance processes and accusations of greenwashing. Such criticisms present the sector with complex challenges. Below, we outline the major areas of criticism. We assert that an understanding of these challenges is fundamental to KIPs as they provide a window on to the urgent needs of the sector.

- Lack of impact: At present, the assurance sector is often criticised for insufficient focus on impact measurement and overreliance on target-based indicators (see Figure 2: Hierarchy of indicators, p13). In the environmental domain, there is also growing cynicism about the actual impact of environmental monitoring.[26] Such cynicism is observable in the voluntary domain (e.g., Voluntary Sustainability Standards (VSS)) and in relation to regulatory assurance. Passing an audit to ensure a social licence to operate for an organisation yet little changing as a result – this is labelled

17. This stream of literature follows from the theoretical underpinnings that were developed by DiMaggio and Powell (1983) – see DiMaggio, P., & Powell, W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. American Sociological Review, 48(2), 147-160.

18. Blind, K., Mangelsdorf, A., & Pohlisch, J. (2018). The effects of cooperation in accreditation on international trade: Empirical evidence on ISO 9000 certifications. International Journal of Production Economics, 198, 50-59.

19. MPI. (2021). Fit for a Better World. Accelerating our economic potential. Wellington, New Zealand: Ministry for Primary Industries.

20. Due diligence legislation and legislation to cover modern slavery has been introduced in several countries (Australia, UK, Germany) and is currently discussed in NZ.

21. There has been extensive research funded by *Our Land and Water* that provides insights on potential opportunities for assurance programmes to incorporate Māori cultural values and the potential demand for products with these attributes in international markets. Publications include The Distinctive Cultural Attributes of Food (Matthew Rout and John Reid, 2019), Cultural Attributes of Ngāi Tahu Food and the International Consumer Cultures that Will Recognise Them (Matthew Rout and John Reid, 2020), and Opportunities for Māori to access premium market (John Reid et al., 2019).

22. ISEAL's The VIA (Values and Impact) Initiative (https://www.isealalliance.org/sites/default/files/resource/2018-06/VIA_Initiative_Report_final.pdf) aims to enhance the credibility of communication in the forest products value chain. Supported by several major companies, such as IKEA, Kingfisher, Tetra Pak, and Precious Woods.

23. https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/

24. Another possible use is for the assessment of biodiversity offsets – see Bull, J., Suttle, K., Gordon, A., Singh, N., & Milner-Gulland, E. (2013). Biodiversity offsets in theory and practice. Oryx, 47(3), 369-380.

25. https://www.sustainablefinance.nz/updates/draft

26. A report by MSI Integrity came out with scathing criticism of sustainability initiatives – perhaps a bit unjustifiably picking on FSC and Fairtrade – but with many valid points.

by the literature a ‘symbolic’ assurance practice.[27]

- Frustration with the compliance process: Organisations are showing growing discontent with assurance practice, particularly a focus on target-based indicators which often leads to increased bureaucratisation and overwhelming documentation. Organisations increasingly consider assurance activities a ‘necessary evil’ which add little value, are disconnected from their everyday processes, lack veracity and timeliness, and lead to ‘audit fatigue’.[28]
- Confusion about standards and labels: With the growing number of assurance schemes and services it is becoming increasingly hard to distinguish between them, for managers and consumers alike. For example, organic certification marks are not relied on by most organic shoppers.[29] The shifts in governance of assurance are also remarkable. Governments seem to be overtaking some domains of assurance that were traditionally managed voluntarily, such as due diligence. Likewise, companies are moving away from NGO-based programmes to develop their own standards and reporting systems. An area of active standard development is regenerative agriculture (RA). Leading food companies such as Unilever, McCain Foods, PepsiCo, General Mills, and Arla Foods have developed and promoted individualised RA assurance programmes. Meanwhile, NGO-led RA assurance programmes are relatively minor, and those developed by government regulators nearly invisible.
- Inconsistency in assurance practice: Numerous studies point out inconsistencies in the assurance sector.[30] Inconsistencies exist in relation to the stringency of standards and indicators.[31] For example, in forestry, the FSC is considered more stringent than both the Programme for the Endorsement of Forest Certification (PEFC) and the Sustainable Forestry Initiative (SFI) – even though all these certifications ‘ensure’ sustainable forestry management. The inconsistencies also relate to operational processes in assurance, such as differences in how individual auditors interpret standards and indicators.[32]

27. Donia, M. B., Ronen, S., Sirsly, C. A. T., & Bonaccio, S. (2017). CSR by any other name? The differential impact of substantive and symbolic CSR attributions on employee outcomes. Journal of Business Ethics, 157(2), 503-523; Delmas, M., & Montes-Sancho, M. (2010). Voluntary agreements to improve environmental quality: symbolic and substantive cooperation. Strategic Management Journal, 31(6), 575-601.

28. Castka, P., Searcy, C., & Mohr, J. (2020). Technology-enhanced auditing: Improving veracity and timeliness in social and environmental audits of supply chains. Journal of Cleaner Production, 258, 120773.

29. Organics Aotearoa New Zealand et al. (2018). 2018 New Zealand Organic Sector Market Report. Organics Aotearoa New Zealand.

30. Dogui, K., Boiral, O., & Heras-Saizarbitoria, I. (2014). Audit Fees and Auditor Independence: The Case of ISO 14001 Certification. International Journal of Auditing, 18(1), 14-26.

31. Castka, P., & Corbett, C. J. (2016). Governance of eco-labels: expert opinion and media coverage. Journal of Business Ethics, 135(2), 309-326.

32. Short, J. L., Toffel, M. W., & Hugill, A. R. (2013). What Shapes the Gatekeepers? Evidence from Global Supply Chain Auditors. Working paper, HBS.

Suitable Indicators/ Frameworks/Systems

The assurance sector collects a wide range of data. The data being sought includes specific domain data (e.g., data for the assessment of erosion control assets, effluent systems or similar) and more general data (e.g., data on health and safety practices, quality of products). The data serves as a factual basis upon which to assess a firm's compliance against a particular reference point (i.e., a standard or code of conduct) and its requirements.

Table 1: Generic assurance references

Organisation	Description
Normative references	
United Nations	United Nations Sustainable Development Goals
FAO	Food and Agriculture Organisation (FAO) Sustainability Assessment of Food and Agriculture systems (SAFA)
OECD	Organisation for Economic Co-operation and Development (OECD) Environment at a Glance Indicators
FAO Livestock Environmental Assessment and Performance Partnership (LEAP)	Environmental performance of large ruminant supply chains Guidelines for Assessment. A harmonized international approach to the assessment of the environmental performance of large ruminant supply chains in a manner that takes account of the specificity of the various production systems involved. It aims to increase understanding of large ruminant supply chains and help improve their environmental performance.
Regulations	
EU	European Union (EU) Regulation on Substantiating Green Claims based on the Product Environmental Footprint (PEF)
EU	The EU Directorate-General for Health and Food Safety is the sustainable food systems law. Expected by the end of 2023, this framework should include principles underpinning a sustainability label.
Standards	
EB2B and B2C assurance standards	There are a number of assurance programmes that have been established to provide verification of sustainability credentials between businesses operating in value chains (B2B). There are a large number of assurance standards (the International Trade Centre (ITC) Standards Map records over 300[28]) established to provide verification of sustainability credentials within value chains between businesses and consumers (B2C).[33]
Organisations/benchmarking/initiatives	
CGF SSCI	Consumer Goods Forum (CGF) Sustainable Supply Chain Initiative (SSCI)[34]
ISEAL	ISEAL has developed a series of standards and initiatives on governance, impact measurement, and verification of claims that have been adopted by assurance providers.
MPI	*"Fit for a better World – Accelerating our economic potential"*[35] presents a conceptual framework called Te Taiao that reflects and supports the current enthusiasm for regenerative agriculture and horticulture in New Zealand.
SAI	The Sustainable Agriculture Initiative (SAI) Platform has over 160 member companies and organisations, and focuses on the establishment of common sustainability assurance pathways.
Planet score	This is a new label developed to inform consumers about the environmental impact of food. The label indicates key points and major environmental issues related to food: pesticides, biodiversity, climate, and rearing methods. In Dec 2022 there were 184 companies testing the Planet-score. It has been positioned as an alternative to the Product Environmental Footprint (PEF) that the European Commission are proposing for the environmental labelling of food products.

