A pathway to Multilateral Data Sharing (MLDS)

Understanding and overcoming barriers to MLDS in New Zealand's primary industries

May 2023

Contents

About this document

This document is the **output of a 'think piece' relating to data sharing within the primary industries.** A 'think piece' looks to answer, explore and/or refine a research question.

Acknowledgements

Key contact

If you have any questions about this work or want to discuss it further, **do not hesitate to contact Adam Barker (Director, Scarlatti)** either by phone (021 220 9026) or email (adam.barker@scarlatti.co.nz).

Executive Summary

Multilateral data sharing (MLDS) is a long-held goal of many organisations working within New Zealand's Food and Fibre industries. MLDS refers to the exchange of *datasets* between three or more *actors*, where *actors* could include farms, businesses, industry organisations, research providers, and government agencies. It is widely accepted that MLDS could provide benefits to farmers and the organisations that work with them, Including reducing the time and cost involved in providing or acquiring data, as well as opening access to more timely and precise information for the purpose of farm management, decision making or benchmarking. Despite these benefits, and the past attempts to solve the problem, widespread MLDS has not yet emerged. This work aims to support groups working towards MLDS solutions in New Zealand's Food and Fibre industries by presenting a broader approach to negotiating MLDS solutions. Important to note is the framing of the problem, definitions of concepts, as well as solutions reported here are specific to the New Zealand context, though certain parts may be applicable elsewhere.

Drawing from lessons of past attempts at *data sharing*, international experiences, multilateral trade *agreements*, game theory, and considerations of Te Mana Raraunga Principles of Māori Data Sovereignty, the following two ideas are proposed:

- A *data sharing collective framework* which aspires to provide a robust way to characterise a single *collective,* inclusive of the *actors,* their *datasets* and *applications,* and their *motivations and hesitations* to share data.

- A *negotiation mechanism* which provides a process to support the formation of MLDS.

The lessons from past attempts at *data sharing* illustrated the inherent human and organisational complexities for reaching *agreement*. Therefore, a key contribution from the *data sharing collective framework* is allowing for *actors' motivations* and *hesitations* to sharing data and analyse how *enablers* could shift *actors* in favour of reaching *agreement*.

With a foundation in game theory yet refined to suit the reality of New Zealand's primary industries, the *proposed negotiation mechanism* provides a pragmatic way to form a *collective*, to draft an initial *agreement* and to iterate the *agreement* until final *agreement* is reached. There are several advantages of the *proposed negotiation mechanism*, including the commitment to reaching the requirements of all stakeholders that have interest in a *data sharing collective* – particularly important to ensure that Māori and other minorities are included and have their voices heard and addressed. The *proposed negotiation mechanism* also distils much of the complexity within the collective and incentivise *actors* to be truthful – enabling productive conversations from the start.

This work aspires to be a stepping-stone towards the formation of a widespread *agreement* within New Zealand's primary industries. The tools presented here will be useful for *facilitators* to understand and design an initial *agreement* for a given *collective* and how to support the formation of a MLDS. This report proposes that the logical next step for this work would be to test the *data sharing collective framework* and *proposed negotiation mechanism* within an isolated small case, identifying Beef + Lamb New Zealand's (B+LNZ) genetics case as a suitable testing ground. This would provide timely feedback on the *data sharing collective framework* and *proposed negotiation mechanism* and the opportunity to refine either, where appropriate. Once tested and refined, there is potential for this work to support MLDS *agreements* at an industry-level.

Introduction

Context

Multilateral data sharing (MLDS) is a long-held goal of many organisations working within New Zealand's Food and Fibre industries. MLDS refers to the exchange of *datasets* between three or more *actors*. In the context of this report, *actors* could include farms, businesses, industry organisations, research providers, and government agencies that work throughout the Food and Fibre industries.

It is widely accepted that MLDS would provide benefits to farmers, and the organisations that work with them, by reducing the time and cost involved in providing or acquiring data, as well as opening access to more timely and precise information. Although, there is no evidence directly supporting this notion, the logic is that MLDS would facilitate the use of tools that support farm management, decision making, and benchmarking – further enabling New Zealand's primary sector to compete within international markets. Substantial effort and investment have been directed at attempts to unlock the benefits, supporting their existence (see discussion later in this report).

There also appears to be growing interest in *data sharing* within the primary sector over the past 12 months, with reports from Rural Leader exploring *data sharing* and data interoperability (Douma, 2023) and open source platforms to enable *data sharing* (Vreugdenhil, 2022). Furthermore, AgritechNZ (2022) explored digital adoption, including attitudes of farmers to *data sharing*. It appears that data sharing has also received political attention, with the National party releasing their 'Getting back to farming' policy. This policy includes a 'no duplication rule' – meaning farmers will only be required to supply data once, transferring *data sharing* responsibility to the officials who received the data (National, 2023).

Despite these benefits, and the past attempts to solve the problem, widespread MLDS has not yet emerged. Apparently, the barriers to MLDS are even more formidable than the designers of previous initiatives have appreciated.

Approach

This work aims to support groups working towards MLDS solutions in New Zealand's Food and Fibre industries, both currently and in the future, as well as taking a structured and holistic approach to analysing a MLDS opportunity and to building MLDS solutions.

This work does not aim to specify all the elements or conditions of a possible solution – which might include, for example, technology *platforms*, data standards, and economic incentives. Instead, the work aims to consider these elements holistically as part of a broader approach to negotiating MLDS solutions. Two ideas are proposed:

- A *data sharing collective framework* – this aspires to provide a robust way to characterise a single *collective,* inclusive of the *actors,* their *datasets* and *applications,* and their *motivations and hesitations* to share data.

- A *negotiation mechanism* – this proposed process should support the formation of *data sharing* agreements. Its design was informed by insights from a diverse mix of sources (lessons from past attempts, Te Mana Raraunga Principles of Māori Data Sovereignty, and economics), and the *data sharing collective framework.*

This work does not have a complete set of answers to this difficult and complex problem. However, it aspires to help others build towards uncovering further solutions in a more informed way.

Background to this work

This work was prompted by an observation that past and present attempts to facilitate MLDS have, or are, mainly focussed on *data interoperability* and/or systems to facilitate data exchange. In a sense, these are the more concrete components of MLDS. The incentives of *actors* to share data, and the economic, organisational, and social costs of *data sharing*, have not received the same level of attention.

It is observed that the current situation with respect to MLDS in New Zealand's Food and Fibre industries loosely resembles the well-known prisoner's dilemma. In game theory, the prisoner's dilemma is a game that presents a situation where two parties, separated and unable to communicate, must each choose between co-operating with the other or not. The highest reward for each party occurs when both parties choose to co-operate, but it is difficult to co-ordinate this outcome. Consequently, the hypothesis is that framing the current situation as a game theory problem might allow the development of solutions by introducing new incentives to break the deadlock.

The hypothesis was initially explored on the assumption that *data interoperability* problems would be addressed by other work, and that *data sharing* technologies already exist or would be developed. That is, the work largely focused on the incentives, in addition to the economic and social barriers. However, it was later observed that attempting to decompose complex *data sharing* problems by assuming that *data interoperability/data sharing* technologies and incentives/barriers would be treated independently did not work well. Even in the case of simple models of *data sharing* ecosystems, it became difficult to separate these.

When considering a simple case study (as discussed more on page 35 and 52), findings suggested that the game theory formulation of the problem would only go so far in uncovering the complexity of this problem. For example:

- There are barriers to, and incentives for, *data sharing* that do not easily translate to the concept of payoffs used in game theory.

- The incentives for individual *actors* to participate is not necessarily defined by the individual good – some agents make their decisions for the collective or public good that *data sharing* provides.

- The incentives for, and barriers to, *data sharing* for individual *actors* may not be understood even to those *actors* themselves.

This work therefore evolved to take a more holistic approach to understanding this problem. Using a game theory lens still proved valuable by providing a more systematic approach to unpacking the incentives and barriers, ultimately leading to a *proposed negotiation mechanism*. Combining this with stakeholder engagement, qualitative logic, and thought experiments, the findings from this report are arguably not only more practical, but more representative of the real-life agents.

Approach

As described above, the approach taken in this work evolved. This occurred as more challenges were revealed relating to *data sharing* from multiple perspectives. An aspiration was for the outputs of the work to provide a fair representation of the complex nature of the *data sharing collective,* whilst

providing all stakeholders with an equitable opportunity to have their concerns addressed in pursuit of a mutually beneficial *agreement*. Therefore, as complexities around *data sharing* were revealed, outputs progressed in parallel. This work drew on:

- **Academic literature in two fields** – As well as game theory (mentioned above), the analogy between negotiations leading to international trade *agreement*s with those leading to *multilateral data sharing* was considered.

- **Lived experiences in this space** – Discussions with a range of stakeholders were undertaken, including:

    - Beef + Lamb New Zealand (B+LNZ), with a current effort in forming an isolated *agreement.*

    - The Ministry for Primary Industries (MPI), with an interest in unlocking the benefits associated with MLDS – and overcoming interoperability challenges.

    - Māori stakeholders to voice their concerns in relation to *data sharing*, the approach and outputs of this work, and the usage of economics as a framework for Māori.

    - Others involved in current *data sharing* initiatives.

- **Specific expertise** – Two of the contributors – Jack Robles and Andrew Sporle – led the thinking in the areas game theory and Māori Data Sovereignty respectively.

- **The authors' own experience** – This drew on the experience of Andrew Cooke, Gavin McEwen, Andrew Sporle and Adam Barker in past *data sharing* attempts.

Structure of this document

Reflecting the approach this work has taken, the remainder of this document has four parts:

1. **A collection of insights on *data sharing*.** This includes lessons from past attempts, considerations for Māori and inspirations from economics.

2. **A *data sharing collective framework*.** This presents a *framework* for characterising a *collective* and an example of applying it to analyse a simple case study.

3. **A *proposed negotiation mechanism*.** This presents a proposed process for groups wishing to form an *agreement* within a *collective*, along with why this could work in hypothetical examples, and some risks that should be considered.

4. **Summary and next steps.** This seeks to provide the authors' view on how this work can be utilised as a stepping-stone for future work, highlighting some considerations for those doing so.

Glossary

These are terms used throughout the document with specific meaning. Terms may also be defined throughout the document (and will point to the page in which a more detailed description is provided).

Actor	An organisation or individual who is willing to work together to negotiate an *agreement* with a group of other *actors*.
Agreement	A formal understanding between *actors* as to how data will be shared between them.
Applications	This refers to how *datasets* are used by an *actor*.
Champion	An individual/single organisation or a group of people/organisations who initiate and drive the initial stages of forming an *agreement.*
Club	Once an *agreement* is reached, the *collective* forms a *club*.
Collective	A set of *actors* who have and want *datasets,* and who have come together to form an MLDS *agreement*.
Completeness	A complete *dataset* will contain all the relevant items. An incomplete *dataset* will be missing some items.
Contractual requirements	These capture the commitments from both parties to give clarity, predictability, and accountability from those involved.
Coverage	The number of data *domains* contained within the *dataset*.
Data interoperability	The ability for *datasets* to be exchanged and utilised by different *applications.*
Data sharing	The act of compiling and distributing *datasets* among *actors*.
Dataset	A collection of information usually structured using a standard file format.
Document of Intent	Akin to a memorandum of understanding, the *Document of Intent* aims to gain a formal but non-binding pledge from *actors* to negotiate an *agreement*.
Domain	The category of information held within a *dataset*.
Enablers	The things which make *data sharing* possible – overcoming *hesitations* and unlocking *motivations*.
Facilitator	An individual that, once employed, takes a lead on driving and facilitating the negotiation process.

Framework	An approach proposed in this work to formally analyse the state of a *data sharing collective.*
Granularity	The level of data aggregation within a *dataset.*
Hesitations	*Actor*-specific barriers to *data sharing* in a *collective*.
Industry-wide agreement	An *agreement* that encompasses the full industry.
Mechanism	A process in which *actors* come together to find an optimal outcome.
Motivations	*Actor*-specific benefits to *data sharing* in a determined *collective*.
Multilateral Data Sharing (MLDS)	*Data sharing* that occurs between three or more *actors*. (Bilateral is *data sharing* between two *actors)*.
Negotiation mechanism	A process in which negotiation can take place between *actors* to find an optimal outcome.
Platform	The technological means in which *data sharing* is *enabled*.
Reliability	The confidence that a user can have that the data are correct.
Sensitivity	Information about some *domains*, such as commercial, personal, and financial information, are likely to make a *dataset* more sensitive.
Shadow proposal	An initial attempt by the *facilitator* at developing an *agreement* that could be suitable for the *actors* within the collective.
Small-scale isolated agreement	An *agreement* that encompasses a small, clearly defined *collective.*
Subjects	This describes the farms, individuals, or organisations whose data are included within the *datasets.*
Transfer payments	Money, or non-monetary incentives, provided to one or more *actors*, to facilitate their participation in an *agreement*.

Part 1: A collection of insights on data sharing

This section contains a collection of insights that are relevant to *data sharing*. This includes that in relation to past attempts to form an *agreement*, international experiences, considerations in relation to Te Mana Raraunga Māori Data Sovereignty, multilateral trade, and game theory.

Ten lessons from past attempts at data sharing

Overview

There has been no shortage of effort by people and organisations attempting to unlock the benefits associated with a MLDS *agreement*. A range of initiatives continue today, working to address and overcome the various barriers.[1] Most of the contributors to this document have been involved in past attempts at *data sharing*, and three continue to be. This section draws heavily on their own reflections, as well as the formal evaluation of *DataLinker* undertaken by the Red Meat Profit Partnership (Scarlatti, 2020). These reflections and evaluation highlight the complexity associated with attempting to form *an agreement* and the subtlety of issues involved.

