Inter-operable Data Modelling in New Zealand Potato value Chain - Chris Claridge

"From Seed to plate" - the potato value chain user case

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Version 1.0

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It quotes parts of this proposal and part of comes out of the "Farm Environment Data Collection - Farm Monitoring System- Farm Environment Plan Proposal by Matt Newman.

1. Executive Summary

The Potato Industry in NZ is represented by Potatoes New Zealand Inc. (PNZ) and covers the main stakeholders of the potato value chain. Seed growers, potato growers, potato processors, agents and exporters are all members of PNZ, with three types of members: growers, trade and associate members.

Generally, the primary sector lacks digitalisation, which causes challenges in data interoperability, the capture, sharing, utilisation of data. The value chain of the potato industry, from imported germplasm to final consumer goods ie potato crisps, involves multiple information systems that operate in isolation or in silos.
Complexity of data handling and traceability starts at imported germplasm for tissue culture multiplication and ends at the shelf for consumers. Due to regulatory compliance, financial management and other management requirements the same data elements need to be generated, managed and processed multiple times. This leads to inefficiency and data redundancy, which can create a higher failure rate due to data inaccuracy.

There exists a clear and strong demand for a data interoperability framework between value chain participants and stakeholders and process steps without losing control of the data ownership and security.

There are three defined areas across the value chain which are critical to data transparency and traceability:

1. Proof of identity e.g. grower or IVA or the buyer or intermediary
2. Proof of location e.g. geospatial data of a paddock or where the goods are currently located
3. Critical control points & transactions e.g. seed registration form, e-phytosanitary certificate

If these data elements are not captured and shared accurately and in a timely manner it can lead to business and environmental risk. It is important that data is provided accurately and in a timely manner to the subsequent process steps otherwise the next events cannot be executed properly. In general traceability and efficiency through the global value chain are lacking. Therefore it is recommend as a starting point to establish a system to prove identity, location and critical control points and transactions through the value chain e.g. a digital identity legitimation per person, a unique location registry, and a secure & trustworthy system for traceability.

2. Background

In September 2019, Government released the National Environment Standard on Freshwater Management and an update to the National Policy Statement, which aims to improve water quality for rivers, lakes and wetlands within five years and resolve water quality issues within a generation.

Ministry of Primary Industries (MPI)

MPI wishes to better understand the trends, distributions and drivers of environmental performance; what farms are currently doing, how farms are changing and the impact on the farm system, farm financial performance and the local environment. This improved knowledge will help government develop better environmental policy options that are backed up by robust analysis.

MPI is seeking to obtain existing Overseer (or equivalent) farm data to identify and analyse current trends, distributions and relationships of key drivers. MPI are also seeking to understand horticultural environmental KPIs and methodologies for analysis.

MPI is seeking to better understand what is required for an effective FEP through the Integrated Farm Planning (IFP) project. This project aims to support farmers to take a whole of system approach to optimise their farm businesses, and as a result improve their economic and environmental performance and resilience as noted in the statement below from the IFP project plan.

"*There is clear need for farmers, their industry representatives, councils and government to work together to find a more efficient way forward for farm planning. Importantly this needs to focus upon value-creation for the farmer while supporting farm assurance and the Government's objectives for sustainable land use".*

MPI is seeking to build on this project by partnering with primary sector industries (including environmental consultants) to obtain farm level environmental data (such as Overseer files or equivalent environmental impact model). This would also include surveys and data collection activities, as well as mitigation modelling and policy evaluation.

An MPI-led project called the Farm Environment Data Collection has been initiated to collect environmental data from 2,000 dairy, 2,000 sheep, beef and deer farms and 800 horticulture or arable blocks over the next four years.

In parallel to this project a key barrier limiting COVID-19 and long-term economic growth in the New Zealand primary sector has been identified by MPI and other Ministries.

There is lack of agritech offering and data interoperability and openness limiting uptake and innovation.

Agritech systems, machinery and services are often designed in isolation without considering how one agritech offering will operate alongside other offerings as there are no uniformly recognised or adhered to standards for agritech products to ensure interoperability across offerings. This results in a fragmented market where products and services are not interoperable or cross-compatible. A modern farmer who is incorporating agritech across his operations may be asked to use a large number of different systems that do not communicate, which produce data in different formats, which cannot be easily amalgamated and analysed. This results in decreased on-farm productivity, lower uptake of agritech and limited innovation as complementary services are more difficult to develop due to the fractured market.

The integrated farm planning project (IFP) is working with the industry to develop an integrated farm planning framework to ensure better coordination between regulators and ease the compliance and reporting burden on farmers. The work includes creating an online resource to set out farmers' minimum regulatory requirements and working with industry to increase the standardisation of farmers' data reporting and audit requirements for animal welfare, biosecurity, employment and environment regulations. "[1]

The IFP sets out an approach to the long-term transformation of the agritech sector to make it more productive, sustainable and inclusive as part of a zero-carbon economy. It has been prepared with a cross government approach and in consultation with industry and the broader agritech ecosystem.