Table 2: Carbon assurance references

Organisation	Description
Norms and regulations	
UNSDG goals	Goal 13 Climate Action
IPCC Reporting Guidelines	The Intergovernmental Panel on Climate Change (IPCC) has completed assessment reports, developed methodology guidelines for national greenhouse gas inventories, special reports, and technical papers.
FAO (LEAP)	Measuring and modelling soil carbon stocks and stock changes in livestock production systems. A harmonised, international approach for estimating soil organic carbon (SOC) stock and stock changes in livestock production systems.
GRI 305 Emissions 2016	Global Reporting Initiative (GRI) 305: Emissions 2016 – this sets out reporting requirements on the topic of emissions.
Standards and Tools	
ISO 14067:2018 Greenhouse gases	Carbon footprint of products — Requirements and guidelines for quantification and reporting of the product carbon footprint (PCF), in a manner consistent with International Standards on life cycle assessment (LCA) (ISO 14040 and ISO 14044). Often used where there are no national standards in place.
IPAS 2050	Specification for the assessment of the life cycle greenhouse gas emissions of goods and services. Group 1: Single-issue methodology, covering only emissions and impacts related to climate change.
Product Environmental Footprint (PEF).	Product Environmental Footprint (PEF). This EU-recommended method to perform LCA studies aims to harmonize existing LCA standards. It requires 16 impact categories to be calculated, but some current legislative proposals recommend the method with climate change as sole indicator to report the PCF. Group 2: Methodology – these have a broader scope, covering environmental issues beyond climate change.
COOL Farm Alliance	The Cool Farm Tool quantifies on-farm greenhouse gas emissions and soil carbon sequestration. The tool has been tested and adopted by a range of multinational companies who are working with their suppliers to measure, manage, and reduce greenhouse gas emissions in the effort to mitigate global climate change.
Verified Carbon Standard (VCS)	The VCS Program provides the standard and framework for independent validation of projects and programs, and verification of Green House Gas (GHG) emission reductions and removals, based on ISO 14064-2:2006 and ISO 14064-3:2006. The program has registered more than 1,400 carbon reduction projects worldwide that have reduced or removed more than 260 million tonnes of CO2 equivalent from the atmosphere
ToiTu Envirocare Carbon Mark	Toitū carbon reduce certification helps clients accurately measure greenhouse gas emissions and put in place strategies to manage and reduce impacts. Provides certification in accordance with ISO 14064-1 or Publicly Available Specification (PAS) 2050.

33. https://www.standardsmap.org/en
34. The mission of SSCI is to provide clear guidance in the consumer goods industry to buyers and suppliers on third-party auditing, monitoring, and certification schemes that cover key sustainability requirements and apply relevant governance and verification. The associated Global Food Safety Initiative (GFSI) work in the benchmarking and harmonization of GFSI-recognized certification programmes across the industry with the ambition to enable a "once certified, accepted everywhere" approach. Certification programmes recognized by GFSI include those operated by: Brand Reputation through Compliance (BRC), Freshcare; FSSC 22000; GLOBALG.A.P; International Featured Standards IFS; Japan Food Safety Management Association; SQF Safe Quality.
35. https://www.mpi.govt.nz/dmsdocument/41031-fit-for-a-better-world-accelerating-our-economic-potential

Assurance systems

In the following tables normative references, regulations, assurance standards, and assurance initiatives are identified which relate to the KIPs project's focal interest areas of carbon, water, and biodiversity. These reflect the range in scope, purpose, and approach for assurance programmes and the types of indicators used within them. A high-level summary of indicators is provided further in Table 5 on based on a synthesis of information from the different sources. Regulations, frameworks and indicators for the KIPs focal domain areas are detailed below. It should be recognised that there are often strong links between domains, frameworks and indicators – for example, the links between biodiversity loss (forests and wetlands) and the release of carbon into the atmosphere. It should also be noted that there are a large number of standards and schemes associated with each of the domain areas, and only some of these are included in the tables.

Biodiversity assurance

The assessment of land use impacts on biodiversity is a relatively recent area in the development of assurance programmes and indicators. Table 3 details some of the key international and New Zealand regulations for the protection of biodiversity, along with assessment frameworks and standards, including those used by market assurance programmes and biodiversity payment schemes.[36]

Table 3: Biodiversity assurance references

Organisation	Description
Norms and regulations	
UNSDG	United Nations Sustainable Development Goals (UNSDG) 13 Climate Actions; 14 Life Below Water; 15 Life on Land
The Convention on Biological Diversity (CBD)	Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity is dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, CBD promotes the development of global targets, national strategies, and action plans for the conservation and sustainable use of biodiversity.
NZ National Biodiversity Strategy and Action Plan	Te Mana o te Taiao, the Aotearoa New Zealand Biodiversity Strategy, guides the way all of Aotearoa works to protect and restore nature. It was launched in August 2020 and sets out a strategic framework for the protection, restoration, and sustainable use of biodiversity, particularly indigenous biodiversity, in Aotearoa New Zealand from 2020 to 2050.
FAO - (LEAP)	Biodiversity and the livestock sector - Guidelines for quantitative assessment. Provides global, regional, and local assessment guidance using two main methods: life cycle assessment (LCA) and pressure-state-response (PSR) indicators.
FAO - (LEAP)	Principles for the assessment of livestock impacts on biodiversity. Provides principles that address two main approaches for biodiversity assessment, the LCA and PSR indicators.
FAO SAFA	E4 Biodiversity

36. https://data.bioheritage.nz/dataset/e81e8c01-755c-4a7f-a2d0-d1606249810a/resource/b5114d3c-3968-4204-b25e-fa69051365fd/download/biodiversity-instruments-hall-and-lindsay.pdf

Table 3. cont.d

Organisation	Description
GRI Draft Biodiversity Standards (2022)	This exposure draft of the revised GRI Biodiversity Topic Standard is published for public comment by the Global Sustainability Standards Board (GSSB), the independent standard-setting body of GRI. This exposure draft is intended to replace GRI 304: Biodiversity 2016.
GRI 304	GRI 304: Biodiversity 2016 – this sets out reporting requirements on the topic of biodiversity. This Standard can be used by an organization of any size, type, sector or geographic location that wants to report on its impacts related to this topic.
OECD	Biodiversity Indicators
FAO Livestock Environmental Assessment and Performance Partnership (LEAP)	Environmental performance of large ruminant supply chains Guidelines for Assessment. A harmonized international approach to the assessment of the environmental performance of large ruminant supply chains in a manner that takes account of the specificity of the various production systems involved. It aims to increase understanding of large ruminant supply chains and help improve their environmental performance.
Standards and Tools	
Cool Farm Alliance	The Cool Farm Biodiversity metric quantifies how well farm management supports biodiversity. A NZ biodiversity assessment tool based on the COOL approach was developed by Landcare Research as part of the NZSD project.
Certified Wildlife Friendly (B2B) Private Standard	The Wildlife Friendly Enterprise Network (WFEN) is a global community dedicated to the development and marketing of products that conserve threatened wildlife while contributing to the economic vitality of rural communities.
FairWild (B2B, B2C) Private Standards	The FairWild Foundation was established to promote the sustainable management and supply chain development of wild-collected natural ingredients and products. FairWild Foundation maintains the FairWild Standard and certification scheme for sustainable collection and fair trade in these ingredients.
GLOBALGAP Biodiversity Addon	The biodiversity add-on lays out a set of rules, principles, and criteria, which help producers to demonstrate their biodiversity management practices. Retailers and traders can ask suppliers to undergo a BioDiversity add-on audit in order to fulfil their corporate social responsibility pledges.
Business and Biodiversity Offsets Programme (BBOP) (Standard)	An international collaboration between companies, financial institutions, governments, and civil society organizations working towards a net gain of biodiversity.
Guidance on Good Practice Biodiversity Offsetting in New Zealand (2014)	Designed for policy makers, planners, developers and decision-makers who need to gain an understanding of the concepts and current good practice around biodiversity offsetting.
International Union for Conservation of Nature (IUCN) Global Standard for Nature-based Solutions (2020	the Global Standard for Nature-based Solutions was developed to be facilitative, incentivising and enabling users to implement strong Nature-based Solutions.
FAO Livestock Environmental Assessment and Performance Partnership (LEAP)	Environmental performance of large ruminant supply chains Guidelines for Assessment. A harmonized international approach to the assessment of the environmental performance of large ruminant supply chains in a manner that takes account of the specificity of the various production systems involved. It aims to increase understanding of large ruminant supply chains and help improve their environmental performance.