DataLinker

DataLinker was an application programme interface (API) software framework that would allow data to be exchanged between multiple data providing organisations and recipient farm businesses – allowing multiple farm businesses to provide data to processing companies. A key intended benefit was to avoid the repeated collection and entry of data, primarily for farmers. When *DataLinker* was made publicly available, organisations were able to pay to join as users – benefiting from having access to *datasets*. However, the *platform* failed to attract enough organisations to make the cost of joining worthwhile.

DataLinker is a valuable case study for this work because:

- It is an example of a previous attempt to establish a *collective* that cleanly aligns with the *framework* proposed in this work.

- It was formally evaluated – by RMPP – providing a documented source to draw on.

- It is well-known to the authors.

Four lessons drawn from the *DataLinker* initiative include:

1. **The cost for participating organisations cannot be too high.** In the case of *DataLinker*, these costs came from:

    – The joining fee

    – The software development and maintenance fee. The initial group of organisations (the early adopters) were faced with the expense of the software. With low numbers of organisations sharing this cost, the expense was too high for organisations.

    – The cost of making data and systems interoperable. This involved, for some organisations, exploring changing their entire IT systems.

2. **The benefit from joining needs to be clear.** Some organisations joined *DataLinker* with the hope that others, that had *datasets* they were interested in, would also join. However, there was never any certainty that these organisations would join or stay linked into the *platform*. As a result, organisations typically chose instead to favour forming direct (i.e., bilateral) *agreement*s with the organisations that had their desired *datasets*.

---

[1] As example, the Data Interoperability Working Group and NZ AgriData Exchange Syndicate.

3. **Underlying farmer need must be translated into clear collective signals.** Collectively, farmers should have been key beneficiaries of *DataLinker*. However, the ability of individual farmers to influence the decision making processes of the organisations that they work with was limited.

4. **The mechanics of the *platform* need to be clear.** Organisations were not clear on what joining *DataLinker* entailed, and therefore they had no reassurance that any concerns around joining would be addressed.

Despite the lack of uptake, components of the *DataLinker* product live on. However, it is predominantly used as a data model specification, rather than a *data sharing platform*.

Integrating Overseer and Farmax

Overseer and Farmax are both well-known and well-used farm management tools. Both originated from research by the same organisation (AgResearch). Despite these common roots, integration of these tools has eluded the efforts of those who have attempted it over the past decade. While integration of these farm management tools is a case study of a *bilateral agreement* rather than a *multilateral* one, it provides two valuable lessons that are, perhaps, less obvious than those provided by *DataLinker*.

5. **Organisational priority levels need to be understood by all parties from the start.** Overseer integration was (and remains) a top priority for Farmax. For Overseer, however, integration has been a much lower priority. A constantly changing technological, regulatory, and political environment means that Overseer has a long list of development demands on it. Integration with Farmax, and other farm management tools, has not been important enough to rise to the top of the list. This prevented Overseer from investing the requisite time and money into making the two tools compatible.

6. **The purpose for *data sharing* needs to be clear, understood and agreed upon by organisations.** Farmax and Overseer have different purposes which, understandably, lead to different views on how farm data are used, such as how results are calculated or what outputs should be provided. Whilst there was a goal in combining the tools, there was never a sole purpose that was clear, understood and agreed upon by the two organisations. These issues relate more to the use of data than to the sharing of data, however, they still create inter-organisational friction that slows discussions about *data sharing*.

A more formalised process to negotiate an *agreement* (likely with an independent *facilitator*) would drill into the outward *motivations* and *hesitations* of both parties, revealing their underlying attitudes, priorities and intended purpose for *data sharing*.

Other experiences

The authors have also been involved in, or actively observed, a range of other past and current initiatives and applications.[2] Four additional lessons drawn from experiences with these initiatives include:

7. **Organisations need to be open about any reservations.** There is genuine desire by many organisations to be a part of collective industry solutions. Also, the expectation of other stakeholders participating is often enough to bring organisations to the table. However,

---

[2] Examples of past initiative include AgHub, SpectraNet and Full Farm System. Examples of current initiatives include Agrigate, FarmIQ, DairyBase, Data Interoperability Working Group, NZ AgriData Syndicate, Trust Alliance.

organisations will often harbour reservations – financial, commercial, technical, and organisational – that they do not share freely and frankly. Without these issues being tabled and addressed, it is difficult to form an *agreement*.

8. ***Multilateral data sharing* may be seen as a competitive threat.** Many organisations that have developed farm management tools, or other similar applications, also develop the ambition to use their tools as hubs for farm *data sharing*. Broader *agreements* therefore become competitive threats to them. Other commercial entities may see *data sharing* as a competitive threat and therefore seek to slow progress down.

9. **The optimal number of stakeholders should be considered.** With more organisations involved, the complexity increases factorially. However, having more organisations involved also increases the potential benefits of MLDS, as network effects reward higher levels of participation.

10. **A process for reaching a contractual *agreement* is required.** Even with perfect information, the sheer complexity of the problem will pose a significant challenge in designing an *agreement* that appreciates everyone's individual wants and needs with respect to *data sharing*.

Conclusions

These past attempts have resulted in positive steps forward, with *data interoperability* barriers to forming *agreements* shrinking. Additional by-products, such as the reuse of DataLinker specifications in international dairy technology standards, have also benefited the industry.

Contractual *agreements* (as per lesson 10) were observed as constructive to *data sharing*, recognising that this could have supported the success of DataLinker through providing organisations with more certainty around their commitment to the *platform*. However, as noted above, the subtlety of issues, both human and organisational, may present complex factors needing to be addressed prior to *data sharing.* It is therefore important that future attempts at MLDS respect such complexities, engraving them within the process for designing an *agreement.*

Considerations for Māori

Overview

> *Māori Data Sovereignty recognises that Māori data should be subject to Māori governance. (Te Mana Raraunga Māori Data Sovereignty Network, Charter)*

An *agreement* will ultimately concern the Te Mana Raraunga Principles of Māori Data Sovereignty (see Figure 1 below). These principles "advocates for the realisation of Māori rights and interests in data, and for the ethical use of data to enhance the wellbeing of our people, language and culture" (Te Mana Raraunga, 2018, p. 1). In the context of an MLDS *agreement*, these considerations would enable Māori to:

- Utilise this resource for self-determination and advancement.

- Unlock opportunities for, and encourage more organisations to work with, Māori.

These principles are therefore required to be considered in the design of a MLDS *agreement*.

Consultation and limitations

Consultation was undertaken with several Māori stakeholders to understand their perspective on what to consider with respect to *data sharing* related to Māori. An attempt has been made to incorporate these considerations into the subsequent work designing the *data sharing collective framework* and *proposed negotiation mechanism*. It is acknowledged that consultation was not extensive and would recommend for future work to continue with consultation to ensure a pragmatic and effective application of this *framework* across different stakeholder groups.

This work does not seek to fully characterise all the considerations for Māori in the context of *data sharing*. Instead, it aims to create a *framework* for analysing and characterising the *collective* and put forward a *proposed negotiation mechanism* that aims to empower and support all stakeholders of a collective to find a mutually agreed upon *agreement*. As outlined within the methodology above (see page 6), this was achieved through testing the *framework* and *mechanism* with real-world examples, some of which involved Māori to an extent. This testing provided a method in which to determine whether the outputs of this report are appropriate in considering Te Mana Raraunga Principles of Māori Data Sovereignty and adapt them appropriately. However, expectation is that as this work develops or gets applied in varying contexts, cases will arise where these outputs fall short in considering Māori. In acknowledging this limitation, it is strongly encouraged that those who may pick up this work adapt the *framework* and *mechanism* to advocate for equitable outcomes with respect to Te Mana Raraunga Principles of Māori Data Sovereignty.

Principles of Māori Data Sovereignty

Figure 1 below is an excerpt taken from here, illustrating the principles of Māori Data Sovereignty. These capture the "inherent rights and interests that Māori have in relation to the collection, ownership and application of Māori data" (Te Mana Raraunga, 2018, p.1) and helped inform the broader approach to negotiating MLDS solutions.

Principles of Māori Data Sovereignty

Te Mana Raraunga | Brief #1 | October 2018

01 Rangatiratanga | Authority

1.1 Control. Māori have an inherent right to exercise control over Māori data and Māori data ecosystems. This right includes, but is not limited to, the creation, collection, access, analysis, interpretation, management, security, dissemination, use and reuse of Māori data.

1.2 Jurisdiction. Decisions about the physical and virtual storage of Māori data shall enhance control for current and future generations. Whenever possible, Māori data shall be stored in Aotearoa New Zealand.

1.3 Self-determination. Māori have the right to data that is relevant and empowers sustainable self-determination and effective self-governance.

02 Whakapapa | Relationships

2.1 Context. All data has a whakapapa (genealogy). Accurate metadata should, at minimum, provide information about the provenance of the data, the purpose(s) for its collection, the context of its collection, and the parties involved.

2.2 Data disaggregation. The ability to disaggregate Māori data increases its relevance for Māori communities and iwi. Māori data shall be collected and coded using categories that prioritise Māori needs and aspirations.

2.3 Future use. Current decision-making over data can have long-term consequences, good and bad, for future generations of Māori. A key goal of Māori data governance should be to protect against future harm.

03 Whanaungatanga | Obligations

3.1 Balancing rights. Individuals' rights (including privacy rights), risks and benefits in relation to data need to be balanced with those of the groups of which they are a part. In some contexts, collective Māori rights will prevail over those of individuals.

3.2 Accountabilities. Individuals and organisations responsible for the creation, collection, analysis, management, access, security or dissemination of Māori data are accountable to the communities, groups and individuals from whom the data derive.

04 Kotahitanga | Collective benefit

4.1 Benefit. Data ecosystems shall be designed and function in ways that enable Māori to derive individual and collective benefit.

4.2 Build capacity. Māori Data Sovereignty requires the development of a Māori workforce to enable the creation, collection, management, security, governance and application of data.

4.3 Connect. Connections between Māori and other Indigenous peoples shall be supported to enable the sharing of strategies, resources and ideas in relation to data, and the attainment of common goals.

05 Manaakitanga | Reciprocity

5.1 Respect. The collection, use and interpretation of data shall uphold the dignity of Māori communities, groups and individuals. Data analysis that stigmatises or blames Māori can result in collective and individual harm and should be actively avoided.

5.2 Consent. Free, prior and informed consent (FPIC)[2] shall underpin the collection and use of all data from or about Māori. Less defined types of consent shall be balanced by stronger governance arrangements.

06 Kaitiakitanga | Guardianship

6.1 Guardianship. Māori data shall be stored and transferred in such a way that it enables and reinforces the capacity of Māori to exercise kaitiakitanga over Māori data.

6.2 Ethics. Tikanga, kawa (protocols) and mātauranga (knowledge) shall underpin the protection, access and use of Māori data.

6.3 Restrictions. Māori shall decide which Māori data shall be controlled (tapu) or open (noa) access.

---

[2] https://www.un.org/development/desa/indigenouspeoples/publications/2016/10/free-prior-and-informed-consent-an-indigenous-peoples-right-and-a-good-practice-for-local-communities-fao/

Figure 1: Principles of Māori Data Sovereignty, authored by Māori data Sovereignty Network and retrieved from here.

Considerations for MLDS

As highlighted in the introduction, this work does not aim to specify all the elements or conditions of a possible solution. Instead, the work aims to consider these elements holistically as part of a broader

approach to negotiating MLDS solutions. However, early consideration of these elements or conditions are important to ensure Te Mana Raraunga Principles of Māori Data Sovereignty are captured within the *data sharing collective framework* and *proposed negotiation mechanism.* Some of the considerations identified within an *agreement* are:

- Triggering a reflection on Te Mana Raraunga Principles of Māori Data Sovereignty whenever the data identifies Māori. This should be led by an acceptable Māori representative.

- Being clear on how the data will be used – particularly if it is for private commercial gain from a non-Māori entity.

- Being deliberate on data governance – having Māori oversight for Māori data is crucial.

Some considerations in the design of a *proposed negotiation mechanism* are:

- Ensuring that Māori have an equally weighted voice and are not overpowered.

- Guaranteeing that Māori stakeholders are always invited to participate in opportunities to form an *agreement*.

- Ensuring that the process enables Māori to vocalise their concerns and have those addressed within an *agreement.*

These will be discussed throughout the document, highlighting where they are applicable and how they are addressed.

Lessons from international experiences

Overview

Data sharing is not just beneficial to the primary industries in New Zealand - it would also unlock significant benefits for other industries, as illustrated by global efforts.

There are a few examples of small-scale MLDS that often involve bilateral *data sharing agreement*s between a small collection of agencies – often for commercial gain. Industry-wide efforts have also been taking steps forward. For example, the development of a Manufacturing Data Excellence Framework is aimed at demystifying the complexity associated with *data sharing* in manufacturing, whereas in biomedical research, the National Institutes of Health (NIH) in the United States has implemented a policy requiring the public sharing and management of any data that arises from research.

There are several themes that have emerged from examining the international experience. First, some issues which hinder *data sharing agreements* can be subtle but significant, such as the importance of trust amongst *data sharing* participants. Next, a formal process or framework is advantageous in reaching *data sharing agreements*. Furthermore, there is a need for a *champion*, either a central industry organisation or government, that would be integral to the initiation, development, and implementation of a successful *data sharing agreement*.

Discussion

The business case for *data sharing* is not unique to New Zealand. In fact, McKinsey estimated the value attached to an open data *collective* (combining government and business data) to be between $3tn-$5tn per year across seven sectors – based on the scenario where over 40 countries implement government open data *platforms* (Manyika et al, 2013). Internationally, there are several examples of small-scale *data sharing*, as well as larger industry-level *data sharing* taking place.