POTATO & VEGETABLE SECTOR

The Potato industry has three key strategic objectives. Double the value of fresh & processed exports by 2025. Enhance the value of the domestic market by 50% by 2025. Zero net nutrient and GHG emissions from the potato industry by 2050. Projects recently completed or underway help achieve the third objective include; the Root Zone Reality Project, Maximising the Value of Irrigation, Future Proofing Vegetable Production, NZGAP Soil Erosion & Phosphate Dashboard, Don't Muddy the Waters, Quick N Measure it & Manage it, Nutrient Emissions Project, Joining the Dots and the Sustainable Vegetable Systems (SVS).

Led by Potatoes New Zealand (PNZ) the SVS project is a multi-stream nationwide project supported by the wider vegetable industry. It is designed to help transition crop production for vegetable crops (potato, onion, leafy greens, vegetable brassicas etc.) to more sustainable land management practices while growing resilient communities and economies. It builds on the body of knowledge from projects outlined previously. It will provide empirical data of nitrogen (N) uptake and nitrate leaching, investigate nutrient modelling and validate Overseer predictions to inform industry and MPI on current practices, develop new systems, strategies and tools to manage nitrate leaching. This will help growers implement good management practice and provide leaching assessments to regulators. PNZ has engagement with Overseer and this has allowed PNZ access to the Overseer Nutrient Budgets engine.

Information systems that track and report improvements of nutrient management are critical to achieving zero emissions. Providing a digital platform to monitor, report and manage leaching to provide benchmarking to track progress is planned as part of the Sustainable Vegetable systems project. Sharing inter-operable data between existing and planned information systems in a permissioned manner is further envisaged to provide tools for growers and industry to better plan and manage towards farm, industry and national goals.

PNZ as a commodity order levy group has a regulatory framework that provides for collection and reporting of economic data at an individual farm and industry level. Growers members records are being updated with a commodity levy payment record so that accurate recording of commodity levy collection is achieved. An information system (BELIS) is being piloted by Potatoes New Zealand. This data will provide the basis for farm economic performance modelling. BELIS has been developed to incorporate mapping data for biosecurity and traceability reasons. The linking of crop maps to economic and emissions data reporting has been architected.

Linking databases where appropriate will streamline the compliance costs and reduce the burden on growers by having information systems that are able exchange data within pre-agreed protocols. It is envisaged that blockchain technology could be used to aggregate and report data.

[1] Source: ITP Agritech Paper

3. Scope of Project

Undertake a project to model data elements and the current information systems in the New Zealand Potato Industry ie "Seed to Shelf".

VISION:

"Potato sector data is managed and shared easily through an enabling ecosystem to participants in the value chain. Clear data ownership and governance has been built within the potato sector to provide trust and confidence. Data is easy to collect and share, supporting better decision making, generating value and insight within and across the potato value chains"[2]. The data ecosystem enables implementation of the Potato Industry Recovery and Transformation Plan.

4. Project objectives

To illustrate how a data system can become a valuable, trusted and widely accepted part of farm and value chain operations in an effective and efficient way.

"To support the future of the industry:

- Data will support better decisions for all
- Data collection effort will be minimised
- Data will be current, valuable and trusted
- Data will be used to build trust in the food system and the care for the environment
- The value of data sharing is understood and translates to action
- There is strong governance over data
- There is good infrastructure (e.g. mobile network access) to enable the use of the tools
- Data will be secure and used appropriately by all
- There is confidence to input, share and use data"

5. What's in

5.1.1. Expectations and outcomes required by Stakeholders.

5.1.1.1. The outline of the stakeholder management plan to ensure engagement and recruitment of industry participants. Includes a stakeholder communication plan that outlines clear benefits and key messages.

5.1.1.2. Issues such as sharing industry data and reports while ensuring data ownership & maintaining privacy of sensitive data are to be addressed.

5.1.2.The purpose of the project.

5.1.2.1. Identification of the value chain participants and the data streams required for those participants to operate efficiently.