Table 4: Water assurance references

Organisation	Description
Norms and regulations	
FAO - Livestock Environmental Assessment and Performance Partnership (LEAP)	A harmonized international approach assessing nutrient flows and impact assessment of eutrophication and acidification for livestock supply chains, taking the specificity of the various production systems involved into consideration.
GRI 303: Water and Effluents 2018	GRI 303: Water and Effluents 2018 sets out reporting requirements on the topic of water and effluents. This Standard can be used by an organization of any size, type, sector or geographic location that wants to report on its impacts related to this topic.
FAO SAFA	E2 Water
NZ Fresh water farm plan regulations	The Essential Freshwater reforms were introduced by the Government in 2020, part of a new national direction to protect and improve New Zealand rivers, streams, lakes and wetlands. A key component is the requirements for farmers to prepare Freshwater Farm Plans.
Standards and tools	
ISO 14046:2014 Environmental management — Water footprint — Principles, requirements and guidelines	This standard is for conducting and reporting a water footprint assessment as a stand-alone assessment, or as part of a more comprehensive environmental assessment.
Water Footprint	The water footprint is one of the family of environmental footprints that help understanding of how production and consumption choices are affecting natural resources.
Cool Farm Alliance	The Cool Farm Tool Water metrics provide crop irrigation requirements and blue and green water footprints
GLOBAL GAP Addon - Spring	SPRING is a farm-level add-on which helps producers, retailers, and traders demonstrate their commitment to sustainable water management and can be implemented together with the GLOBALG.A.P. IFA standard for crops.

Potential indicators for automation

There are a number of opportunities to automate the monitoring of indicators to support conformance assessment.

Column 1 in Table 5 includes assessment criteria that are often included in assurance standards in relation to the assessment of the key focal areas of the KIPs project – biodiversity, carbon, and water. The selection of the criteria was informed by the UN International Trade Centre – Standards Map tool for the comparison of assurance standards.

Column 2 provides examples of indicators used in some key assurance programmes.

Column 3 provides an assessment of the potential for the automation of monitoring.

Key

Green: Positive potential for automation.

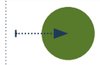
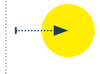
Yellow: Possible or the potential to automate the monitoring of some indicators.

Red: Low potential for automation.

Table 5: Potential Indicators for automation

Assurance Standards Criteria	Example indicators	Potential
Biodiversity		
Biodiversity: general principle	**GlobalGAP** • Control Points: AF 7.1.1 (minor) Does each producer have a wildlife management and conservation plan for the farm business that acknowledges the impact of farming activities on the environment? • AF 7.1.2 (recom.) Has the producer considered how to enhance the environment for the benefit of the local community and flora and fauna? Is this policy compatible with sustainable commercial agricultural production and does it strive to minimize environmental impact of the agricultural activity? **Rainforest Alliance** An assessment is undertaken and includes: • Identification of on farm rare and endangered species (plant and animal). • Identification of priority actions that promote biodiversity on farm.	
Sustainable management and use of natural resources	**SAFA** • This indicator refers to the protection, in situ conservation, and rehabilitation of the genetic diversity of domesticated plant, animal, and aquaculture fish species in agriculture-based food chains.	
Criteria to ensure adherence to international conventions on biodiversity and best practices (CITES, CBD, CMS, CCD, among others)	**Rainforest Alliance** • 6.4.1 Threatened animals and plants are not hunted, killed, fished, collected or trafficked. • 6.1.3 Management includes the mitigation measures from the Risk Assessment Tool in 1.3.1 with regard to High Conservation Values in the management plan (1.3.2). Management implements these measures. (RAMSAR). • 6.4.3 Producers do not intentionally introduce or release invasive species. Producers do not dispose of existing invasive species or their parts in aquatic ecosystems.	
Criteria on impact mitigation prior to production / harvesting operations	**Linking Environment And Food (Leaf) Marque** • 8.6 Environmental impact is minimised if the business has brought or is planning to bring “uncultivated land or semi-natural areas” into agricultural use in the last 12 months or near future. • Landscape and Nature Conservation and Enhancement Plan (see 8.2) includes records that show that the business has taken measures to minimise negative consequences to the environment if uncultivated land or semi-natural areas have been brought into agricultural use in the last 12 months or the business is planning to do so • Areas or sites with statutory landscape designations have not been brought into agricultural use in the last 12 months nor does the business have any plans to do so • Bringing land into agricultural use includes clearance of vegetation, cultivation, fertilisation, liming, drainage, introducing high stocking rates, earth moving or building • Where appropriate, relevant authorities have been notified and approval received prior to land use change	

Table 5. cont.

Assurance Standards Criteria	Example indicators	Potential
Impact assessment policy for new production	**Rainforest Alliance** · 6.1.1 Natural forests and other natural ecosystems have not been converted into agricultural production or other land uses. · 6.1.2 Production or processing does not occur in protected areas or their officially designated buffer zones, except where it complies with applicable law.	
Criteria on spatial management (creating / maintaining / protecting set asides, buffer zones, or conservation areas)	**Leaf Marque** · 8.14 Field margins and boundaries are under sympathetic management · Field margins and boundaries are managed with minimal and appropriate use of fertiliser or plant protection products · Spot control of noxious weeds is carried out as appropriate · Field margins and boundaries are cut late in the summer (or during the least destructive period for flora and fauna) and cuttings are removed where possible. Alternatively, margins are grazed every two to three years · Travel on field margins and boundaries is minimised · Margins should be at least two-metres wide, measured from the middle of the permanent boundary feature (e.g. hedge, fence, stone wall or watercourse), unless justification provided · In fields less than two hectares with permanent boundary features there is no requirement for two-metre margins · In fields where there is not a boundary feature, and the natural habitat extends from the crop or crop headland there is no need for a specified margin · Margins are sensitively grazed (see 5.6) · Green tracks can be included as margins on the first inspection only if presented alongside plans to develop margins	
Criteria relating to identifying risks and impacts on ecosystem services	**SAI** · 8.1 There is a documented Landscape and Nature Conservation Audit (including map) · Landscape and Nature Conservation Audit includes map(s) with reference to the following key environmental features: o areas and sites on farm with any statutory landscape designation o lakes, ponds, and watercourses o semi-natural habitats (e.g., moorland, wetlands, lowland heath, species-rich grassland, carbon sinks) o linear features (e.g., hedges, fence lines, verges, field margins, walls, ditches) of public rights of way o archaeological or historical sites o land on which other important species are found o areas that are grazed o lists of any important species recorded in the area o traditional buildings or fire breaks that help protect crops and habitats · Audit includes notes on how the farming operations could damage, or have detrimental effects, on these features · Audit completed or reviewed by a specialist conservation advisor or consultant · Audit regularly reviewed (at least every five years) by the specialist advisor and annually by farmer	
Criteria for the monitoring and protection of High Conservation Value Areas	The Sustainability Consortium (TSC) · % of production (including feed inputs) from HVC areas – by % of production/inputs	

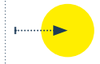
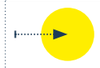
Assurance Standards Criteria	Example indicators	Potential
Criteria relating to post-production practices	**Leaf Marque** · 8.19 Flora and fauna are able to thrive through rotation and leaving land uncropped · Farm records and farmland give evidence of land being left uncropped · Uncropped land will not be appropriate on all soil types · Where applicable, grazing is managed to allow for flora and fauna	
Criteria on habitat/ eco-system restoration/ rehabilitation	**Rainforest Alliance** · 6.2.3 Producers maintain and management monitors natural vegetation cover and reports annually on the indicator from year one onwards. If there is less than 10% of the total area under natural vegetation cover (or less than 15% for farms growing shade-tolerant crops), management sets targets and takes actions for farms to reach these thresholds as required in 6.2.4. Natural vegetation is vegetation made up predominantly of native or locally adapted species, resembling in species composition and structure the vegetation that occurs or would occur in the absence of human interference. Natural vegetation can include one or more of the following (not exclusive): o Riparian buffers o Conservation areas within the farm o Natural vegetation in agroforestry systems o Border plantings, live fences and barriers around housing and infrastructure, or in other ways o Conservation and restoration areas outside the certified farm that effectively provide for long-term protection of the subject areas (for at least 25 years) and yield additional conservation value and protection status relative to the status quo	
Criteria on habitat eco-system restoration/ rehabilitation	**SAI** The reporting organization shall report the following: · Size and location of all habitat areas protected or restored, and whether the success of the restoration measure was or is approved by independent external professionals. · Whether partnerships exist with third parties to protect or restore habitat areas distinct from where the organization has overseen and implemented restoration or protection measures. · Status of each area based on its condition at the close of the reporting period. · Standards, methodologies, and assumptions used.	
Criteria on maintaining, restoring, and prioritizing native species	**GRI** The reporting organization shall report the following: · Size and location of all habitat areas protected or restored, and whether the success of the restoration measure was or is approved by independent external professionals. · Whether partnerships exist with third parties to protect or restore habitat areas distinct from where the organization has overseen and implemented restoration or protection measures. · Status of each area based on its condition at the close of the reporting period. · Standards, methodologies, and assumptions used.	
Criteria for the use of biotechnologies	Standards vary in relation to the acceptance of Genetically Modified Organism (GMO) crops/animals.	