Case studies published by the Royal Academy of Engineering (2018) illustrate different approaches to *data sharing* in smaller scale arrangements, covering areas such as transportation, infrastructure, and weather. Key themes which emerged from their work related to the importance of trust amongst *data sharing* participants, the need for *data sharing agreements* and the role of government in encouraging *data sharing*. Examples of small-scale *data sharing* is 365FarmNet, who brought together multiple partners and *datasets* to form a single farm management tool.[3]

At an industry-level, there has been increasing recognition of the value of *data sharing*, with potential improvements in productivity and innovation (Zampati, 2023). The manufacturing industry provides a good example of this, being central to the Manufacturing Data Excellence Framework – an initiative led by the World Economic Forum in collaboration with Boston Consulting Group. Their 2021 report proposed a set of priorities for decision makers and highlighted opportunities for cross-company collaboration. One of the advantages of the framework is for companies to determine their strengths and development areas for building and implementing more sophisticated data systems that would enable widespread *data sharing*.

Another example of *data sharing* at an industry-level relates to biomedical research. Comparatively, biomedical research has been ahead of the curve with exploring the benefits and challenges of *data*

---

[3] https://www.365farmnet.com/

sharing (Kaye et al, 2018; Devriendt et al, 2021). However, there has been a significant breakthrough in unlocking these benefits recently, with the NIH requiring grant proposals to also "submit a plan for managing the data the project produces and sharing them in public repositories" (Kaiser & Brainard, 2018, para. 1) from January 2023. This is an attempt from the NIH to make science more 'powerful' with freely shared data. No sophisticated rules or standards have been developed to facilitate *data interoperability*, suggesting that the costs associated with *data sharing* possible sit with the researchers. Consequently, researchers would either need to upskill or hire a data manager to resolve the *data interoperability* and management challenges. Even though the costs would be imposed on the researchers, they would likely also be beneficiaries of such a policy, thereby offsetting these costs. Whilst this advancement will cause a shock to the current methods attached to data management for biomedical researchers, it is also expected to unlock significant benefits – core to which is the advancement of science. Whilst this has been successful in a research industry, it is unlikely that this method would translate to industries that do not have an analogous central organisation – such as New Zealand primary industries. However, what it does highlight is the potential requirement for there to be a central *champion* organisation to initiate, develop, and implement *an agreement*.

Lessons from multilateral trade negotiations

Overview

The MLDS terminology that is used in this document was inspired by the analogy to Multilateral Trade *Agreements*. In both trade and *data sharing*, there are a set of parties that would collectively be better off if they all collaborated. There are complexities associated with bringing these parties together given their individual circumstances, unique objectives (both directly and indirectly relating to the *agreement*), and differing levels of benefits associated with the *agreement*s. The challenge in understanding and overcoming this complexity presents significant barriers to the formation of *agreement*s. However, in trade, multilateral *agreement*s have been successfully reached. This suggests either that *data sharing agreement*s are more complex, or that they have underdeveloped systems and processes to overcome the complexity. This is explored further below, landing on the view that multilateral trade negotiations have more sophisticated systems in place supporting their formation – highlighting this as the potential direction required for *data sharing*.

Multilateral trade negotiations

Multilateral trade is trade conducted with more than two involved parties. It will often involve ongoing multilateral negotiations designed to amend, refine, and alter the terms of any existing trade *agreement*s, norms, or standards. Multilateral trade is typically more complex than bilateral trade but can also give rise to significant benefits not realized in less expansive trade arrangements. Multilateral trade also has several similarities with the MLDS – particularly noting the synergies that exist when bringing together multiple parties to form a single *agreement*, in comparison with the formation of a series of bilateral *agreement*s. Additionally, much like multilateral trade, MLDS faces increasing complexity with a growing number of parties interested in the formation of an *agreement*.

The analogy with multilateral trade enables the identification of the benefits and barriers associated with the formation of an *agreement*. As noted by Amadeo (2022), there are five advantages to multilateral trade:

1. **All signatories are treated equally, with developing countries benefiting the most.** This is in comparison with bilateral *agreement*s, where smaller trading partners are often excluded and do not benefit from participation. In the context of *data sharing*, there is an analogy to providing significant benefits for smaller organisations and underserved communities within New Zealand's primary industries, including Māori.

2. **It increases trade for every participant.** This is much the same for *data sharing*, with significant direct *data sharing* benefits for all *actors* in an *agreement* if it is effective in its design – and indirect benefits for all through a more productive and competitive industry.

3. **It standardises regulations across trade partners.** In the context of *data sharing*, this will force organisations to standardise their data formats and procedures, supporting *data interoperability*.

4. **Emerging markets are supported to succeed.** A widespread *agreement* will foster innovation within the sector, supporting them to succeed.

5. **Multiple nations are covered by one treaty.** A widespread *agreement* would eliminate the complicated network of bilateral *agreement*s, with their corresponding cost of delay during negotiation.

In saying that, Amadeo (2022) noted four disadvantages, akin to the barriers to forming an *agreement:*

1. **Negotiations can be lengthy and risk breaking down**. This has been observed with past attempts to form an *agreement,* with negotiations relating to current initiatives still on-going.

2. **Easily misunderstood by the public.** The complicated nature of *agreement*s can be hard to communicate and can lead to misconceptions around what they entail. *DataLinker* offers an example of this.

3. **Removing trade borders affects businesses.** An *agreement* can disrupt the status-quo for some organisations – which may not necessarily be a bad thing for the common good. However, when disruption impacts a powerful organisation, it may present a barrier to form *an agreement*.

4. **Benefits large corporations but not small businesses**. This should not be applicable as the organisations will be direct signatories in the *data sharing* context – rather than being subject to the decisions of a government.

One of the core differences between multilateral trade and MLDS is the success in forming *agreement*s. An enabler to successful multilateral trade *agreement*s has been the support and guidance from the World Trade Organisation (WTO) – an independent organisation. Countries therefore have access to support and protection from the WTO when they navigate forming a trade *agreement* – supporting them to overcome collaboration challenges.

Conclusions

Multilateral trade and MLDS are closely analogous – aligned in both their benefits and barriers. However, unlike MLDS, multilateral trade negotiations are supported by formal systems and processes and guided by independent *facilitators,* such as the WTO, to overcome collaboration challenges. The investment in these resources is substantial.

In contrast, there are no such systems and processes with respect to MLDS in New Zealand (at least in the Food and Fibre industries). The analogy to trade negotiations hints that the absence of these systems and processes is a leading cause for the current absence of successful *agreements*, which suggests that to effectively form MLDS in the future, formalised systems, processes and the guidance of an independent *facilitator* will be required.

Lessons from game theory

Overview

To understand the systems required for *data sharing*, game theory provides some insights. This section explores some of the existing literature in relevant branches of game theory. Subsequently, the limitations in taking a purely game theoretical approach in solving this problem are also discussed, highlighting how it is best to combine these findings with the lessons from past attempts (see page 11), considering how this suits Māori (see page 14), and why testing this with real-life examples is best practice.

As noted in the introduction, the current situation with respect to MLDS resembles the well-known prisoner's dilemma. It presents a situation where two parties, separated and unable to communicate, must each choose between co-operating with the other or not. The highest reward for each party occurs when both parties choose to co-operate, but it is difficult to co-ordinate this outcome. This appears to loosely resemble the situation for *actors* in New Zealand's Food and Fibre industries. That is, a greater collective good is difficult to obtain because of the uncertainty around the other agents' actions and *motivations*, constraining them from acting together.

Arguably the greatest value of game theory for the problem of MLDS is in providing a systematic way to characterise a *collective*, providing a useful foundation for building the *data sharing collective framework*. That said, game theory has also provided inspiration for a *proposed negotiation mechanism.* A *mechanism* is a way in which agents can work through achieving a desired outcome. The relevant game theory literature, along with the mechanistic literature, are discussed below.

Mechanism design

Game theory provides insights into a potential process for forming *agreements,* called *mechanism* design. This, as defined by Chen (2021), "explores how businesses and institutions can achieve desirable social or economic outcomes given the constraints of individual self-interest and incomplete information". It considers problems where:

1. There is a set of possible outcomes O to select from.

2. There are n individuals each of whom has a value function V_{io}, where i is the individual and $o \subset O$ is the outcome.

3. There is a set of payments $p = (p_1, \ldots, p_n)$ which are made to each individual.

The *mechanism* then enables the individuals to find the outcome for each individual and the respective payment (effectively a way of choosing o and p). In theory, calculating the *transfer payments* and the particular outcome for each person is straight forward if you have clarity around the value each individual places on each outcome. However, in practice this is difficult to determine. Individuals can self-report their value ($\tilde{V}$), however it will not necessarily be accurately representative of their true preferences.

Vickrey-Clarke-Groves *mechanism*

The Vickrey-Clarke-Groves (VCG) *mechanism* (as described by Johari, 2007) presents a way to uncover these values, in theory, in the case of a public good. Players are asked to report the value that they place on all the possible outcomes. These players would then be committed to participating – despite not having clarity on the outcomes. Based on this, the socially optimal level of outcome is determined,

which is imposed for all players. Using an algorithm, the *mechanism* then determines the degree of *transfer payments* in a way that everyone is incentivised to tell the truth about the value of an outcome at the beginning, regardless of the decisions of others. As highlighted in the lessons from past attempts at MLDS, quiet reservations from organisations are a likely downfall of future *agreement*s (see page 12). This *mechanism* may provide insight as to how to overcome this through getting organisations to be transparent about any reservations that they may be harbouring, whether financial, commercial, technical, or organisational.

In practice, understanding the complete picture or have enough information to determine the socially optimal level of outcomes and appropriate *transfer payments* proves challenging given the complexity of the system (see page 12). Additionally, committing to a process where the payoff is uncertain will be a deterrent for organisations, as was observed in past attempts (see page 11). Beyond that, even if individuals and organisations were truthful in their self-reported values on different outcomes, it is not certain that they know the true value of the outcomes themselves to begin with.

Vernon Smith's *mechanism*

Using an experimental approach, Smith (1980) overcomes the limitations of the VCH *mechanism* by first asking the players how much they would be willing to pay to participate given a range of outcomes. He then revealed the overall value that would be created, and then asks those same players to vote "yes" or "no" regarding their participation. Those that voted yes would then be bound by the *agreement*, paying their contributions, and receiving the benefits from participation. Those that voted no were then offered the chance to re-consider the value of their contribution and vote again – repeating the process. In practice, Smith found that this process was effective at forming a shared *agreement* between players. This approach is effective at overcoming the foundational Groves *mechanism* – preventing players from having to commit to an unknown process and the designers do not need complete information.

Benefits and limitations

Vernon Smith's *mechanism* has provided an interesting starting point for a potential solution for MLDS. It has potential, albeit with some alterations, to facilitate future attempts to succeed. Retuning to the 10 lessons from past attempts, detailed below are the ways in which the *mechanism* could address them:

1. **The cost for participating organisations cannot be too high.** The *mechanism* would enable each organisation to find their own individual price point, given the magnitude of benefits they would receive from the participation. This would enable all *actors* to pay what they were willing to pay. If it is the case that even the sum of all the 'willingness to pay' from the *actors* were not enough to cover these costs, then an answer could be to attract more *actors* to join to further defray the fixed costs. This could be resolved by considering some of the other lessons below, but also noted as a risk on page 48.

2. **The benefit from joining needs to be clear.** The *mechanism* would require that the conditions and outcomes of the *agreement* be laid out from the beginning, therefore an *actor's participation* was conditional on them receiving the benefits as stated within the *agreement*. This would give them certainty.

    However, as noted, some *actors* may not be clear on the benefit themselves. Therefore, it may be a requirement within the facilitation *mechanism* to illustrate what this benefit is – potentially

by means of financial modelling and other qualitative analysis. This is noted as a risk on page 48.

3. **Underlying farmer need must be translated into clear collective signals.** The *mechanism* would force a deeper understanding of why there was insufficient demand and put conditions in place that would attract and lock in more farmers to participate. However, co-ordinating these farmers within this *mechanism* could prove to be a challenge. This is noted as a risk on page 48.

4. **The mechanics of the *platform* need to be clear.** The *mechanism* would provide clarity to all parties upon their commitment to the *agreement*. However, issues concerning the *platform* may raise post-*agreement* risks, which are noted on page 48.

5. **Organisational priority levels need to be understood by all parties from the start.** Having an independent *facilitator* would control the pace of the formation of an *agreement*. The pace of the implementation of the *agreement*, however, is another consideration. The *mechanism* could enable a condition within the *agreement* that clearly states who is responsible for progress and the timelines for achievement that would control this, assuming that there is appropriate accountability in place – should this be of concern to the *actors* involved. This is noted as a post-*agreement* risk on page 48.

6. **The purpose for *data sharing* needs to be clear, understood and agreed upon by organisations.** This will be reflected in the different valuations that organisations place on different *datasets* and their *applications.* In the case where an *agreement* is required on the methodologies around the *datasets*, this would be negotiated within the *mechanism*.

7. **Organisations need to be open about any reservations.** The *mechanism* would not only force organisations to make binding commitments but would also illustrate that it is in their best interests to voice their perspectives honestly.

8. **_Multilateral data sharing_ may be seen as a competitive threat.** Threatened organisations may participate in the *mechanism*, but actively seek to prevent it from succeeding. This is noted as a risk on page 48, and will be considered the adaption of the *mechanism*.