[2]Source: PNZ Strategy Paper

5.1.2.2. Scope the source, hierarchy and tiers of information available and data required by participants to operate.

5.1.2.3. Identify core elements of the value chain stage datasets that need to be prioritised for the project.

5.1.2.4. Identification of the inter-operability models/tools that could be utilised at these stages.

6. Challenges

General process steps of the data journey:

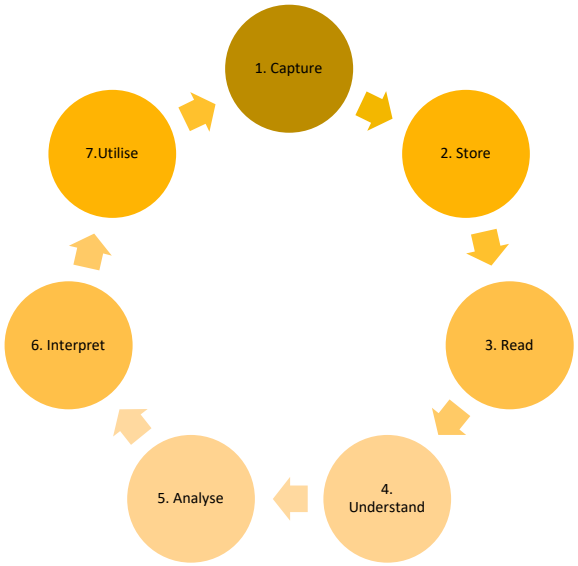


Figure 1: Data process cycle

Different steps of the data life cycle entail separate challenges per stage.

In researching the first two steps, “Capturing” and “Storing”, we discovered that data is collected in many different ways and stored amongst numerous different systems. Many data elements are non-digital e.g. paper maps. The silo storage approach makes it exceedingly difficult to share data in an efficient and immutable way between the key stakeholders.

At the “Read” stage, the challenge is managing access and permissions to the selected data element with other selected parties. Without linkages or connectivity with other data elements derived information is not meaningful, relationships between data elements are missing, which means it cannot be understood in the way it should. At the “Analyse” and “Interpret” stages the key issue is the individual siloed approach to data use, rather than an integrated collective approach. The risk is that data will be interpreted by different parties using differing assumptions with incomplete access to all relevant data, which might lead to incorrect conclusions.

The last step “Utilise” is a particularly important one. It comes down to data reliability and trustworthiness, in this case for the data user. How can they rely and trust the data they are receiving without proof of identity or verification processes by different stakeholders?

An especially important challenge through the whole industry is compliance with data standards, especially when it comes to aggregating and consolidating data, and comparing and setting benchmark levels. A lack of standardisation makes matching data sets very difficult.

Additional aspects to be considered and addressed within the data ecosystem include:

6.1.1. Lack of digitalisation in general within the primary industry due to:

- Lack of urgency
- No clear understanding of the benefits
- Limited knowledge of the technology, which drives uncertainty
- Lack of capability & motivation to transform and change in general
- Outdated legislative frameworks

6.1.2. Wide spread of digitalisation levels e.g. at "behind the gate" and "beyond the gate" are often two different worlds e.g. from pure paper- based operations up to full IoT device and AI driven businesses.

6.1.3. Mining data to optimize value within the whole system. Data sets need to be brought together to unlock valuable information.

6.1.4. Value chain surveillance by capturing the right data elements to:

6.1.4.1. monitor, identify and understand risk e.g. setting clear benchmark levels for early alerts at control points and allocating & prioritising resources accordingly

6.1.4.2. having the ability to access data in a controlled and manageable way e.g. for root cause analysis and to define & execute the appropriate counter measures to optimize the whole value chain on a global level.

6.1.4.3. ensure that the overall system is statistically "in control"[3] the process steps must be defined, measure, analysed, improved and controlled (following the DMAIC Methodology[4]). When this methodology is applied, the system/value chain could be called "in control".

6.1.5. Trustability of the data.

6.1.6. Ownership handling of the data e.g. complexity of legal framework & governance

6.1.7. Controlling & managing the data e.g. in particular for shared data

[3] "When we talk of a process operating "In-Control" it translates to situation that only common cause variation is present, process is predictable and process is stable". Source: Six Sigma Institute

[4] Please see details: https://www.isixsigma.com/

6.1.8. Fragmented linkages between critical data elements and the transaction steps through the entire value chain

6.1.9. Access to data for informing the right policy regarding e.g. environmental protection & sustainability for “best farming practice” or health and safety purpose

6.1.10. Lack of utilisation of data to improve the primary industry business e.g. improving growing procedures on farm level and on sector/region level

6.1.11. Unavailability of tools to manage digital assets

7. Outcomes

The core data elements along the industry value chain have been mapped. The participants have been identified and there is a clear understanding of their requirements and what permissioned data is required. What needs to be done to make the data elements inter-operable have been identified, the benefits of doing this and what the barriers to implementation are.

8. Deliverables

8.1.1. Industry Information System Map.
8.1.2. Set of recommendations to ensure the optimisation of the Industry information system and critical success factors.