Table 5. cont.

Assurance Standards Criteria	Example indicators	Potential
Criteria on the protection of rare and threatened species and their habitats	**SAFA** · This indicator refers to all practices that aim at the protection and rehabilitation of wild species in agriculture-based food chains. Many practices can contribute to this goal, such as maintaining a diversity of plants and animals (including fish) in production, the cultivation of structurally diverse stands of perennials, the protection of structures and habitats needed by wildlife (e.g., bird nesting aids and insect nesting boxes), and the establishment of habitats within cultivated landscapes that can serve as a refuge to animals.	
Requirements for no net loss in biodiversity	**SAI** Ecosystem Enhancing Practices: · Land-cover and land use change to more structurally complex and species-diverse systems, such as agroforestry, mixed crop-livestock systems, mixed rice-fish systems, intercropping, perennials, forest gardens, etc. · The net LULCC caused by the enterprise is positive (more "upgrading" than "downgrading" of habitat) and the enterprise has not caused any ecologically degrading LULCC off-site.	
Criteria on the protection of ecosystems against invasive species	**Rainforest Alliance** · 6.4.3 Producers do not intentionally introduce or release invasive species. Producers do not dispose of existing invasive species or their parts in aquatic ecosystems. · 6.4.9 L1 (Mandatory Improvement) Producers take measures to contain and reduce existing invasive species.	
Carbon		
GHG policies: general principle	**TSC** · Producer's document net Greenhouse Gases (GHG) emissions from main sources in production and processing operations. This includes emissions from use of fossil fuels and electricity, fertilizer, waste and wastewater and land use change. **GRI** · The reporting organization shall report its management approach for emissions · When reporting on GHG emissions targets, the reporting organization shall explain whether offsets were used to meet the targets, including the type, amount, criteria or scheme of which the offsets are part.	
Criteria on quantifying GHG emissions	**TSC** · Total annual net GHG emissions from sources (tons of CO2e) · Net GHG emissions from the above indicated sources per unit of the final product (tons of CO2e per unit) · Calculation of GHG emissions intensity by product volume/farm area · The average GHG emissions intensity associated with transportation of product from distribution facilities to downstream retailers: grams CO2e per tonne-km of transported product **GRI** The reporting organization shall report the following information: · GHG emissions reduced as a direct result of reduction initiatives, in metric tons of CO2 equivalent. · Gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all. · Base year or baseline, including the rationale for choosing it. · Scopes in which reductions took place; whether direct (Scope 1), energy indirect (Scope 2), and/or other indirect (Scope 3). · Standards, methodologies, assumptions, and/or calculation tools used.	

Assurance Standards Criteria	Example indicators	Potential
Requirements to perform analysis of possible alternatives to reduce GHG emissions	**TSC** · Amounts of renewable and non-renewable energy used, by type (e.g., volume of fuel, KWh electricity, quantity of biomass energy) · Total energy use · Total energy use per kg of product · Identify measures to reduce energy demand and consumption with reduced dependency on non-renewable energy sources for production and processing.	
Criteria for reducing GHG emissions	**GRI** The reporting organization shall report the following information: · GHG emissions reduced as a direct result of reduction initiatives, in metric tons of CO2 equivalent. · Gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all. · Base year or baseline, including the rationale for choosing it. · Scopes in which reductions took place; whether direct (Scope 1), energy indirect (Scope 2), and/or other indirect (Scope 3). · Standards, methodologies, assumptions, and/or calculation tools used.	
Criteria relating to soil or trees sequestration	**Carbon Trust Product Certification** · 5.7 Treatment of soil carbon change in existing systems. Where not arising from land use change. · 5.5 Changes in the carbon content of soils including both emissions and removals shall be excluded from the assessment of GHG emissions under this PAS unless provided for in supplementary requirements in accordance with the principles set out in 4.3. Where supplementary requirements relating to soil carbon change have been developed for the product being assessed in accordance with the principles set out in 4.3, they should be used. · 7.8 Non-CO2 emissions data for livestock and soils. The estimation of the non-CO2 GHG emissions arising from livestock, their manure or soils shall use whichever of the two approaches yields the highest assessment with reference to the data quality rules specified in 7.2: a) the highest tier approach set out in the IPCC Guidelines for National Greenhouse Gas Inventories.	
Criteria for using offsets	**GRI** · The reporting organization shall report its management approach for emissions. · When reporting on GHG emissions targets, the reporting organization shall explain whether offsets were used to meet the targets, including the type, amount, criteria or scheme of which the offsets are part.	
Water		
Criteria on verification of mandatory certificates and permits related to water use	**GlobalGAP** · Control Points: CB 5.4.1 (minor) Where legally required, are there valid permits/ licenses available for all farm water extraction, water storage infrastructure, on-farm usage and, where appropriate, any subsequent water discharge?	

Table 5. cont.

Assurance Standards Criteria	Example indicators	Potential
Water resource monitoring, use, and consumption	**GlobalGAP** · 5.2.1 (major) Has a risk assessment been undertaken that evaluates environmental issues for water management on the farm and has it been reviewed by the management within the previous 12 months? · 5.2.2 (major) Is there a water management plan available that identifies water sources and measures to ensure the efficiency of application and which management has approved within the previous 12 months? · 5.2.3. (min) Are records for crop irrigation/fertigation water usage and for the previous individual crop cycle/s with total application volumes maintained? **TSC** · Water use intensity – cubic m per kg of product.	
Water management plan	**GlobalGAP** · 5.2.2 (major) Is there a water management plan available that identifies water sources and measures to ensure the efficiency of application and which management has approved within the previous 12 months? **TSC** · Presence of a verified nutrient management plan · An irrigation management plan that optimises crop productivity and water use efficiency, based on: a) Crop water needs? b) Water availability? c) Irrigation equipment calibration and maintenance? d) Duration and frequency of application?	
Criteria on water usage records keeping	**GlobalGAP** · Control Points: CB 5.2.3 (minor) Are records for crop irrigation/fertigation water usage and for the previous individual crop cycle/s with total application volumes maintained?	
Criteria on water dependencies and water scarcity	**GlobalGAP** · 5.1.1 (minor) Are tools used routinely to calculate and optimize the crop irrigation requirements? · 5.5.1 (rec) Are water storage facilities present and well maintained to take advantage of periods of maximum water availability	
Water use, including reuse, recycling, and harvesting	**SAFA** · This indicator refers to the suitability of wastewater for disposal or re-use. Recommended water testing methodologies, parameters and legal thresholds vary among countries, as well as with the intended use or discharge location. For instance, the characteristics of wastewater from food processing factories can be characterized by high biochemical oxygen demand (BOD), suspended solids (SS), and high oil concentrations, as well as smells from acidification.	
Wastewater quality management and treatment	**TSC** · The average biological oxygen demand (BOD) and chemical oxygen demand (COD) of directly discharged wastewater – (mg per litre of wastewater or by product mass	
Mitigation of transboundary effects of water pollution	**SAFA** · This indicator refers to all practices that aim at preventing and reducing water pollution from agriculture and fisheries-based food chains. The indicator concerns the pollution of both freshwater and saltwater.	
Water extraction/irrigation	**SAFA** · Ground and surface water withdrawals aim to balance freshwater withdrawals for the enterprise in relation with the regionally available freshwater resources, that is, annual rainfall, annual groundwater recharge, and water carried into the region by rivers.	
Water usage records keeping	**TSC** · Producers record the amount of water used for irrigation from year one onwards. Indicator: o Water use for irrigation in total and per unit of product (L, L/kg)	
Criteria on quality of water used in production	**GlobalGAP** · 5.3.1 (major) Is the use of treated sewage water in preharvest activities justified according to a risk assessment? · 5.3.2 (minor) Has a risk assessment on physical and chemical pollution of water used on preharvest activities (e.g. irrigation/fertigation, washings, spraying) been completed and has it been reviewed by the management within the last 12 months? · 5.3.3 (minor) Is water used on pre-harvest activities analysed at a frequency in line with the risk assessment (CB 5.3.2) (minor) taking into account current sector specific standards? · 5.3.4 (minor) According to the risk assessment in CB 5.3.2 and current sector specific standards, does the laboratory analysis consider chemical and physical contamination, and is the laboratory accredited against ISO17025 or by competent national authorities for testing water? · 5.3.5 (minor) Are corrective actions taken based on adverse results from the risk assessment before the next harvest cycle? · FV 5.7.1 Is the source of water used for final product washing potable or declared suitable by the competent authorities?	
Water contamination/ pollution	**TSC** · N use intensity and P surplus – by metric tonne of products/area (Ha) **Rain Forest Alliance** · 6.3.1 Farms maintain existing riparian buffers adjacent to aquatic ecosystems. · 6.3.2 Producers maintain the following additional safeguards for the protection of drinking water in case the farm is located closer than 50 m to a source of drinking water. Around the source: o Maintain or establish a riparian buffer > 10 m o Maintain a pesticides non-application zone > 20 m o Maintain an additional zone > 40 m, in which pesticides are only applied through mechanical, hand-assisted or targeted application · 6.6.1 Tests for processing wastewater are conducted at all discharge points during the representative period(s) of operation, and results are documented. For farm groups, this is done at all group-managed (collective) processing facilities and at a representative sample of member processing operations including the different types of treatment systems. Wastewater from processing operations discharged into aquatic ecosystems meets legal wastewater quality parameters. In absence of these, it meets the wastewater parameters. Wastewater from processing operations may not be mixed with clean water to meet the parameters. · 6.6.2 Human sewage, sludge, and sewage water is not used for production and/or processing activities. Sewage is not discharged into aquatic ecosystems unless it has been treated. Treated discharge is demonstrated to meet legal wastewater quality parameters or, in the absence of these, the wastewater parameters (not applicable to smallholders).	