9. **The optimal number of stakeholders should be considered.** The *mechanism* distils this complexity down to a singular relationship between a party and the wider *collective.* This means that each added stakeholder only increases the complexity linearly, enabling a larger cohort to come together.

10. **A process for reaching a contractual *agreement* is required.** This is directly the purpose and benefit of the *mechanism*.

There are also limitations to Vernon Smith's *mechanism* worth considering. In particular, there are instances where game theory and economics are limited in real-world applications. This includes, but is not limited to:

- **The degree of benefits and barriers to *data sharing* cannot be distilled into a single net pay-off measure.** Contractual *agreement*s will be necessary for some individuals and organisations to share their *datasets.* This is particularly important to ensure that Te Mana Raraunga Principles of Māori Data Sovereignty are upheld and that individual and organisational goals other than financial gain (such as environmental, current, and future wellbeing outcomes) are recognised.

- **Agents are not motivated by maximising a single outcome (i.e. profit).** Game theory, and *mechanism* design, predominately uses *rational agents* who are looking to maximise their

individual payoff – often with homogeneous *actors.* However, as illustrated, this work is concerned with bringing together a range of *actors,* from central government through to commercial organisations, to share data for a range of reasons. A core and relevant example of this, described in Rout et al (2020), is the holistic *motivations* of Māori businesses to often make decisions that favour whānau, mana[4], and kaitiakitanga[5] over profit. This differs from the decision making of other commercial organisations that operate to maximise the wealth of their shareholders (these are often the subjects within economics).

Caution is needed when applying game theory frameworks to Māori. Rout et al. (2020) highlights how Te Ao Māori does not align with mainstream economics due to its foundations of Western values. Furthermore, Mika et al. (2019) discusses the limitations of mainstream economics for Māori, where Hēnare (2016) outlines how for Māori, the economy should be embedded in, and constrained by, the natural and socials – not the other way around. Consequently, the design of the *data sharing framework* and *negotiation mechanism* is inspired by game theory, but as also incorporated lessons from other sources, to consider Te Mana Raraunga Principles of Māori Data Sovereignty.

---

[4] "Usually defined as 'power and presitge', mana has a broader range of meanings including: spiritual authority; vested and acquired knowledge; intrinsic value; and dignity." (Rout et al. 2020).
[5] "At the core of Māori relationships with the environment is the ethic of kaitiakitanga. Often translated as 'the act of guardianship'". (Rout et al. 2020).

Summary

Framing the challenges

The lessons from past attempts and considerations for Māori have supported the framing of the challenges associated with achieving MLDS. These provided useful insights that should be taken into the thinking and design of a potential solution for achieving MLDS.

10 lessons from past attempts

1. The cost for participating organisations cannot be too high.

2. The benefit from joining needs to be clear.

3. Underlying farmer need must be translated into clear collective signals.

4. The mechanics of the *platform* need to be clear.

5. Organisational priority levels need to be understood by all parties from the start.

6. The purpose for *data sharing* needs to be clear, understood and agreed upon by organisations.

7. Organisations need to be open about any reservations.

8. *Multilateral data sharing* may be seen as a competitive threat.

9. The optimal number of stakeholders should be considered.

10. A process for reaching a contractual *agreement* is required.

Additional considerations for Māori

Over and above the challenges above, as per Te Mana Raraunga Principles of Māori Data Sovereignty, there are additional considerations surrounding MLDS for Māori. Some of the considerations identified within an *agreement* are:

- Triggering a reflection on Te Mana Raraunga Principles of Māori Data Sovereignty whenever the data identifies Māori. This should be led by an acceptable Māori representative.

- Being clear on how the data will be used – particularly if it is for private commercial gain from a non-Māori entity.

- Being deliberate on data governance – having Māori oversight for Māori data is crucial.

Some considerations for Māori in the design of a *proposed negotiation mechanism* are:

- Ensuring that Māori have an equally weighted voice and are not overpowered.

- Guaranteeing that Māori stakeholders are always invited to participate in opportunities to form an *agreement*.

- Ensuring that the process enables Māori to vocalise their concerns and have those addressed within an *agreement.*

Inspiring the solution

International experience, with the recent success of a *data sharing* policy within the biomedical research space, has illustrated that widespread *data sharing* is possible. Whilst it is acknowledged that the approach by the NIH is not suitable here, it does highlight the merit in having a *champion* for forming an *agreement* – someone that will take the initiative and drive the formation of an *agreement.*

Economics (multilateral trade and game theory) have provided inspiration for a solution to achieve MLDS. From multilateral trade, the secret to success may be in having:

- An independent *facilitator* supporting the *agreement*.

- Pre-determined processes, guidelines and protection for parties involved.

From game theory, it could be beneficial to have:

- A *mechanism* akin to Vernon Smith's *mechanism* (albeit with some adaptions to address the limitations discussed on page 22). This has several design features that will support the overcoming of challenges with past attempts. These are discussed further within the *proposed negotiation mechanism*, along with how the *mechanism* was refined to attempt to address considerations for Māori.

Part 2: The data sharing collective framework

This section presents and details how to use the *data sharing collective framework.*

The data sharing collective framework

This section proposes a *framework* to describe a *collective*. This *framework* can be used as a tool to help negotiate an *agreement.*

Overview

The term *collective* is used to describe *actors* who have and want *datasets,* and who have come together to form an *agreement.* An *agreement* is assumed as essential to enabling MLDS.

Features of the *collective* include *applications* that *actors* will use *datasets* for, *motivations* for *actors* to share *datasets,* and *hesitations* that get in the way of them doing so. A robust, shared understanding of these features will be valuable to support the *actors* in a *collective* to form an *agreement*.

This section proposes a generalised *data sharing collective framework*. This aspires to identify what components and attributes need to be considered within a *collective*, before attempting to form an *agreement*. The *framework* is summarised in Figure 2.
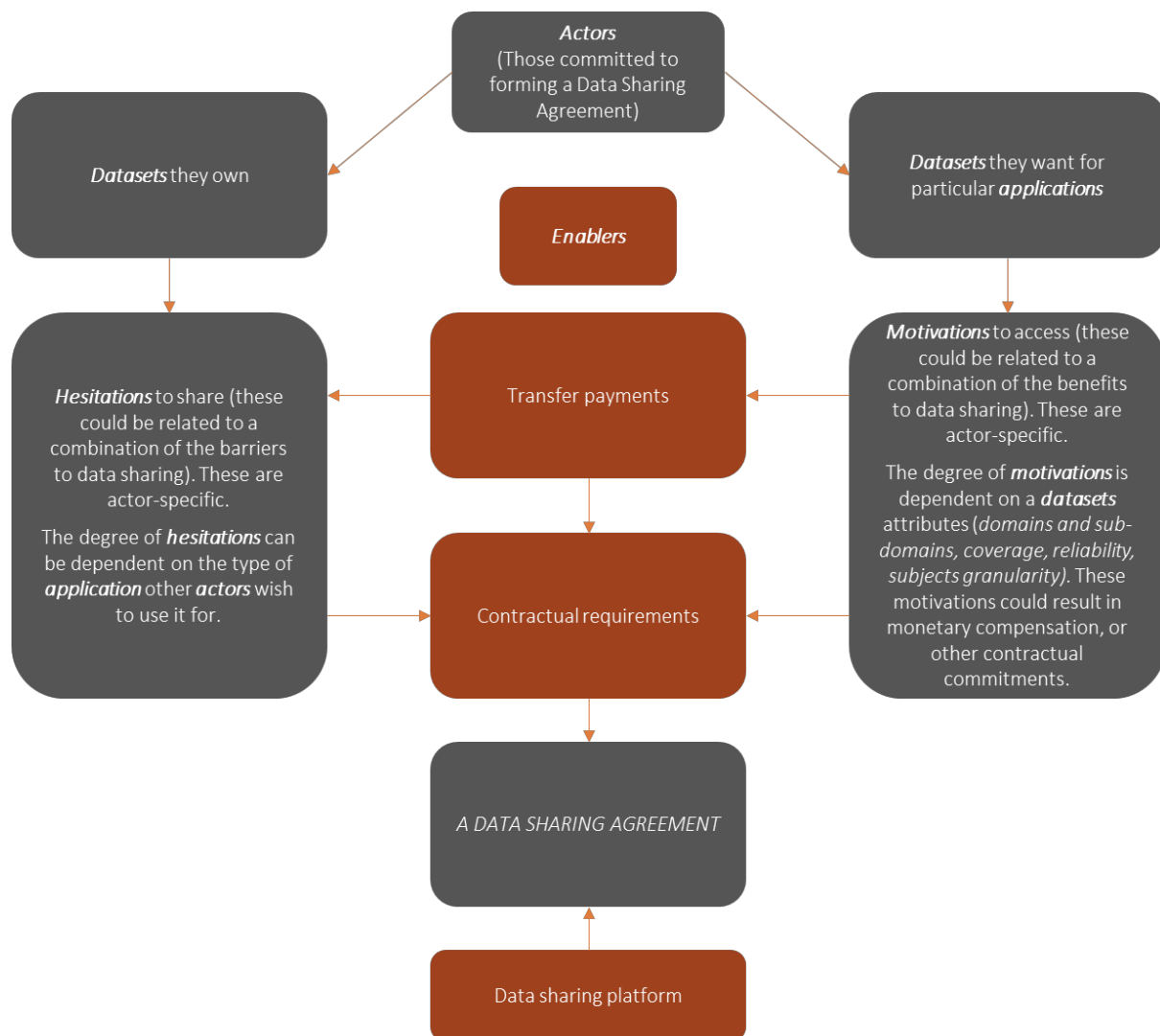

Figure 2: The data sharing collective framework.

At a high level, the *data sharing collective framework* involves five components (as bolded in Figure 2):

1. **Actors**. An organisation or individual who is willing to work together to negotiate an *agreement* with a group of other *actors*.

2. **Datasets**. The collection of information that *actors* have, want, or have some interest in.

3. **Applications.** These are the current and potential uses of the *datasets.*

4. **Motivations** and **hesitations.** These are the *actor*-specific benefits and barriers to sharing or gaining *datasets.*

5. **Enablers**. These are the interventions that could be put in place to enable the formation of an *agreement.*

Each of these are discussed in more detail below.

Actors

In this report, the term *actor* refers to organisations and individuals who are willing to work together to negotiate an *agreement* with a group of other *actors*.

Actors may be open to sharing their *datasets* (typically, for some sort of return), wish to gain access to other *datasets,* and/or be interested in a *dataset* being shared between other *actors.* Within the context of New Zealand's primary industries, *actors* include:

- Farm businesses (incl. Māori businesses).

- Landowners (incl. Māori landowners).

- Processors (incl. Māori businesses).

- Suppliers to farm businesses (incl. Māori businesses).

- Iwi and hapū.

- Local government organisations.

- Central government organisations.

- Industry organisations.

Datasets

It is assumed that *actors* in the *data sharing collective* control access to, and desire access to, different *datasets*. *Datasets* can be described in a range of different ways that can affect how useful and interoperable they are. Relevant attributes of *datasets* include:

- **Domains** – The term "*domains"* is used to describe broad topics areas such as:

  - Spatial data – like farm maps

  - Financial data – like farm accounts

  - Animal data – like animal health records.

  Each *domain* could be broken into sub-*domains*, sub-sub-*domains* and so on. There is no specific hierarchy of data *domains* proposed ,here as groups working on *data interoperability* will be better placed to do this.

- *Coverage* – The term *coverage* relates to the number of data *domains* contained within the *dataset*.

- *Subjects* – this describes the farms, individuals, or organisations whose data are included within the *datasets.* This is of particular importance when Māori are identifiable within a *dataset.*

- *Sample size* – this refers to the number of *subjects* within a *dataset*.

- *Completeness* – a complete *dataset* will contain all the relevant data fields. An incomplete *dataset* will be missing some fields.

- *Reliability* – this refers to the confidence that a user can have that the data are correct. Self-reported data will typically have low *reliability*. Data collected by a third party providing a curation role, or data collected for administrative purposes, may have higher *reliability*.

- *Granularity* – data about a quantity could be provided at varying levels of aggregation. For example, a dairy farm's production data could be broken down at a daily level or totalled over a year. Or a farm's area could be described with a single value for effective area or characterised as a set of land blocks with each described in detail.

- *Sensitivity* – information about some *domains*, such as commercial, personal, and financial information, are likely to make a *dataset* more sensitive.

It is assumed that *datasets* become more interoperable and valuable for all *actors* when:

- They have greater *coverage.*

- They have larger *sample size.*

- The are more *complete.*

- They are more *reliable.*

- They are more *granular* (assuming that it is easy to aggregate up if the *granularity* is not required, but the opposite is not true). It is only possible to aggregate up if the *dataset* is complete and consistent.

Improving *datasets* on any of these dimensions is potentially an *enabler* (see below) to facilitate *data sharing*.

Applications

Actors in the *collective* have a wide variety of different uses, or *applications*, for *datasets*. Examples of *applications* include:

- For individual farm businesses:

    - Monitoring performance

    - Using farm management tools, like MINDA, Trev and Farmax

    - Declaring animal movements

    - Preparing farm plans.

- For central and local government organisations:

- – Informing policy design and decision making

- – Ensuring compliance with regulatory requirements.

- For industry organisations:

- – Providing farm benchmarking tools, like DairyBase or Yardstick

- – Contributing to research and development.

Applications can both use *datasets* and generate new *datasets*. For example, Overseer takes data about a farm business as an input and creates an output file that can be used in other *applications*, such as preparing a farm plan.

Motivations

Actors in the *collective* could be motivated both to gain access to *datasets,* and to provide access to *datasets,* for a range of reasons. Examples include:

Financial and time savings

- **Avoided costs to collect data** – by collecting the same data less often, there are cost savings for the organisations interested in the data.

- **Avoided costs to provide data** – by providing data less often, there are savings for the farm businesses and landowners (and organisations in some cases) providing the data.

Enabling additional *applications*

- **More informed decision making** – *actors* can gain access to information that they may have otherwise not, enabling them to have a more in-depth understanding when making decisions. This encompasses decision making at a range of levels, from an individual farm to policy-setting by central government. This encompasses all categories of *actors*, potentially also enabling farm businesses and landowners to access more information.

- **Unlocking applications not previously available** – *actors* may gain the ability to use a tool or technology that could not otherwise be used because of its dependence on data. For example, a milking robot that needs animal data, or an automated irrigation system that needs soil, rainfall, and crop data.

- **Better benchmarking** – as a special case of the above, *actors* will have access to more information on the industry, enabling them to benchmark their performance more accurately. This may also enable fairer benchmarking to be put in place for Māori farm businesses and landowners, better reflecting their value-based approach to their operations.

Other *motivations*

- **Adding to the production value** – connecting the data from behind the farm gate through to the consumer enables more efficient information transfer, informing the production decisions and operations to match consumer demand.

- **Supporting marketing and brand image** – this could, for example, support New Zealand's green image in international markets. As noted by Douma (2023), across industries, there is a growing

demand for transparency with respect to the impact of what you are doing. This is a growing trend and one that cannot be ignored by those in the New Zealand's Food and Fibre industries.[6]

- **An ability to challenge the status quo** – an *agreement* may disrupt the status-quo – which may not be favourable for some *actors*. The process of initiating and negotiating this will enable these *actors* to have their concerns heard and addressed, giving them more authority over their own data. This, in the case of Māori, would enable them to require Māori data governance for their *datasets* and request more robust insights back.

- **Improved personal experiences** – in addition to cost and time savings, individuals may experience emotional benefits, such as reduced frustration with entering the same data more than once. Offering this will enable users to get more out of *applications*.

Hesitations

Actors in the *collective* could be hesitant to share their *datasets,* or to enter an *agreement,* for a range of reasons. These could include any of the following barriers:

Financial and time costs

- **The costs to maintain a *data sharing platform*** – It is assumed that one of the *enablers* of a *collective* is some form of *platform*. This carries with it a set of costs such as software maintenance and governance time. These costs must be shared by at least some of the *actors* that participate in an *agreement.*

- **The costs to adapt in-house systems** – organisations may require changes to their systems to effectively connect to any *platform.*

- **The costs to make *datasets* interoperable** – *actors* could be faced with a high cost (financial and time investment) to make their *datasets* interoperable. This might include costs to increase the *sample size*, *coverage*, *completeness*, *reliability,* or *granularity* of their *dataset(s)*.

- **An aversion to asymmetric costs** – there is a risk of some organisations getting a "free ride" from other organisations fronting the costs of making an *agreement* work. This may put off some organisations who feel unfairly burdened by this.

These costs could potentially be offset by *transfer payments*, one of the *enablers* – see below.

Data protection

- ***Sensitivity* and privacy** – an *actor* may be concerned around sensitive information within the *datasets* being accessed by certain *actors,* and the potential for them to be used in *applications* beyond their control. An often-cited example is the perceived risk for farmers that shared data will be used, without their consent, to manage compliance with regulatory requirements.

- **Commercial advantage** - commercial organisations may be hesitant to share their *datasets* if unique access to that *dataset* confers a competitive advantage.

---

[6] For example, The New Zealand Merino Company launched ZQRX in 2020, which offers a way for farmers to be measured against a set of sustainability indicators covering human, environmental and animal domains. This acts as a benchmarking exercise, ultimately offering farmers with evidence to inform decision making.

- **Loss of option value** – in a special case of the point above, organisations may be hesitant to share a *datasets* if they see potential value to use it exclusively for an *application* in the future, even if that *application* does not yet exist.

- **Data protection for Māori** – for Māori, there are additional concerns when Māori are identifiable within the *dataset*, as per Te Mana Raraunga Principles of Māori Data Sovereignty. These additional concerns are embedded within considerations around data governance, *applications* and commercial gains made using Māori *datasets*. See page 14 for more information on the considerations for Māori.

These barriers could possibly be offset by *contractual requirements*, one of the *enablers* – see below.

Limited interest

There could be insufficient interest to participate within an *agreement* to overcome the costs if, for example, there are:

- **Misaligned *dataset* requirements** – *datasets* available for sharing may not be fit-for-purpose for the *actor's application*. To share data, the *actor* may then have to alter their *dataset* to suit a particular *application*, or vice versa.

- **No direct benefit for the *actor*** – their *datasets* may be the reason other *actors* are getting involved, but their participation does not provide them with sufficient individual benefit to make sharing their *datasets* worthwhile.[7]

- **Ignorance of benefits** – *actors* may not be aware of the benefits they could receive through participation.[8]

These barriers could be offset by *transfer payments*, adding *actors* and potentially by making *datasets* interoperable – see below.

Execution-related barriers

- **Human resource** – organisations may have the budget to address the costs noted above, but not have the human resources to implement aspects of an *agreement*. For example, organisations may lack software developers with the knowledge to make system changes needed to connect with a *platform*.

- **Management priority** – a special case of the above, managers in an organisation may not prioritise the time to contribute to the work needed to agree an *agreement.*

These barriers could possibly be offset by *transfer payments* and possibly by designing a *platform* that minimises the demands on human resources – see below.

Enablers

Enablers are the things which make *data sharing* possible – overcoming *hesitations* and unlocking *motivations*. Examples are:

---

[7] This is an important consideration, as 77% of farmers and growers are happy to share data where the data provides direct benefit to them (AgriTechNZ, 2022).
[8] One of the biggest barriers to *data sharing* observed was farmers and growers not believing that their data would be of value to anyone else (AgriTechNZ, 2022).

- A *platform* – this enables the transfer of data to occur in a safe and effective manner. It is assumed that this will be a part of any *collective*. No attempt is made here to describe the form of this *platform*, though it is assumed that it will be able to address the technical requirements of *data sharing*.

- Making *datasets* interoperable – this minimises the time and cost requirements to implement a seamless *agreement* and unlock the benefits.

- *Transfer payments* – a transfer payment is money, or a non-monetary incentive, provided to one or more parties in exchange for sharing data. *Transfer payments* could address any asymmetric value creation and cost burdens.

- Recognition – by industry, government, or valued customers - of an organisation's investment in sharing data and the benefits it brings. This could be thought of as a special case of a transfer payment.

- Adding *actors* – this increases the overall value of participation, unlocking more benefits for all *actors*. A *collective* is an excellent example of how network effects provide increasing returns to *actors* as more *actors* join.

- Removing *actors* – if an *agreement* is possible, but does not suit an individual *actor*, that *actor* could opt out. This deserves careful consideration to ensure that Māori organisations are not removed from *agreement*s relating to *datasets* with Māori *subjects*.

- *Contractual requirements* – these capture the commitments from all parties to give clarity, predictability, and accountability from those involved.

A simple case study

Overview

To illustrate how this *data sharing collective framework* can be applied, and the value in doing so, a simple case study isa considered relating to a single *dataset* collected from sheep and beef farmers across New Zealand. The design of this case study is loosely based on a real-world situation. However, it has been adapted to narrow the scope and include Māori identifiers – to explore the considerations for Te Mana Raraunga Principles of Māori Data Sovereignty.

The case study considers a scenario where farm businesses and landowners supply data about their farms to multiple organisations. There is an opportunity for these organisations to co-ordinate their data collection efforts, saving time and money for both the organisations and the farm businesses and landowners. However, there are several challenges associated with achieving this. In exploring these challenges, potential mitigation strategies are highlighted, along with determining whether the formation of an *agreement* could be achieved without any formal *mechanisms* in place.

To distil this into a simple case study, three organisations that are interested in data about farms (Ministry of Primary Industries [MPI], B+LNZ and a generic commercial organisation [a GCO]), and the farm businesses and landowners that provide that data. Each of these *actors* has their own set of *motivations* and *hesitations* to receive and share (respectively) data. The case study first works through considering how MPI and B+LNZ could cooperating on this, before introducing a GCO to consider how that impose additional opportunities and/or complexities.

This case study illustrates that, although this *collective* is small and simpler than most practical ones would be, it nevertheless throws up many complexities. The organisations involved weigh up the trouble of forming an *agreement* with their expected benefits – concluding that the status quo is not worth disrupting. The main losers in this are the farm businesses and landowners, who are subjected to the decisions of the organisations with no representation within the negotiations. This case study is considered again in **'Part 3: A proposed negotiation mechanism'** of this report, highlighting that with this *mechanism*, an *agreement* could be reached – unlocking the associated benefits.

Methodology

This case study will be analysed as follows:

1. Define the *collective.*

2. Form a profile on each *actor,* highlighting the *datasets* they have and want and their *application* for each *dataset.*

3. Outline a proposed approach for the group*,* that will be used to initially assess the feasibility of an *agreement*.

4. Analyse each *actor's motivations* and *hesitations* with respect to the proposed approach.

5. Explore how *enablers* could shift each *actor* in favour of the *agreement.*

6. Make an assessment on the likelihood of forming an *agreement.*

A: MPI and B+LNZ cooperation

1) Define the *collective.*

It is assumed in this sub-case study, that MPI, B+LNZ, and farmers are the only *actors* within this *collective.*

2) Form a profile on each *actor*, highlighting the *datasets* they have and want and their *application* for each *dataset*.

Beef + Lamb New Zealand (B+LNZ)

B+LNZ collect a *dataset* containing farm data as part of a data collection process for the B+LNZ Economic Service. This data are collected by data collectors visiting farms. The *dataset* has the following attributes:

- **Coverage** – it covers multiple *domains* about the farms' operations, including their on-farm stock numbers, farm accounts and staff numbers.

- **Sample size** – it covers approximately 500 farms in the sheep and beef sector.

- **Reliability** – B+LNZ use trained data collectors to curate the data collected, which ensures that this *dataset* is reasonably accurate and of high quality.

- **Granularity** – the *granularity* of the data collected varies by *domain* but is generally at an aggregated level. For example, total area rather than block by block spatial data, total stock numbers by category rather than individual animal data.

- **Subjects** – Māori are identified in this *dataset*.

The Ministry for Primary Industries (MPI)

MPI (in partnership with Stats NZ) also collect a *dataset* containing information about farm production via the Agricultural Production Census. This *dataset* has the following attributes:

- **Coverage** – it covers multiple *domains* about the farms' operations, with a focus on production statistics. However, its *coverage* is smaller when compared to B+LNZ's *dataset*.

- **Sample size** – it is intended to cover all farm businesses in the sheep and beef sector, albeit not all will complete the survey.

- **Reliability** – the data is self-reported by farm businesses and landowners.

- **Granularity** – the *granularity* of the data collected varies by *domain* but is generally at an aggregated level, for example, total area rather than block by block spatial data, total stock numbers by category rather than individual animal data.

- **Subjects** – Māori are identified in this *dataset*.

Farm businesses and landowners

This includes Māori farm businesses and landowners. In this simple case study, it is assumed that all farmers and landowners have similar *datasets*, *motivations,* and *hesitations*. Individually, each farm business and landowner control their own *dataset* with the following attributes:

- *Coverage* – each farm's *dataset* covers multiple *domains* about the farm's operations, such as their stock numbers, farm accounts and staff numbers.

- *Sample size* – it covers only one farm business or landowner's information.

- *Reliability* – the data are typically self-generated by farmers. However, in some instances farmers may refer to administrative data sources, such as invoices provided by suppliers.

- *Granularity* – the data can be as granular as the farm business aspires.

- *Subjects* – Māori businesses can be identified.

3) Outline a proposed approach for the group, that will be used to initially assess the feasibility of an *agreement*.

There is an opportunity for B+LNZ and MPI to co-ordinate in their data collection efforts, providing cost savings for all *actors* involved. B+LNZ's *dataset* has smaller *sample size* but higher *reliability* and *coverage* than MPI's. Each party's respective *dataset* is suitable only for their particular *application*, removing the option that both parties could rely on a single one of their *datasets*. Instead, the proposed approach will require a process that captures the efficiency gains in data collection efforts whilst ensuring that both B+LNZ and MPI have access to a *dataset* with their required attributes.

Farm businesses and landowners are likely to be unaware of the prospects of forming an *agreement*, with no requirement or incentive for MPI or B+LNZ to involve them in the negotiations. This makes them subject to the outcome of the negotiations. However, they are also beneficiaries of a prospective *agreement*, as they will be able to capture time savings.

As a result, the following approach is proposed:

- B+LNZ agree to ensure that they collect all MPI's required data fields in their data collection process with the 500 farmers.

- MPI agree to not survey those same 500 farmers and make to their *dataset* interoperable for B+LNZ.

- Both parties invest in the development of a *platform* that would enable the appropriate transfer of data, one that considers both data governance and farmer permissions.

4) Analyse each *actor's motivations* and *hesitations* with respect to the proposed approach.

Table 1 below seeks to highlight some of the *motivations* and *hesitations* of the *actors* involved in this case study. Although there is a possible opportunity for collaboration, it will be challenging to unlock the benefits.

Table 1: Actors and their motivations and hesitations towards the opportunity (outlined above) within an isolated collective – Part A.