Whilst this debate is in its infancy, some assurance providers are developing the capabilities to automate their service. For example, Lopatin, Trishkin, and Gavrilova have mapped the requirements of PEFC (a certification scheme in forestry sector) and developed a functional algorithm to assess compliance against the geospatial requirements of PEFC.[37]

Some geospatial requirements could be also seen as suitable for remote auditing and have been adopted. For example, FSC certification in forestry is using Geographic Information System (GIS) to assess geospatial requirements – this is done remotely and prior to the audit itself. Another example includes the use of drones to support the auditing of Farm Environment Plans by Environment Canterbury.[38]

37. Lopatin, E., Trishkin, M., & Gavrilova, O. (2016). Assessment of compliance with PEFC forest certification indicators with remote sensing. Forests, 7(4), 85.

38. Lucock et al. (2021) identified that aerial views provided additional, high-quality information for an audit (though subject to weather conditions) and reductions in audit time were dependent on farm scale, topography, and the auditor's knowledge of the farm and the farmer – see Lucock, X.; Westbrooke, V. (2021). Trusting in the "Eye in the Sky"? Farmers' and Auditors' Perceptions of Drone Use in Environmental Auditing. Sustainability, 13, 13208. https://doi.org/10.3390/su132313208

Possible Constraints or Limitations

There are a range of possible constraints to the deployment of new monitoring technology as proposed by the KIPs project. In part, these constraints are related to a relatively low level of digitalisation and reliance on pre-internet era processes in many assurance programmes. Although this is changing, the sector is still relatively slow in the uptake of technologies (especially more advanced technologies such as satellite monitoring). Moreover, the assurance sector is quite heavily regulated and decision making (and approval) regarding new approaches takes time (it takes 3-5 years to develop a new international standard, for instance). The assurance sector is also grasping with harmonisation issues (too many standards, inconsistency of assurance process, variation of stringency of standards in the same domain – e.g., sustainable forestry), which increases difficulty for new entrants. Finally, the assurance sector is lagging with respect to the level of investment by assurance organisations in enhancing their operations and technology. For example, high tech solutions in farming such as automation of soil monitoring or predictive analysis for crop management are increasingly becoming available to support assurance processes, but have not yet been widely adopted. This has further degraded common perception of the benefits associated with assurance services.

Low level of digitalisation and slow adoption of new technologies

For decades the assurance sector has been using a largely unchanged approach in the provision of assurance services.[39] Despite the recent rapid uptake of rudimentary ICT technologies during the COVID-19 pandemic, practices in the assurance sector are still primarily based on *in situ* approaches.[40] In a 'traditional' (*in situ*) audit, the data is collected on site and compared to the requirements of any given reference point. An auditor (or a team of auditors) then determines compliance (or non-compliance). During the pandemic, remote audits became the *de facto* norm – especially during lockdowns when auditors could not visit facilities in person. In the post-pandemic environment, hybrid audits (a combination of i*n situ* and remote audits) are increasingly popular.

Alongside the development of hybrid auditing capabilities, the assurance sector is primarily focused on the digitalisation of existing processes. Putting aside ICT adoption (Videoconferencing etc.), the uptake of more advanced technologies (e.g., satellite monitoring) is relatively slow. However, a 2021 global survey of the assurance sector concluded that "a growing number of Certification Accreditation Body (CAB)s are piloting [advanced] technologies and indicate that they will roll out these technologies within next 2-5 years."[41]

International assurance and audit organisations have also identified the potential of new tools that can support auditing processes, such as those identified by the Information Systems Audit and Control Association (ISACA). Likewise, the International Auditing and Assurance Standards Board (IAASB) leads in both the analysis of opportunities to incorporate auditing support technologies and the development of international auditing standards on their use. As detailed in Figure 3, IAASB see potential in a wide range of technologies, but have identified some barriers to adoption.

Implementation constraints

Adoption of any new approaches to assurance practice requires alignment with the institutional practices of the assurance sector. Implementation constraints relate to the authorization of any given approach, the buy-in of key actors into new solutions, and the competence of assurance sector personnel.

The response of existing assurance actors may be antagonistic to new technology that they view as a threat to the status quo or their role in the assurance process.[42] Certification bodies, accreditation agencies, and owners of standards may also have a role in the authorisation and use of new monitoring technology. Their scheduled review timetables could create delays in the potential inclusion of new innovations in assurance methodologies. Some, such as the Global Food Safety Initiative (GFSI), have reviewed and see limitations in the use of remote sensing as they do not have clear evidence of its efficacy in supporting food safety audits.

The acceptance of new assurance monitoring approaches by key value chain operators such as supermarkets could be an issue. There are initiatives to support the adoption of assurance innovations by retailers. The results appear mixed however, and in New Zealand the two main chains are primarily focused on protecting the integrity/story of their own brands and products. Possibly associated with this is the trend towards business-to-business (B2B) assurance away from business-to-consumer (B2C) assurance led by NGO. This may influence the rate of adoption of new technology – however it could be a positive if the adoption rate of regenerative monitoring innovations is considered.

Training of auditors in the use of any monitoring technology. The scope of expertise required of auditors keeps expanding, making it difficult to add additional skill requirements. There could also be steep learning and adoption curves in the use of the technology for those being audited, as well as those providing the technologies. In other words, it may take time to embed new audit practices.

Implementation issues can be addressed by the development of partnerships with key actors in the sector. For example, once the KIPs project finalises the identification of indicators that can be automated, targeted partnerships with actors who currently use such indicators should be developed. These partnerships can be established with retailers, certification bodies, accreditation bodies, environmental NGOs, or regulators. Further analysis of the best market pathways would be needed.

Cultural, capacity, and trust issues. The increasing complexity of assurance systems and requirements for organisations to achieve compliance can be significant,

39. Herding, W., & Fischer, S. (2015). Smart Data: An Exploration of Technology Innovations for Sustainability Standards Systems. London: the ISEAL Alliance.

40. Castka, P., Zhao, X., Bremer, P., Wood, L., & Mirosa, M. (2021). Remote auditing and assessment during the COVID-19 pandemic in New Zealand and China. Learnings from the food industry and guidance for the future. Wellington, New Zealand: A report for New Zealand China Food Protection Network (NZCFPN); UNIDO. (2020). QUALITY & STANDARDS AND THEIR ROLE IN RESPONDING TO COVID-19: United Nations Industrial Development Organization.