Actor	Motivations (incl. financial and time savings, enabling additional *applications* and other *motivations*)	Hesitations (Incl. financial and time costs, data protection, limited interest, and execution-related barriers)
MPI	**Financial and time savings** • There is a small cost savings opportunity by avoiding resurveying farms that B+LNZ already collect data from, provided B+LNZ collect the *domains* required. • The outcome will result in cost savings for the 500 New Zealand sheep and beef farmers that would have also completed MPI's survey. **Enabling additional *applications*** • B+LNZ's high *reliability* data for a subset of farms may provide benefits for some MPI *applications*.	**Financial and time costs** • Additional time will be required to make their *dataset* interoperable with B+LNZ's. • Investment will be required to develop a *platform*. **Data protection** • A process for gaining farmer permission for sharing the data between MPI and B+LNZ will need to be established.
B+LNZ	**Financial and cost savings** • The outcome will result in cost savings for their levy payers. **Enabling additional *applications*** • They will also have access to MPI's survey data. This could, for example, enable them to infer their data from their 500 farms with the full sheep and beef farmer population.	**Financial and time costs** • B+LNZ will be required to collect additional data points within their data collection. • Investment will be required to develop a *platform*. **Data protection** • A process for gaining farmer permission for sharing the data between MPI and B+LNZ will need to be established. • B+LNZ is worried that asking farm businesses and landowners for permission to share their data with MPI in the future will influence their willingness to supply their information. This will be based on the farmers' perceptions around how MPI will use the data.
Farm businesses and landowners	**Financial and cost savings** • An *agreement* would prevent the 500 farmers that would have also completed the MPI survey from supplying the same data twice. **Other *motivations***	**Financial and time costs** • The farmers providing B+LNZ with data will be required to supply more data. **Data protection** • Farmers may be willing to provide their data to one party, but not the

Actor	Motivations (incl. financial and time savings, enabling additional *applications* and other *motivations*)	Hesitations (Incl. financial and time costs, data protection, limited interest, and execution-related barriers)
	• An *agreement* also offers farm businesses and landowners an opening to voice any requirements they have – if offered the chance.	other hurting response and participation rates.
Māori farm businesses and landowners		**Data protection** • There is a requirement that, as per Te Mana Raraunga Principles of Māori Data Sovereignty, *datasets* are used to enable individual and collective benefit for Māori. **Execution-related barriers** • In parallel, there is a desire for appropriate Māori data governance to give confidence and trust that the data is used as per Te Mana Raraunga Principles of Māori Data Sovereignty.

5) Explore how *enablers* could shift each *actor* in favour of the *agreement*.

The *enablers* that would likely be used here are:

- A *platform* – this can be utilised to address data protection and execution-related barriers.

- Making *datasets* interoperable – this would involve MPI changing their data system – as outlined in the proposed approach.

- *Transfer payments* – this is something that could be explored to offset *hesitations.* This will be discussed this below.

- *Contractual requirements* – these could address some of the *hesitations* of farm businesses and landowners (including Māori). This could be built into the *platform*.

- Adding *actors* – this is explored further in the next stage of this case study (see below). For now, this will not be counted as an option.

6) Make an assessment on the likelihood of forming an *agreement.*

As per the analysis of the *motivations* and *hesitations*, there would likely be a significant investment required from MPI and B+LNZ to unlock the benefits from this *agreement* and the benefits are unlikely to justify this. To increase the likelihood of forming an *agreement*, MPI and B+LNZ would need to receive additional benefits.

In theory the benefits received by farmers could be used to pay for some of the costs (e.g., by B+LNZ allocating some levy funds for this purpose). Whilst B+LNZ's 500 farmers would save time by not having to complete MPI's survey, they would also be faced with having to provide additional data points to satisfy MPI's *dataset* requirements. It is unlikely that the net gain is significant. Therefore, it is concluded that within this closed system, there are not enough benefits created to offset the costs – making everyone better off with the status-quo. Furthermore, this case study also highlighted that there is no

assurance that Te Mana Raraunga Principles of Māori Data Sovereignty will be considered and addressed. This is something that will be considered within the *proposed negotiation mechanism.*

B: Adding a generic commercial organisation (GCO)

As highlighted in part A of this case study, the costs were too high relative to the benefits. As mentioned briefly within the *enablers*, one of the options could be to add in more *actors* to share this cost. This part (B) of the case study will explore just that, adding in a GCO. In this scenario, the GCO provides products and/or services to sheep and beef farmers. A GCO was deliberately chosen as this adds in unique challenges relating to commercial interests. To keep it simple, it is assumed that the GCO does not have *datasets* to share with the other organisations, rather that it simply wishes to gain access to data on farm stock numbers.

1) Define the *collective.*

It is assumed in this sub-case study, that MPI, B+LNZ, a GCO, and farmers are the only *actors* within this *collective.*

2) Form a profile on each *actor*, highlighting the *datasets* they have and want and their *application* for each *dataset*.

It is assumed that the GCO does not have current access to any farm data but is interested in gaining access. In additional, it is assumed that their minimum *dataset application* requirements would make them indifferent between the higher *sample size* of MPI's *dataset* and the higher *reliability* of B+LNZ's *dataset.*

3) Outline a proposed approach for the group, that will be used to initially assess the feasibility of an *agreement*.

The opportunity, as outlined in the first case, stays the same. However, the GCO would have access to the resulting *platform* developed by B+LNZ and MPI.

4) Analyse each *actor's motivations* and *hesitations* with respect to the proposed approach.

The addition of a GCO has two overarching effects. First, all parties that were in Part A are now considering why a GCO wants to be involved and what the consequences of their access to the data could be – particularly if it adversely affects sheep and beef farmers. Second, where a GCO makes gains by using Māori data, such gains must be shared back with Māori, as per Te Mana Raraunga Māori Data Sovereignty. This is illustrated in Table 2, where the black text indicates the additional *motivations* and *hesitations* associated with the addition of a GCO.

Table 2: actors and their motivations and hesitations towards an agreement within an isolated collective – Part B (highlighting the additional motivations and hesitations associated with adding in a GCO to this case study)

Actor	Motivations (incl. financial and time savings, enabling additional *applications* and other *motivations*)	Hesitations (Incl. financial and time costs, data protection, limited interest, and execution-related barriers)
MPI	**Financial and time savings** • There is a small cost savings opportunity by avoiding resurveying those farms that B+LNZ already collect data from, provided B+LNZ collect the *domains* required. • The outcome will result in cost savings for the 500 New Zealand sheep and beef farmers that would have also completed MPI's survey. **Enabling additional *applications*** • B+LNZ's high *reliability* data for a subset of farms may provide some benefits for some MPI *applications*.	**Financial and time costs** • Additional time will be required to make their *dataset* interoperable with B+LNZ's. • Investment will be required to develop a *platform*. **Data protection** • A process for gaining farmer permission for sharing the data between MPI and B+LNZ and a GCO will need to be established. • They want to ensure that a GCO's involvement does not have any adverse impacts on New Zealand's sheep and beef farmers.
B+LNZ	**Financial and cost savings** • The outcome will result in cost savings for their levy payers. **Enabling additional *applications*** • They will also have access to MPI's survey data. This could, for example, enable them to infer their data from their 500 farms with the full sheep and beef farmer population.	**Financial and time costs** • B+LNZ will be required to collect additional data points within their data collection. • Investment will be required to develop a *platform*. **Data protection** • A process for gaining farmer permission for sharing the data between MPI and B+LNZ and a GCO will need to be established. • B+LNZ is worried that asking farm businesses and landowners for permission to share their data with MPI in the future will influence their willingness to supply their information. This will be based on the farmers conceptions around how MPI will use the data. • They want to ensure that a GCO's involvement does not have any adverse impacts on New Zealand's sheep and beef farmers.

Actor	Motivations (incl. financial and time savings, enabling additional *applications* and other *motivations*)	Hesitations (Incl. financial and time costs, data protection, limited interest, and execution-related barriers)
Farm businesses and landowners	**Financial and cost savings** • An *agreement* would prevent the 500 farmers that would have also completed the MPI survey from supplying the same data twice. **Other *motivations*** • An *agreement* also offers farm businesses and landowners an opening to voice any requirements they have – if offered the chance.	**Financial and time costs** • The farmers providing B+LNZ with data will be required to supply more data. **Data protection** • Farmers may be willing to provide their data to one party, but not the other hurting response and participation rates.
Māori farm businesses and landowners		**Data protection** • There is a requirement that, as per Te Mana Raraunga Principles of Māori Data Sovereignty, *datasets* are used to enable individual and collective benefit for Māori. • There is a requirement that any gains made from a GCO using Māori data are shared with Māori. **Execution-related barriers** • In parallel, there is a desire for appropriate Māori data governance to give confidence and trust that the data is used as per Te Mana Raraunga Principles of Māori Data Sovereignty.
A GCO	**Enabling additional *applications*** • They will be able to utilise the data to make more informed business decisions.	**Execution-related barriers** • This is a low priority for a GCO.

5) Explore how *enablers* could shift each *actor* in favour of the *agreement*.

Much like part A to this case, these are the following *enablers* that are available to form an *agreement:*

- A *platform* – this can be utilised to address data protection and execution-related barriers.

- Making *datasets* interoperable – this would involve MPI changing their data system – as outlined in the proposed approach.

- *Transfer payments* – this is something that could explored to offset *hesitations.* This will be discussed this below.

- *Contractual requirements* – these could address some of the *hesitations* of farm businesses and landowners (including Māori). This could be built into the *platform*.

- Adding *actors* – this has been utilised with the addition of a GCO (relative to the first part of this case study). Expanding this to include more *actors* could be an option.

6) Make an assessment on the likelihood of forming an *agreement.*

As outlined in the first part of this case study, *transfer payments* would likely be required to compensate B+LNZ and MPI for this investment. Farmers had been ruled out as the net gain (i.e., time savings and time costs) was insignificant. The addition of a GCO provides a potential source of funding that could support this investment.

As was observed in the analysis of the *motivations* and *hesitations*, the addition of a GCO adds additional barriers to form an *agreement*, particularly because a GCO is a commercial organisation. This added complexity makes the design of the *platform* more challenging, as it requires additional data protection considerations to be addressed.

If such complexities could be overcome, then the appropriate *transfer payments* would also need to be considered. It is unlikely that B+LNZ, MPI and a GCO have an accurate idea about the scale of the benefits that could result from this *agreement*. Even if they could make an estimate, other costs such as making the *data interoperable* and building the *platform* would also be difficult to determine. Therefore, determining the level of the *transfer payments* would be challenging, and even still, would likely reveal that this system does not have enough value-creation to offset the costs. It is likely that the addition of more *actors* would be required – further increasing the complexity and possibly giving rise to scenario akin to an infinite loop.

The initial proposed approach has therefore been shown to not be optimal and will require iteration. However, as was shown, the iterations that follow will add more complexity into the system. A process or *mechanism* would be beneficial to support navigating these subsequent iterations, which is explored in the following part of this report.

Conclusions

These simplified case studies revealed the complexities of *agreements*. Furthermore, there is a critical mass of *actors* that participate for the business case of MLDS to stack up. However, with more *actors* the complexity associated with forming an *agreement* increases factorially. In concluding each part, the following two shortfalls with having no formal process to reach *agreement* were observed. These are:

1. There is no assurance or process to fairly consider and address Te Mana Raraunga Māori Data Sovereignty.

2. There is no formal process in place that is equipped to distil and manage the complexity associated with co-ordinating multiple *agents*.

These will both be considered in the next section of this report where a *proposed negotiation mechanism* is presented.

Part 3: A proposed negotiation mechanism

This section presents and outlines the value of the *proposed negotiation mechanism.*

Proposed negotiation mechanism

Overview

Vernon Smith's *mechanism* (see page 21) provides a practical way for the individual values and respective *transfer payments* to be revealed through an iterative approach, rather than requiring complete information from the start. This provides a useful starting point for the design of a negotiation *mechanism*, while recognising that there are limitations when applying this directly to the MLDS (e.g., Te Mana Raraunga Māori Data Sovereignty considerations).

Based on this, a *negotiation mechanism* to work towards to an agreement is proposed. The *negotiation mechanism* uses Vernon Smith's approach as a foundation while adjusting it to better suit the reality of New Zealand's primary industries. This section presents the *mechanism*, with a subsequent section exploring how this could work in a real-world situation.

Design principles

From the discussions above, the following is taken into account:

- **Vernon Smith's mechanism provides a good starting point** to address the lessons from past attempts, albeit with some risks (see page 22 for how it overcomes these lessons).

- **A *champion* is needed to initiate and drive an *agreement*** (identified from lessons from international experience on page 17).

- **There are several considerations relating to Te Mana Raraunga Māori Data Sovereignty within the design of the *mechanism*** (see page 14 and 40).

- **An independent body and formal processes can support the formation of an *agreement*** (see inspirations from multilateral trade on page 17).

- **Caution should be applied to directly utilising game theory *mechanisms***, particularly due to their misalignment with the holistic *motivations* for Māori businesses (see page 22).

- **A process that can manage the complexity of a real-world *data sharing collective* is required –** there is a critical mass of organisations needed to create the network effects that will deliver benefit. However, with multiple *actors* involved, there is more complexity to manage (see page 35).

These lessons are considered within the design of a *proposed negotiation mechanism.*

New concepts

To help work towards a *negotiation mechanism*, several new concepts are introduced:

Champion - an individual/single organisation or a group of people/organisations who initiate and drive the initial stages of forming an *agreement*.

Facilitator - an individual or organisation that, once employed, takes a lead on driving and facilitating the negotiation process. Ideally the *facilitator* is different to the *champion* and does not have a direct interest in the *data sharing collective*. An approach of co-facilitation with an appropriate Māori representative could possibly be of value with respect to Te Mana Raraunga Māori Data Sovereignty considerations.

Shadow proposal - this is akin to the opportunity as outlined in the simple case study above (see page 37). This is an initial attempt, by the *facilitator*, at developing an *agreement* that could be suitable for the *actors* within the *collective*.