41. Koch, C., Asna-Ashari, P., Blind, K., Castka, P., & Mirtsch, M. (2021). Digital Maturity in Conformity Assessment. A report of global study in Conformity Assessment.

42. An in-depth analysis of the impact of remote sensing on assurance sector is provided by Reid and Castka (2023). They look specifically at the congruence of actors, tasks, technology, and structures to determine the 'friction' points in the existing system. See Reid, J., & Castka, P. (2023). The impact of remote sensing on monitoring and reporting - The case of conformance systems. Journal of Cleaner Production, 393, 136331. https://doi.org/10.1016/j.jclepro.2023.136331

Table 6: Characteristics of On-site, Assisted Remote, Remote, and Technology-Enhanced Auditing [43]

Note:[1] Assisted Remote Audit definition by ASC: "An audit that is conducted partly remotely and partly on-site. It typically occurs when at least one auditor (not technical expert or interpreter) of the audit team is able to be on site while the rest of the team are not due to the travel restrictions. The remote auditor shall coordinate and guide the collection of evidence with the auditor on-site".

	On-site Auditing	Assisted Remote Auditing[1]	Remote Auditing	Technology-Enhanced Auditing
Approach	Auditor determines compliance based on the evidence that is primarily collected on-site	Same as on-site; on-site auditor is assisted by technical experts or others that operate remotely	Technology is used to replicate on-site auditing	Technology is used to assist in auditor's decision-making
Data collection	Data exchanged between clients and auditors on-site (e.g., review of hard copies, review of electronic files/databases, in-person interviews)	Data exchanged between clients and auditors on-site (e.g., review of hard copies, review of electronic files/ databases, in-person interviews through videoconferencing)	Data exchanged between clients and auditors remotely (e.g., review of scanned documents, review of cloud-based platforms, review of satellite imaging, technology in real-time, interview through videoconferencing)	Data exchange amongst multiple parties exchanged remotely (e.g., review of cloud-based platforms, review of social media platforms, review of data collected by
Type of technology	Technology is secondary to the audit process (though it may be used to facilitate the process)	ICT used to communicate between on-site and remotely based auditors	ICT, such as audio/video conferencing, screen sharing is used to replicate on-side audit	Various technologies (e.g., machine learning to identify patterns, make predictions, guide decision-making; sensors collecting real-time information) are used to assist an auditor with an audit
Reliance on technology	Low Audit can be essentially performed without technology	Low/Medium Remotely based auditors need to be able to connect with on-site auditors	Medium Relies predominantly on ICT; off-line (e.g., desktop review), or real-time (e.g., e-interviews) or a combination of thereof	High Audit relies on multiple technologies
Auditor competence	Auditing competence (as specified in IAF Guidelines)	Auditing competence and ICT competence	Auditing competence and ICT competence	Auditing competence, ICT competence, and competence in Big Data Analytics

43. Castka, P., Searcy, C., & Fischer, S. (2020). Technology-Enhanced Auditing in Voluntary Sustainability Standards: The Impact of COVID-19. Sustainability, 12(11), 4740.

44. https://www.iaasb.org/news-events/2023-03/iaasb-digital-technology-market-scan-digital-assets

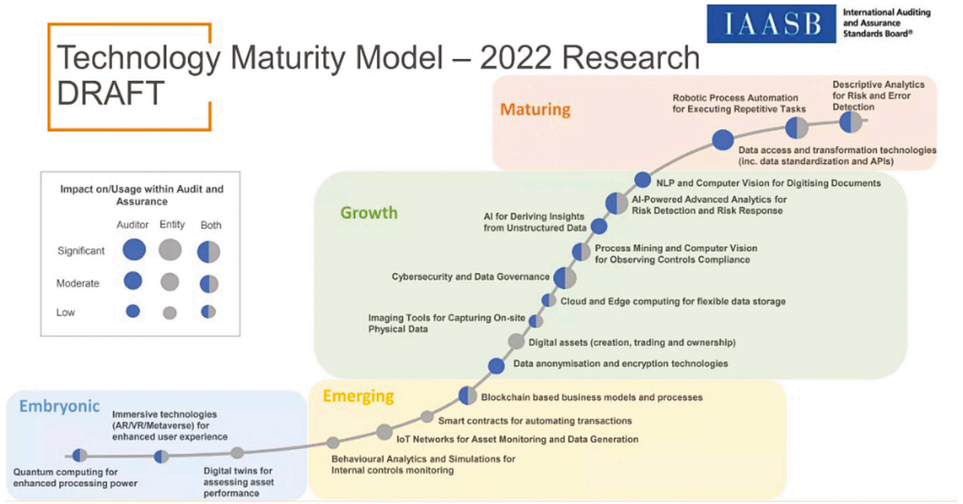


Figure 3. Technology Maturity Model[44]

especially for small and medium sized enterprises. These can create significant barriers to market access and overall sustainability of operations. Associated with this is increasing resistance from certain stakeholders (such as some farmers) to share their information, as they do not see the benefits associated with doing this but only significant potential risk to their freedom to operate.

Lack of harmonisation of standards and indicators

There are hundreds of sustainability standards and potential indicators – accompanied by significant consumer and user confusion. This could create an issue around whether a specific monitoring technology will gain widespread adoption, to a point where there would be economies of scale for its adoption. The following are some of the key initiatives that have emerged to address this problem:

- Benchmarking of standards – via ISEAL, Consumer Goods Forum, etc.;
- Regulatory oversight of indicators and standars, for example the EU Regulation on Substantiating Green Claims based on Product Environmental Footprint, and regulations and activity relating to geographic indicators;
- International sector initiatives to harmonise standards such as those undertaken by the World Wine Trade Group, SAI Platform, International Federation of Organic Agriculture Movements (IFOAM)

Alongside addressing harmonisation problems, there will be further challenges ahead once advanced technologies and Artificial Intelligence (AI) become the norm in the assurance sector. The introduction of new technologies and AI will mean a radical redesign of the assurance 'eco-system'. A possible outlook on such an eco-system has been recently proposed in *Quality Progress* (See Figure 4). It is, however, uncertain how such a system would function and how collaborations and partnerships will be developed.

The eco-system from Figure 4 could be used by KIPs to position their offerings and target the right partners for the development of their products and services. For example, KIPs could position themselves as a third-party data provider, a provider of AI analytics, or even develop their own auditing services. Further analysis is needed to determine the feasible pathway to market.

Alignment with other technological investments

Individual firms, supply chains, and industry groups have been investing heavily into smart technology and monitoring for some time. In agribusiness, robots and AI are deployed in precision and regenerative farming, for example.[46] Numerous firms have invested heavily into AI solutions around precision farming and in the provision of measurement tools:[47]

- Teralytic builds wireless sensors that detect 26 different parameters of soil health, giving farmers a detailed map of soil conditions across their farm;
- Farmer's Edge is a hardware and software product that uses satellite imagery and precision technology to help growers identify, map and manage farmland variability;
- McCain Foods recently invested in Resson, which uses near real-time predictive analysis for crop management;
- Farmobile enables farmers to collect and then sell their field data to third parties;
- The development of measurement tools, such as *Ecdysis*, which is building an insect database that will use artificial intelligence to identify insect species and extrapolate the population of each species on a farm (more examples are provided in the endnote).[48]

The assurance sector is finding it difficult to audit high-tech firms and automated (or semi-automated) solutions. Often, traditional auditing approaches are used in highly automated environments. This is changing, although rather slowly. The disconnect between the technological development of a firm's operations and its assurance processes creates a gap for assurance providers. This could be seen as an opportunity for KIPs: if solutions from the KIPs project provide a bridge between these two systems, acceptance of KIPs could be enhanced.

45. Castka, P., & Searcy, C. (2021). Artificially Intelligent Audits. The Era of Technology-Enhanced Auditing Is Upon Us. Quality Progress, 54(9), 26-31. 46. https://www.thefuturescentre.org/here-come-the-robots-precision-and-regenerative-farming/. An analysis of technological developments in agribusiness is also outlined in Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. Harvard Business Review, 92(11), 64-88.

47. These examples also provide an inspiration for how to monetize the outcomes from the KIPs project.

48. Useful examples are provided at https://www.greenbiz.com/article/5-cool-measurement-tools-attempting-quantify-regenerative-agriculture. The examples include Chris Tolles, CEO of Yard Stick, who is working with Christine Morgan, Ph.D., a chief scientific officer at the Soil Health Institute, to create a handheld soil probe that measures carbon levels with VisNIR spectrometry and pressure sensors; Mapping soil health with satellite data and remote sensors: using satellite data publicly available from National Aeronautics and Space Administration and the European Space Agency, along with specialized algorithms, Dagan is monitoring the landscape to map adoption of conservation practices and soil health management; Evaluating bird diversity with microphones: Wildlife Acoustics, the 18-year-old Massachusetts-based company has created a programmable, weatherproof recorder that evaluates bird diversity with microphones; Identifying insects using lasers: Denmark-based FaunaPhotonics creates a sensor that gives farmers real-time information about the type, number, and activity of insects flitting between their crops.

Figure 4. A futuristic outlook on the assurance eco-system[45]

Next Stages

Prioritisation of indicators

There are many possible indicators that can be monitored as part of an assurance process. However, there are limited resources both to fund monitoring and manage the process. A prioritisation of indicators to be monitored in assurance programmes and given focus in the KIPs project is important. Based on the concept of materiality, the prioritisation process developed by the New Zealand Sustainability Dashboard (NZSD) project could be useful.[49] Material issues in sustainability include those that have a direct or indirect impact on an organisation's ability to create, preserve, or erode economic, environmental, and social value for itself, its stakeholders, and society – and can therefore be the focus of any assurance activity. A three-step process is used: 1) Determine issue importance; 2) Determine issue risk; 3) Combine issue importance and risk to determine priority. Materiality analysis could possibly be used to identify hotspots for assurance/KIPs focus, as well as support process innovations such as audit by 'exception' (any finding that falls outside of the expected results of an audit after going through the necessary steps).

Technology validation

A requirement for the adoption of any monitoring technology/process used in assurance processes is that it needs to be independently tested and validated before use. Testing and validation are lengthy processes that can result in delays and significant costs.

The assurance sector has existing processes and procedures in place to facilitate this. These must be analysed and plans be developed to ensure a swift technology validation process once solutions stemming from the KIPs project are ready for use. Depending on the 'end' product, there could be different paths to technology validation.

At the present stage of the KIPs project, it is our understanding that the 'end' product could:

- Provide ground-breaking solutions for the assurance sector such as fully automated monitoring of certain indicators.
- Provide incremental solutions that can enhance current assurance practices, such as provision of data that would be used by assurance providers to enhance their current audit processes (for example, as part of a hybrid audit).

Validation will also depend on the market segment within the assurance sector that KIPs will progress with. There are several potential market segments and consequently partnerships that will need to be developed. Here we present two illustrative examples of how KIPs can take initiative in different market segments – recognising that there are multiple ways to position KIPs within the assurance sector which need further analysis:

- Provision of (and collaborating with actors that develop) in-house solutions for assurance along supply chains: targeting organisations that monitor their own supply chains (for example, Synlait's Lead with Pride). Lead with Pride has requirements such as the management of biodiversity, waste, and Mahinga Kai – KIPs could provide a service to address. Data from KIPs could also determine compliance against geospatial requirements. Working with private actors can lead to a faster validation process, as in-house solutions are usually more flexible. If this is a preferred approach, KIPs needs to develop partnerships with leading supply chains (e.g., Fonterra, Synlait)
- Provision of (and collaborating with actors that develop) in-house solutions for assurance across supply chains: external parties develop standards and monitoring mechanisms for actors within a particular sector or similar supply chains. For example, the NZ Farm Assured (NZFAP) and Food Safety System Certification (FSSC) 22000 are used by multiple supply chains – some of which are competitors. As in the previous example, data from KIPs can determine compliance against geospatial criteria – for example, NZFAP Plus has requirements for a farm environment plan that includes both a map with all land features and physical resources, and a component that identifies opportunities to protect, enhance, and monitor terrestrial and aquatic flora and fauna species. If this is a preferred way to enter the market, KIPs needs to link to assurance providers, accreditation bodies, or NGOs. The validation processes in this domain tend to be lengthy and complex.

Depending on the market segment, validation would require validation of the technology itself and its functionality, as well as approval for systemic changes in assurance processes. More analysis of market segments would be the next natural step in determining strategies for technology validation.

The introduction of new technologies and assurance systems into the New Zealand conformity system needs to be supported, such as how the NZ Measurement Standards Laboratory supports the standardisation of the calibration of environmental monitoring equipment.[50] More broadly, the technological solution provided by KIPs should be aligned with NZ Conformance strategy.[51] Buy-in from leaders in the assurance sector (organised in the Standardisation, Assurance, and Metrology Group) would increase the likelihood of its acceptance.[52]

Data sharing and governance

Assurance practice does not usually require an exchange of data. Data collection tends to be confined to individual audits and the data is not usually shared. There are some exceptions, such as audit platforms (discussed in the following section 'New forms of collaboration') that aim to utilise data from individual audits for multiple benefits. Since the COVID-19 pandemic and the introduction of remote audits, the assurance sector has been struggling with data exchange and ensuring data privacy and legal compliance related to data sharing.[53] With the introduction of

49. Whitehead, J. (2017). Prioritizing sustainability indicators: Using materiality analysis to guide sustainability assessment and strategy. Business Strategy and the Environment, 26(3), 399- 412. https://static1.squarespace.com/static/5c4a6229f407b46bb9097ff4/t/60dbc8c3b70db4761fc78931/1625016516233/Policy%2BBrief%2B-%2BMateriality.pdf

50. https://www.measurement.govt.nz/

51. MBIE. (2019). Conformance System Strategy. A Common Direction and goals for enhancing conformance system. Wellington, New Zealand: Ministry for Business, Innovation and Employment.

52. https://www.mbie.govt.nz/business-and-employment/business/standards-and-conformance/standards-and-conformance-organisations-in-new-zealand/

53. Castka, P., Zhao, X., Bremer, P., Wood, L., & Mirosa, M. (2021). Remote auditing and assessment during the COVID-19 pandemic in New Zealand and China. Learnings from the food industry and guidance for the future. Wellington, New Zealand: A report for New Zealand China Food Protection Network (NZCFPN).

more advanced forms of collaborations (as in Figure 4 and the futuristic outlook on the assurance eco-system), data sharing and governance need further scrutiny. A key issue will be to ensure the protection of data integrity, requiring the establishment of robust security measures.

There are several initiatives that KIPs can link to or take insights from. The most important include:

- NZ Farm Data Code of Practice and the associated Farm Data Accreditation Ltd (FDAL), which was established to own and manage the Code of Practice (COP).[54] The COP has an existing accreditation process;[55]
- Integrated National Farm Data Platform (INFDP) and a project titled Kēti Pāmu have been proposed by MPI as a potential interim step towards a more advanced solution for the Trust Alliance.[56] Kēti Pāmu would offer a centralised data architecture that enables the real-time sharing of data by allowing farmers to connect who they are, the business they represent, and the land (farm operations) in the form of identifiers which then, through permissions, allow others to access that data;
- Agritech NZ are running an Agritech Data Leaders Reference Group that is leading collaboration.[57]

To facilitate collaboration but maintain data privacy and enhance data sovereignty, solutions such as those proposed by Trust Alliance NZ (TANZ) (a non-profit membership consortium for New Zealand producers, growers, exporters, retailers, and service providers to easily share trusted data) are more feasible and acceptable by multiple stakeholders. Rather than another centralised platform holding the data, Trust Alliance is driving an open industry-based implementation of the Self Sovereign Identity model using decentralised digital identifiers. This approach enables trusted, secure proof of identity and sharing of data between parties without the need for centralised data holding or trusted third parties, removing many of the weaknesses of existing digital identity solutions. While a relatively new technology, it is gaining rapid adoption and is currently being implemented by the European Union though the European Self-Sovereign Identity Framework (ESSIF). TANZ aims to create a digital identity ecosystem for New Zealand compatible with and based entirely on these global open standards.

54. https://www.farmdatacode.org.nz; The Farm Data Code of Practice requires organizations to outline steps they take to safeguard farmer data. Compliant organizations agree to take two actions: (1) They will help farmers and other data users understand a) who has the rights to data, b) the rules for processing and sharing data, and c) data security and storage guidelines; (2) They will implement practices that provide farmers with utmost confidence their data is safe and is managed appropriately.