Document of Intent - akin to a memorandum of understanding, the *Document of Intent* aims to gain a formal, but non-binding, pledge from *actors* to negotiate an *agreement*.

*Clu*b - Once an *agreement* is reached, the *collective* forms a *club*, which comprises a voluntary group deriving benefits from sharing a good characterised as excludable (Sandler, 2013) and non-rival (McNutt, 1999). Within the context of MLDS, the data being shared being considered the *club's* good. This characterisation of the *club and club's* good is considered appropriate given:

- **Shared data are excludable** - individuals and/or organisations external to the *club* do not have access to the data being shared within the *club*.

- **Shared data are non-rival** - all *club* members could theoretically access the same data at the same time, without impairing other members' access.

The proposed negotiation mechanism

There are three parts to this *mechanism*:

Part one: the *collective* is formed.

The term *collective* is used to describe *actors* who have and want *datasets,* and who have come together to form an *agreement. Actor*, as defined above, refers to organisations and individuals who are willing to work together to negotiate an *agreement* with a group of other *actors*. In this context, a *collective* is formed, and *actors* are identified once they sign a *Document of Intent*. This signals that they are open to participate in the negotiation process to form an *agreement.*

The process of forming this collective involves identifying stakeholders who could become *actors* and giving them the chance to sign the *Document of Intent*. Once there is a unanimous signing, the *collective* is formed. To drive this process, a *champion* and a *facilitator* are required*. The process of forming a *collective* detailed below:

1. **A *champion* comes forth.** This organisation or individual likely recognises an opportunity to form an *agreement.*

2. **The *champion* brings together a cohort of *actors*.** These are all organisations and/or individuals that have an interest in the *agreement*.

3. **The group employs a *facilitator*.** The *facilitator* should be independent from the group. At this point that the *facilitator* takes over from the *champion* as the driver of this *agreement*.

4. **The *facilitator* forms the *collective*.** The *facilitator* presents the *actors* with a *Document of Intent* to sign. This will gain their formal but not legally binding pledge to participate in the *negotiation mechanism.* Once all *actors* have signed this (or chosen to opt out), then the *collective* is formed.

Part two: An initial *agreement* is drafted.

It is expected that it will likely take multiple iterations to find a mutual *agreement*. However, it is also recognised that a robust starting point will enable efficient negotiations. Therefore, the *facilitator* will

be tasked with conducting an analysis of the *collective* to develop this initial *agreement.* The process is as follows:

1. The *facilitator* forms profiles of each *actor.*

2. The *facilitator* develops a *shadow proposal*.

3. The *facilitator* analyses each *actor's* theoretical *motivations* and *hesitations* towards the *shadow proposal.*

4. The *facilitator* explores how *enablers* could shift each *actor* in favour of the proposal.

5. The *facilitator* refines the *shadow proposal* accordingly to develop an initial draft of the *agreement.*

Part three: The *agreement* is iterated, and one is reached.

With a *collective* formed and an initial *agreement* designed, the group is well-positioned to begin negotiating this through an organised *mechanism.* This aims to encourage all *actors* to be honest and focused on solutions. This process is as follows:

1. The *facilitator* presents the initial *agreement* to all *actors* individually.

2. **All *actors* vote on whether the *agreement* is suitable for them.** This vote is a simple yes or no. It then considers that:

   a. If all *actors* vote yes, then the *agreement* is binding. There is no need to continue with the remaining steps.

   b. If one *actor* votes no, then the *agreement* is void for all *actors.* For the *actor(s)* that voted no, their reasons why are noted.

   c. If only one *actor* votes no, then the remaining *actors* have the power to unanimously remove that *actor* from the *agreement*. The *facilitator* has the discretion to block this on the grounds of Te Mana Raraunga Principles of Māori Data Sovereignty. If the *actor* is removed, the *agreement* is then binding, and there is no need to continue with the remaining steps.

3. **There is the option to change *actors*.** At this point, *actors* can opt out and other stakeholders can join. The *facilitator* has the discretion to put a movement forward for the involuntary dismissal of any *actor.*

4. The *facilitator* investigates the justification for some *actors* turning down the *agreement*, iterates the *agreement* respectively and presents the *actors* with an updated *agreement.*

5. Repeat steps 2, 3 and 4 until an *agreement* is reached and the *club* is formed.

Advantages of the mechanism

The processes currently being used to form *agreements* are arguably much less structured than what are outlined here. This *proposed negotiation mechanism* recognises the lessons from past attempts, builds on the *data sharing collective framework*, considers game theory literature, and considers Māori interests within the design. Overall, the following advantages were observed:

- Includes and commits to reaching the requirements of all stakeholders that have interests in a *data sharing collective.* This will ensure that Māori and other minorities are included and have their voices heard and addressed.

- Separates out politics of participation from the barriers to find an *agreement.* Once the *actors* have committed to forming an *agreement*, many of the politics around sharing data will be put to the side, enabling the group to focus in on making it work.

- Simplifies the *collective* down to the relationship between one *actor* and the *collective.* As concluded in Part A and Part B of this report, the *data sharing collective* is incredibly complex – too complex to design a successful *agreement* from scratch. This *mechanism* distils this complexity into a single relationship between the *actor* and the *collective.*

- Recognises the heterogeneous nature of *actors.* Enables each *actor* to signal their own *motivations* and *hesitations* in relation to this *agreement* – highlighting the specific requirements they have.

- Enables *actors* to express demands other than monetary requirements. This recognises that the solution is not solely *transfer payments*, and the resulting outcome will likely require determined data governance among other contractual obligations from those involved.

- Reveals the preferences and requirements of *actors.* It is likely that the *actors* themselves are not clear on their own degree of *motivations* or *hesitations.* This *mechanism* will force them to identify these through the process, akin to a choice experiment.

Risk mitigation strategies have also been put in place, including:

- An *actor* is uncommitted to forming an *agreement* and wishes to sabotage the formation of one based on their own interests. If it were a single *actor,* the *mechanism* would enable easy expulsion of said *actor.* However, if there appears to be a coalition of *actors* conspiring on this, then the *facilitator* can use their discretion to put forward a motion to remove the respective coalition.

- A *Māori actor's* objectives for being involved differ from the rest of the group, making them vulnerable to expulsion. This is of particular concern for Māori. This is why the *facilitator* has discretionary power to block this dismissal if they are convinced that the *actor's* exclusion would go against Te Mana Raraunga Principles of Māori Data Sovereignty.

Risks and limitations

However, this *mechanism* is not without limitations, summarised below:

- *Actors* could join the process to block an *agreement* forming. The design of the mechanism considered risks such as:

  - A single *actor* joining the *negotiation mechanism* to prevent it from eventuating.

  - A cohort of *actors* collude to prevent an *agreement* from being formed.

  To manage these, mitigation strategies are included within the *mechanism* and gives the *facilitator* responsibility to oversee this risk. This requires consideration when selecting an appropriate *facilitator.*

- An *actor's* objectives for being involved differ significantly from the rest of the group. As above, mitigation strategies and discretionary powers for the *facilitator* are included in the *mechanism* to manage a case where a single *actor* joins the *negotiation mechanism* to prevent it from eventuating. This has been addressed through enabling the group to remove an *actor* if they are the only party voting against the *agreement*. However, it is recognised that this situation may also arise in a genuine sense, where the *actor* is still interested in participating in the *agreement* but has unique objectives. It is envisioned that this may occur for Māori entities, who can have objectives that differ from the mainstream (see Rout et al, 2021 for more). To mitigate this, the *facilitator* has discretionary power to block the removal of an *actor* on the grounds of Te Mana Raraunga Principles of Māori Data Sovereignty. This should be carefully considered, ensuring that the *facilitator* is understanding and respectful of Te Mana Raraunga Principles of Māori Data Sovereignty.[9]

- The formation of an *agreement* could take time. The *mechanism* will repeat until either an *agreement* is formed, or all *actors* have opted out or been expelled. The process of consulting the *agreement*, designing the *agreement*, voting on the *agreement*, and re-designing the *mechanism* takes time. The number of negotiation rounds may be large, increasing the cost to benefit ratio of forming an *agreement*.

- There is no fair representation of farm businesses and landowners. There are of these *actors*, and it would be incredibly challenging to co-ordinate an effort to form a worthwhile *agreement* with only the more engaged of the group. It should be considered how to fairly represent the interests of all farm businesses and landowners within the *agreement* negotiations. It will be important to consider having separate representation for Māori farm businesses and landowners given their different interests to the mainstream.

- It does not assure outcomes post-*agreement*. These could be considered and factored into the *agreement*. Hence, several post-*agreement* risks were identified that could be mitigated in the *agreement*:

  - The *platform* developed to facilitate *data sharing* is not fit-for-purpose.

  - The group loses momentum to follow through on *agreement* commitments. The pace will likely be set by the organisations with the lowest priority or least to gain.

- The benefits from an *agreement* do not outweigh the costs of unlocking them. The scope of the *agreement* could evolve throughout the negotiation phase. As a result, the benefits attached may diminish to the point where an *agreement* is no longer worth it.

Preliminary thoughts on the role of the champion and facilitator

The design principles introduce two *actors* central to forming the collective (the *champion*) and working towards an *agreement* and formation of a *club* (the *facilitator*). Shared below are preliminary thoughts on why the government would be well positioned to take the role of *champion* for larger industry-level MLDS, and how appointment and funding of the *facilitator* can proceed.

---

[9] As noted, an approach of co-facilitation with an appropriate Māori representative could possibly be of value in this scenario.

The role of government as the *champion*

The *champion*, as defined above, is someone that will initiate and drive the formation of an *agreement*. For the *champion* to identify themselves, the outcomes of an *agreement* will align with their organisational goals, providing them with significant benefits. Their role is then to identify and employ a *facilitator*.

Who should be the *champion* depends on the situation at hand. In certain instances, where *data sharing* is contained at a smaller scale (see the B+LNZ beef genetics collective case studies below), a central organisation can logically take this role. However, at larger scale industry-levels, the natural choice for *champion* would be central government.

Farm *data sharing* can be important to the government:

- **Transformational change in environmental outcomes** – accessibility to timely and correct data could support sustainability/environmental initiatives (e.g., greenhouse gas emissions, water quality management) at both the individual farm and aggregate industry-level.

- **Farm data could support proactive management of resources** – shared farm data could provide a basis support wider adoption of innovation by providing a benchmark of benefits. These innovations could promote less reliance on certain resources or support sustainability/environmental initiatives.

- **Interest at a government-level for open and shareable data** – although the Government Data and Strategy Roadmap is targeted at a government agency-level, there appears to be an understanding of the benefits of *data sharing*.

Another reason why the government would be a natural choice of *champion* is that industry would be an unlikely *actor* to kickstart the process of forming an *industry-wide agreement*. This is because the role involves investment – a contribution industry may be unwilling to make given their expected share of benefits (considering the risk that an *agreement* may not eventuate). The government, on the other hand, seeks to gain the most from this *agreement*. They are also well positioned to invest in the process and absorb any risk of non-success.

Funding the *facilitator*

Within the *proposed negotiation mechanism,* the funding of the *facilitator* is determined by the initial cohort of *actors*. In the case of an *industry-wide agreement*, developing a co-funded model would be challenging. The *actors* would likely discuss the asymmetry of value creation resulting from a hypothetical *agreement*, and therefore what the appropriate split of the funding would be – a conversation that mirrors negotiating the substance of an *agreement*. This may become a significant barrier to the *negotiation mechanism* kicking off. Therefore, there is arguably a case for the government to fund an independent *facilitator* to gather immediate momentum on forming an *agreement*.

Cautions

It is recognised that the government's involvement in such an initiative may raise tensions within the industry. Suspicions may be raised by farmers on how the data would be utilised by the government, or concerns about how *data sharing* would erode the competitiveness of the collective. A survey of New Zealand farmers and growers by AgriTechNZ observed roughly a quarter of respondents believe the risks of *data sharing* outweigh the benefits, with over a third being worried about who has access

to their data.[10] However, what the *proposed negotiation mechanism* enables the government to initiate the process and participate in a collaborative process – handing the responsibility over to the *facilitator* to engage with industry.

---

[10] From AgriTechNZ (2022).

Theoretical case studies

Overview

As highlighted above, the *proposed negotiation mechanism* presents a possible way forward for *data sharing* within the primary industries. Initially, the *mechanism* could be used in small-scale isolated cases, to evaluating its effectiveness and evolving it appropriately. Ideally, it could be utilised to facilitate the formation of an *industry-wide agreement* – unlocking benefits for New Zealand's primary industries. Within this section, the benefits of the *mechanism* are evaluated through theoretical case studies. The purpose of this is to illustrate how this *proposed mechanism* can support *collectives* in forming an *agreement*.[11]

Continuation of MPI, B+LNZ and a GCO

This case illustrated the complexity surrounding a hypothetical *agreement* between MPI, B+LNZ and a GCO in relation to on-farm stock numbers (see page 35). In that instance, it was concluded that the value of the *agreement* was not sufficient to offset the cost of forming an *agreement*. To address this, it was suggested that additional *actors* could be added to the *agreement* to share the costs and potentially increase the benefits. The main drawback of this approach would be managing the complexity introduced by additional *actors*. However, in applying the *proposed negotiation mechanism* to the case*,* any complexity associated with additional *actors* could be managed and minimised effectively.

To initiative the *proposed negotiation mechanism,* MPI, B+LNZ and a GCO could *champion* the formation of a wider *collective*, bringing in more stakeholders and employing a *facilitator*. This *facilitator* would then conduct similar analysis to what has been described on pages 35 - 43 to develop a *shadow proposal,* before iterating the *agreement* outlined in part three of the *proposed negotiation mechanism.* Throughout this process, utilising this *mechanism* would ensure:

- **Te Mana Raraunga Principles of Māori Data Sovereignty** were represented and optimistically upheld.

- **Value created from an *agreement* was distributed efficiently** such to make all *actors* better off.

- **The development of an *agreement*** on the basis that there is sufficient benefit generated from combining data to offset the associated costs.

B+LNZ genetics opportunity

Overview of the opportunity

This real-life example is based on current efforts to form an *agreement* within the beef genetics data *collective*. Having a shared database would enable genetic information to be used more effectively in breeding decisions for farmers and bull breeders, unlocking the potential to guide New Zealand's beef herd to be more productive, profitable, and environmentally friendly, and to improve animal welfare.

---

[11] Note that analysing the contents of the *agreement* is out of scope.

Currently, the *datasets* are held by breed societies[12] – and thereby the participating farmers. These are sent to other commercial organisations to undertake the genetic evaluation[13]. Currently, their customers are unsatisfied with their outputs, and are seeking alternative genetic evaluation suppliers. They could invest in building a data warehouse that is interoperable with overseas suppliers or consider an opportunity with B+LNZ.

B+LNZ, with co-funding from the government, is investing in forming their own systems for genetic evaluation. Their overarching goal is to provide New Zealand beef farmers with the tools and insights to make informed genetic decisions, supporting them to improve their sector's productivity, environmental footprint, and animal welfare outcomes. They are engaging with commercial farmers throughout this process, encouraging them to better utilise genetic data in their bull-buying decisions. To do this, their ideal outcome is to have access to all breeding societies' data.

With the existence of B+LNZ's system, breed societies risk being left behind. B+LNZ's genetic evaluation system alongside their extension efforts will encourage commercial farmers to make more informed decisions, exposing any sub-par genetics within a given breed. This incentivises breed societies to be involved, ensuring that they put their best genetics forward for commercial farmer demand. This will also, subsequently, improve the value of their products.

Within this example, an analysis of each *actor,* their *datasets* and respective *motivations* and *hesitations* will not be undertaken. Therefore, determining what an *agreement* may look like is out of scope. Instead, the process of forming an *agreement* will be the focus, outlining why the *proposed negotiation mechanism* is suitable for this example.

Advantages of the *mechanism*

This *mechanism* presents the following advantages for this case study in forming an *agreement*:

- **It gets the politics out of the way.** Beyond this, this example has a lot of mixed emotions about participation in the first place. The two-part approach to this *mechanism* will force stakeholders to decide whether they want to be involved early on. For the breed societies, this will force them to commit either way, understanding more of what they might be gaining or missing out on.

- **It will put any *hesitations* out in the open.** An initial barrier for this example is gaining an open understanding of what each of the *actors* is thinking, and how this *agreement* would interfere with their independent objectives. Breed societies that are resistant to this *agreement* will then be forced to either express their reasons and have them addressed or get left behind.

- **It distils the complexity.** This example presents a range of *actors,* each with a unique set of *motivations* and *hesitations* for the multiple combinations of *actors* that participate. Comparatively, given the context of the B+LNZ genetics opportunity, it is more complex than the hypothetical MPI, B+LNZ and GCO case study. However, much like the previous example, the *proposed negotiation mechanism* presents a process in which the complexity can be distilled down, looking at singular relationships between an *actor and* the broader *collective,* given the involvement of a pre-determined set of *actors.*

---

[12] These are associations of farmers who have a common interest in a single bull breed, such as Hereford or Angus.
[13] The process of assessing data to provide insights for genetic decision making.

- **It enables a solution to be found in a timely fashion.** An *agreement* is required here within the next six months. Following this *mechanism* would initiate productive conversation and negotiation.

- **It gives valuable direction to whether an *agreement* is possible.** Even if no *agreement* was reached, the application of the *data collective framework* and *negotiation mechanism* reveal information regarding actors' *motivations* and *hesitations*, and whether there is merit in pursuing a future MDLS *agreement* between B+LNZ and breed societies, or whether resources should be reallocated.

Risks

This isolated case has the following risks summarised below, along with ideas for overcoming them:

- **An *actor* joining to block this *agreement* is likely.** Some breed societies may wish that genetic information was not widely available or used by commercial farmers, thereby joining this initiative to slow down and ideally halt any progress. Any *actor* could bring this to the attention of the *facilitator,* who will be able to make an independent assessment and act on their findings – potentially removing said *actor*. This *actor* may also get automatically removed if they are the sole *actor* voting against an *agreement*.

- **There is no clear organisation representing the interests of Māori.** Whilst there may be representatives within a single organisation, there is a risk that there is not sufficient representation of Māori. In this case, it would be recommend that any identifiers of Māori are removed from the datasets. This recommendation is made as there appears to be no clear benefit to beef genetics for Māori commercial farmers or bull breeders to be identified for the purpose of this *agreement*.

Part 4: Next steps

This section proposes next steps towards forming an *agreement* within New Zealand's primary industries.

Proposed next steps

Overview

This work aspires to be a stepping-stone towards the formation of a widespread *agreement* within New Zealand's primary industries. However, further work is required to test and refine the *data sharing collective framework* and the *proposed negotiation mechanism.* The refined *mechanism* would then be suitable to enable smooth and timely negotiations involving many organisations. This section outlines some proposed next steps and highlights who should be *championing* them.

Next steps

Testing of the data sharing collective framework and negotiation mechanism

As noted above, the *data framework* and *mechanism* remain untested. Ideally, these could both be tested within an isolated small case to provide close monitoring and timely feedback to enable refinements as appropriate. Therefore, one of the next steps of this work is to find a suitable case where the *data sharing* framework and *negotiation* mechanism can be applied.

One such opportunity is the Beef + Lamb Genetics case examined above (see page 52). There are benefits associated with the testing and refinement of the *data sharing collective framework* and *proposed negotiation mechanism*, which include:

- **The case is isolated and small** involving B+LNZ and breed societies. Although much smaller when compared to industry-level cases the *data sharing collective framework* and *proposed negotiation mechanism* is designed for, the complexities of *actors* coming together to form an *agreement* will still be tested and thus provide valid feedback.

- **Enabling close monitoring and timely feedback**. The timeframe associated with this case would be no more than six months from initiation, which would be timely feedback on the effectiveness of both the *data sharing collective framework* and *proposed negotiation mechanism*.

- **Tangible data, observations, and reflections from a real-world case** to refine the *data sharing collective framework* and *proposed negotiation mechanism* as appropriate.

In addition, there would also be other benefits, which include:

- **A potential MLDS *agreement* between B+LNZ and breed societies**. This would support the work by B+LNZ to help farmers make optimal breeding decisions, while improving their sector's productivity, environmental footprint, and animal welfare outcomes.

- **The potential for unlocking access to overseas evaluation organisations** which may have been not have been possible for an individual breed society (assuming data are interoperable with overseas suppliers).

- **A potential benchmark of MLDS *agreement*** which groups in other sectors could examine and implement. As noted, although it is accepted that MLDS would provide benefits to farmers, widespread MLDS has not yet come about. Therefore, any progress in this area would be beneficial to support wider adoption.

Socialisation and integration of the data sharing collective framework and negotiation mechanism

Beyond testing the *framework* and *mechanism*, Scarlatti will continue the socialisation of these tools given the value they could deliver for future attempts at reaching MLDS *agreements*. Scarlatti will also explore whether any opportunities exist where the work presented in this report may be integrated with other projects closely related to *data sharing* in New Zealand's primary sector. For example, MPI is currently undertaken work on *data interoperability*, which this report identified as a key important to MLDS, though did not explore in depth. Consequently, there may be benefits to both projects to collaborate to further develop a deeper understanding to MLDS.

References

AgriTechNZ. (2022). Baseline of digital adoption in primary industries. Retrieved from: https://agritechnz.org.nz/wp-content/uploads/sites/34/2022/08/AgriTechNZ-Digital-Adoption-in-Primary-Industries-Report-2022.pdf

Amadeo, K. (2022). *Pros and cons of multilateral trade agreements.* The Balance. Retrieved from: https://www.thebalancemoney.com/multilateral-trade-*agreement*s-pros-cons-and-examples-3305949

Chen, J. (2021). *Mechanism design theory.* Investopedia. Retrieved from: https://www.investopedia.com/terms/m/mechanism-design-theory.asp#:~:text=Mechanism%20design%20is%20a%20branch,self%2Dinterest%20and%20incomplete%20information

Curtis Glossary definition of multilateral trade retrieved from: https://www.curtis.com/glossary/international-trade/multilateral-negotiations

Devriendt, T., Shabani, M., Borry, P. (2021). Data sharing in biomedical sciences: a systematic review of incentives. *Biopreservation and Biobanking, 19*(3). 219-227. http://doi.org/10.1089/bio.2020.0037

Douma, L. (2023). Data sharing to achieve data interoperability. Retrieved from https://ruralleaders.co.nz/wp-content/uploads/2023/04/FINAL-Nuffield-Report_Lucie-Douma.pdf

Hēnare, M. (2016). In search of harmony: Indigenous traditions of the Pacific and ecology. In W. J. Jenkins, M. E. Tucker, & J. Frim (Eds.), *Routledge handbook of religion and ecology (pp. 129-137).* London, England: Routledge.

Johari, R. (2007). The price of anarchy and the design of scalable resource allocation mechanism. In N. Nisan, T. Roughgarden, É. Tardos, & V. Vazirani (Eds.), *Algorithmic game theory (pp. 543-570). New York:* Cambridge University Press. Retrieved from http://www.cs.cmu.edu/~sandholm/cs15-892F13/algorithmic-game-theory.pdf

Kaiser, J., Brainard, J. (2023). Ready, set, share! *Science Magazine*. Retrieved from https://www.science.org/content/article/ready-set-share-researchers-brace-new-data-sharing-rules

Kaye, J., Terry, S.F., Juengst, E. et al. (2018) Including all voices in international data-sharing governance. *Human Genomics*, *12*(13). Retrieved from https://link.springer.com/article/10.1186/s40246-018-0143-9

Maniyika, J., Chui, M., Groves, P., Farrell, D., Van Kuiken, S., Almasi Doshi, E. (2013). *Open data: unlocking innovation and performance with liquid information.* McKinsey Global Institute. Retrieved from https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/open-data-unlocking-innovation-and-performance-with-liquid-information

McNutt, P. (1999). Public goods and club goods. *Encyclopedia for Law and Economics, 1,* 927-951. Retrieved from https://www.academia.edu/download/67609710/PUBLIC_GOODS_AND_CLUB_GOODS20210612-27127-p58sy7.pdf

Mika, J., Reid, J., Awatere, S., Gillies, A., Bodwitch, H., Rout, M., Hikuroa, D., Wiremu, F., Lythberg, B., Rakena, M., Robertson, N. (2019). Māori marine economy: a literature review. National Science Challenges: Sustainable Seas. Retrieved from https://www.sustainableseaschallenge.co.nz/public/assets/dms/Reports/Maori-marine-economy-a-literature-review/MME20JMika20Maori20Marine20Economy-20Lit20Review20LR_0.pdf

National. (2023). *Getting back to farming.* Retrieved from https://assets.nationbuilder.com/nationalparty/pages/17748/attachments/original/1681853780/Getting_back_to_Farming.pdf?1681853780

New Zealand Government. (2021, September 17). *Government and strategy roadmap 2021*. https://www.data.govt.nz/docs/data-strategy-and-roadmap-for-new-zealand-2021/#outcomes

Rout, M., Awatere, S., Mika, J., Reid, J., Roskruge, M. (2021). Te ao tūroa, te ao hurihuri, te ao mārama—the old world, a changing world, a world of light: A Māori approach to environmental economics. *Oxford Research Encyclopaedia of Environmental Science*. https://doi.org/10.1093/acrefore/9780199389414.013.715

Royal Academy of Engineering. (2018). *data sharing: implications for policy and practice.* Royal Academy of Engineering. Retrieved from https://reports.raeng.org.uk/datasharing/cover/

Sandler, T. (2013). Buchanan clubs. *Constitutional Political Economy, 24*, 265-284. https://doi.org/10.1007/s10602-013-9148-5

Scarlatti. (2020). *Evaluation of RMPP.* RMPP website (https://www.rmpp.co.nz/evaluation-reports/)

Smith, V. (1980). *Experiments with a decentralised mechanism for public good decisions.* The American Economic Review, 70(4), pp. 594 – 599.

Vreugdenhil, S. (2022). *Is open source the best way to manage and share data in New Zealand agriculture?* Retrieved from https://ruralleaders.co.nz/wp-content/uploads/2022/04/Is-open-source-the-best-way-to-manage-and-share-data-in-New-Zealand-agriculture-Sonja-Vreugdenhil.pdfshare-data-in

Te Mana Raraunga. (2018). *Principles of Māori Data Sovereignty.* Te Mana Raraunga – Principles of Māori Data Sovereignty (Brief #1, October 2018). Retrieved from https://www.temanararaunga.maori.nz/nga-rauemi

World Economic Forum., Boston Consulting Group. (2021). *Data excellence: transforming manufacturing and supply chains.* World Economic Forum. Retrieved from https://www3.weforum.org/docs/WEF_Data_Excellence_Transforming_manufacturing_2021.pdf

Zampati, P. (2023).Ethical and legal considerations in smart farming: A farmer's perspective. In H. F. Williamson & S. Leonelli (Eds.), *Towards Responsible Plant Data Linkage: Data Challenges for Agricultural Research and Development,* (pp. 257-272). Springer. https://doi.org/10.1007/978-3-031-13276-6