55. http://www.farmdatacode.org.nz/?page_id=201

56. https://agritechnz.org.nz/projects/data-interoperability/

57. https://agritechnz.org.nz/projects/data-interoperability/ See here a useful presentation on the groups plans etc – linked very much with MPI https://agritechnz.org.nz/wp-content/uploads/sites/34/2021/11/Data-Reference-Group-Kick-Off-July-21st.pdf

Future Developments

Monitoring of impact is crucially important for the assurance sector. Leading assurance schemes have increasingly focused on collecting data on their social and environmental impacts. Prominent in this domain is the work of ISEAL Alliance and its members. However, their work is in its infancy. KIPs can address a growing demand for impact data and provide automated solutions for some management practices (process/systems data). This includes those related to geospatial requirements which are part of many assurance systems, such as assessment of property boundaries, stock holding infrastructure, river crossings, and similar. Under the assumption that the issues covered in the Next stages section will be addressed by the project, we outline here some other areas that could be of interest to KIPs.

New entrants to the assurance sector

There are numerous companies (in New Zealand and internationally) that specialise in data collection and analytics. Such companies can potentially investigate ways to penetrate the assurance sector. For example:

- Kea Aerospace provides aerial imagery collected by a solar-powered, remotely piloted stratospheric aircraft;[58]
- SNAPIT Group provides monitoring tech (cameras and AI analytics) for multiple sectors (construction, fishing industry, tourism).[59]

Such companies have significant competence in data collection and data analytics. For example, SNAPIT Group has a technology that can provide assurance on fishing vessels. However, it could be argued, these firms might not have much assurance related competence and knowledge about the assurance process. Understanding how tech firms penetrate the market would be worth pursuing.

New forms of collaboration

Although the assurance sector is in general quite conservative, new forms of collaboration are emerging. These include:

- Programs such as the Social & Labor Convergence Program (SCLP) or Supply Shift provide e-audit platforms to support data sharing amongst buyers and suppliers; these platforms are currently used primarily by companies seeking certification;[60]
- The World Forest ID Initiative aims to develop a reference database of wood samples from around the globe that can be used to verify timber origin and species, in part to address illegal logging;[61]
- Organisations such as *amfori* or *Sedex* have created membership platforms to streamline data collection and exchange;[62]
- Data collected by citizen scientists can also be used to support triangulation from multiple data sources; citizen-science initiatives can engage the general public in monitoring of issues such as air pollution, trace locations of medicinal plant species, or food provenance and contamination;[63]
- Integrated Farm Planning and links to assurance.[64] This MPI initiative aims to streamline and integrate farm, financial, and environmental management, make compliance more efficient by reducing duplication in assurance compliance, and make it easier to meet both market and regulatory requirements. It is anticipated that this will foster cross sector collaboration between industry, national, and local government agencies, as well as the adoption of common and consistent farm planning standards including for freshwater and greenhouse gases;
- There are some private initiatives such as Map of Ag – a NZ company whose services include assurance services https://mapof.ag/products/;
- Data collection – see https://agritechnz.org.nz/projects/baselining-digital-adoption/

Exploring emergent forms of collaboration is among the next stages of the KIPs project.

Deep dive into AI

The use of AI and Machine Learning is the inevitable destiny of the assurance sector. There will be many in-between stages to reach AI (or AI technology) driven assurance. Further work should concentrate on analysing transitions in the assurance sector. Central to this issue is institutional transition (such as standard development processes, standards for validation of technologies) as well as studying the interactions between auditors and technologies (e.g., how auditors can benefit from AI and other forms of monitoring in their decisions).

KIPs can address a growing demand for impact data and provide automated solutions for some management practices (process/systems data). This includes those related to geospatial requirements which are part of many assurance systems, such as assessment of property boundaries, stock holding infrastructure, river crossings, and similar.

58. https://www.keaaerospace.com/
59. https://www.snapit.group/
60. https://slconvergence.org; https://www.supplyshift.net
61. https://worldforestid.org
62. A full overview of Modern Slavery service providers is provided in a Gartner Report "Market Guide for Supplier Sustainability Applications". The report is available online (registration required).
63. https://www.theguardian.com/education/2020/nov/16/the-rise-of-citizen-science-can-the-public-help-solve-our-biggest-problems
64. https://www.nzipim.co.nz/Folder?Action=View%20File&Folder_id=65&File=Freshwater%20seminar%20Wairarapa%20-%20IFP%20Overview%20Collier%20Isaacs.pdf https://unfss.org

Glossary

Assurance scheme owner (or 'scheme owner'):
An organisation (or a group of organisations) that develop reference points (standards, etc.) for a scheme and oversee its governance.

Assurance sector:
An industry sector providing conformity assessment services (testing, inspections, certification, and compliance) for other industry sectors.

Assurance process:
A process through which assurance providers collect and analyse evidence (data) to establish compliance with a reference point.

Assurance provider:
An organisation that provides assurance services for voluntary and/or mandatory schemes.

Framework:
A supporting structure underlying an assurance system. A framework organises and connects a range of intended outcomes, objectives, and indicators which are intended to improve sustainability.

Indicator:
A device providing specific information on the state or condition of something. A key function of an indicator is to reduce the volume of information to which decision makers must attend.

Measure:
A specific metric used to determine performance against an indicator. An indicator can have several measures. For example, the indicator 'Water Quality' will require multiple chemical, biological, and cultural metrics to assess it.

Reference point:
A standard, regulation, code of conduct (or similar) that specifies a set of requirements.

Voluntary Sustainability Standards (VSS):
The UN Forum for Sustainability Standards (UNFSS) defines VSS as: "...standards specifying requirements that producers, traders, manufacturers, retailers or service providers may be asked to meet, relating to a wide range of sustainability metrics, including respect for basic human rights, worker health and safety, environmental impacts, community relations, land-use planning and others".

Acronyms

AI:	Artificial Intelligence
ASC:	Assisted Remote Audit
B2B:	Business to Business
B2C:	Business to Consumer
BBOP:	Business and Biodiversity Offsets Programme
CAB:	Certification Accreditation Body
CBD:	Convention on Biological Diversity
CGF:	Consumer Goods Forum
COP:	Code of Practice
ECAN:	Environment Canterbury
ESG:	Environmental, Social Governance
ESSIF:	European Self-Sovereign Identity Framework
ETS:	Emissions Trading Scheme
EU:	European Union
FAO:	Food and Agriculture Organisation
FDAL:	Farm Data Accreditation Ltd
FSC:	Forest Stewardship Council
GHG:	Green House Gas
GIS:	Geographic Information System
GMO:	Genetically Modified Organism
GRI:	Global Reporting Initiative
GSSB:	Global Sustainability Standards Board
IAF:	International Accreditation Forum
ICT:	Information and Communications Technology
IEC:	International Electrotechnical Commission
IFOAM:	International Federation of Organic Agriculture Movements
INFDP:	Integrated National Farm Data Platform
IPCC:	Intergovernmental Panel on Climate Change
ISEAL:	International Social and Environmental Accreditation and Labelling Alliance
ISO:	International Standards Organisation
ITC:	International Trade Centre
KIPs:	Kaitiaki Intelligence Platforms
LCA:	Life Cycle Assessment
LEAP:	Livestock Environmental Assessment and Performance Partnership
MALITs:	Māori Land Incorporations and Trusts
MPI:	Ministry for Primary Industries
MSI:	Multi Stakeholder Initiatives
NGO:	Non-Government Organisation
NZFAP:	New Zealand Farm Assurance
NZSD:	New Zealand Sustainability Dashboard
OECD:	Organisation for Economic Co-operation and Development
PAS:	Publicly Available Specification
PCF:	Product Carbon Footprint
PEF:	Product Environmental Footprint
PEFC:	Programme for the Endorsement of Forest Certification
PSGE:	Post Settlement Governance Entities
PSR:	Pressure State Response
RA:	Regenerative Agriculture
RSPO:	Roundtable on Sustainable Palm Oil
SAFA:	Sustainability Assessment of Food and Agriculture systems
SAFI:	Sustainable Agriculture and Finance Initiative
SAI:	Sustainable Agriculture Initiative
SCLP:	Social & Labor Convergence Program
SDG:	Sustainable Development Goals
SFI:	Sustainable Forestry Initiative
SOC:	Soil Organic Carbon
SSCI:	Sustainable Supply Chain Initiative (SSCI)
TANZ:	Trust Alliance New Zealand
TSC:	The Sustainability Consortium
VCS:	Verified Carbon Standard
VSS:	Voluntary Sustainability Standards
WFEN:	Wildlife Friendly Enterprise Network
WWII:	World War Two

National Science Challenges

OUR LAND AND WATER

Toitū te Whenua, Toiora te Wai