9. Project team & key stakeholders

9.1.1. Potato NZ Team
9.1.2. Seed Authority Board
9.1.3. MPI Biosecurity
9.1.4. Seed Merchant
9.1.5. Seed Growers
9.1.6. Commercial growers
9.1.7. IVA (SGS) e.g. Field and Tuber inspectors
9.1.8. Seed inspection organisation
9.1.9. MPI Phytosanitary & Export
9.1.10. Food processors e.g. McCain, Talley’s, Heartland Chips
9.1.11. Retailers e.g. Foodstuff North Island
9.1.12. Consumers
9.1.13. Enablers e.g. IT systems and providers

10. Methodology

The business analysis process and data element identification was undertaken by several interviews and workshops with the key stakeholders mainly Potato NZ, seed authority, seed growers, IVA's and retailer to discover the end to end value chain regarding data interoperability.

11. Overview of Potato New Zealand Industry

The New Zealand Potato Industry contributed $1,088,000,000 to the NZ economy in 2019.

Potatoes are grown across Aotearoa, from Northland to Southland, with the majority of production in Canterbury and Pukekohe. There are 172 growers in total at present, with 78 of those in Canterbury and 30 in Pukekohe. The area planted in 2019 was 10,417 hectares, from which 533,130 metric tonne of potatoes was produced. The farmgate value in 2019 was $190,000,000.
The Industry has a total export value of $128,211,000 and total domestic retail of $959,659,000.
Potatoes growers produce seed, fresh potatoes and processing potatoes for the 9 processors across the country.
Potatoes New Zealand Inc. (PNZ) is the industry association representing the interests of the New Zealand potato industry. Potatoes NZ Inc. became incorporated in, previously it had been operating as a product group within Horticulture New Zealand. In June 2013 PNZ started collecting a commodity levy in accordance with the Commodity Levies Act (1990) – Commodity Levies (Potatoes) Order 2013.

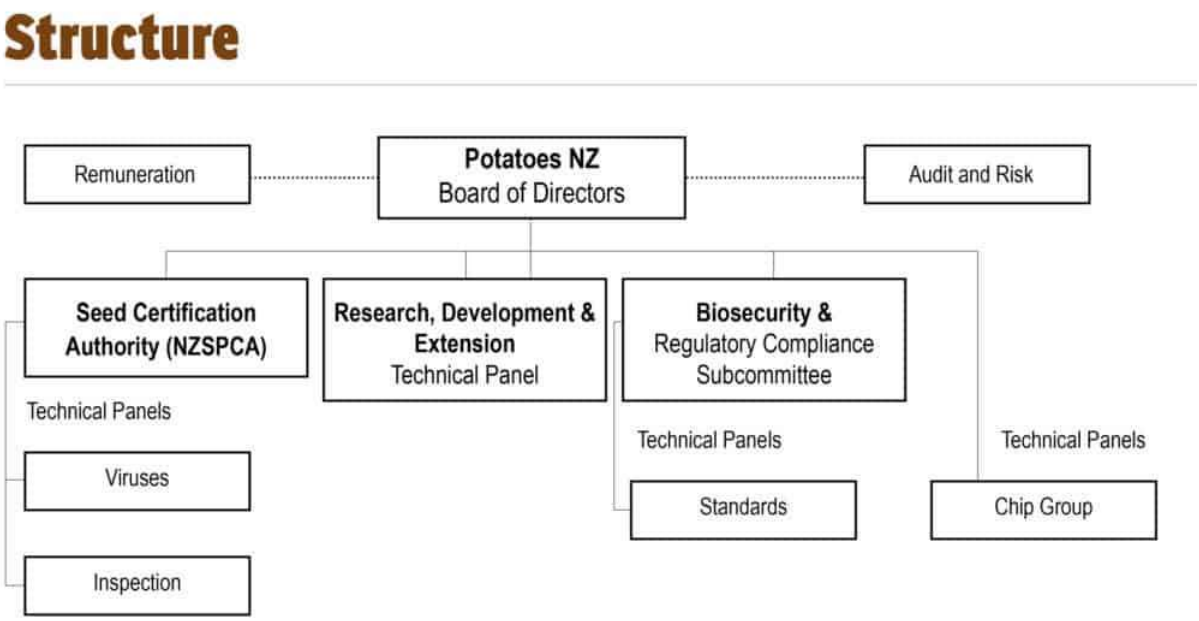
PNZ has three membership types:

Grower Members are actively engaged in the production of potatoes in New Zealand for commercial processing, domestic fresh market, export, or seed who, in the preceding 12 month period, have paid a levy pursuant to the Commodity Levies (Potatoes) Order 2013. There are 172 Grower Members who have full voting rights.

Trade Members are actively engaged in processing, trading or retailing New Zealand grown potatoes or potato product. There are five Trade Members who have voting rights but not Levy Voting rights.

Associate Members are associated with the potato industry and are engaged in supplying services to Grower members or Trade members. PNZ currently has ten Associate Members. Association Members do not have voting rights.

The current PNZ Industry Strategy is to double the value of fresh and processed exports by 2025; increase domestic market value by 50% and achieve zero net nutrient and GHG emissions by 2025



12. Market Overview

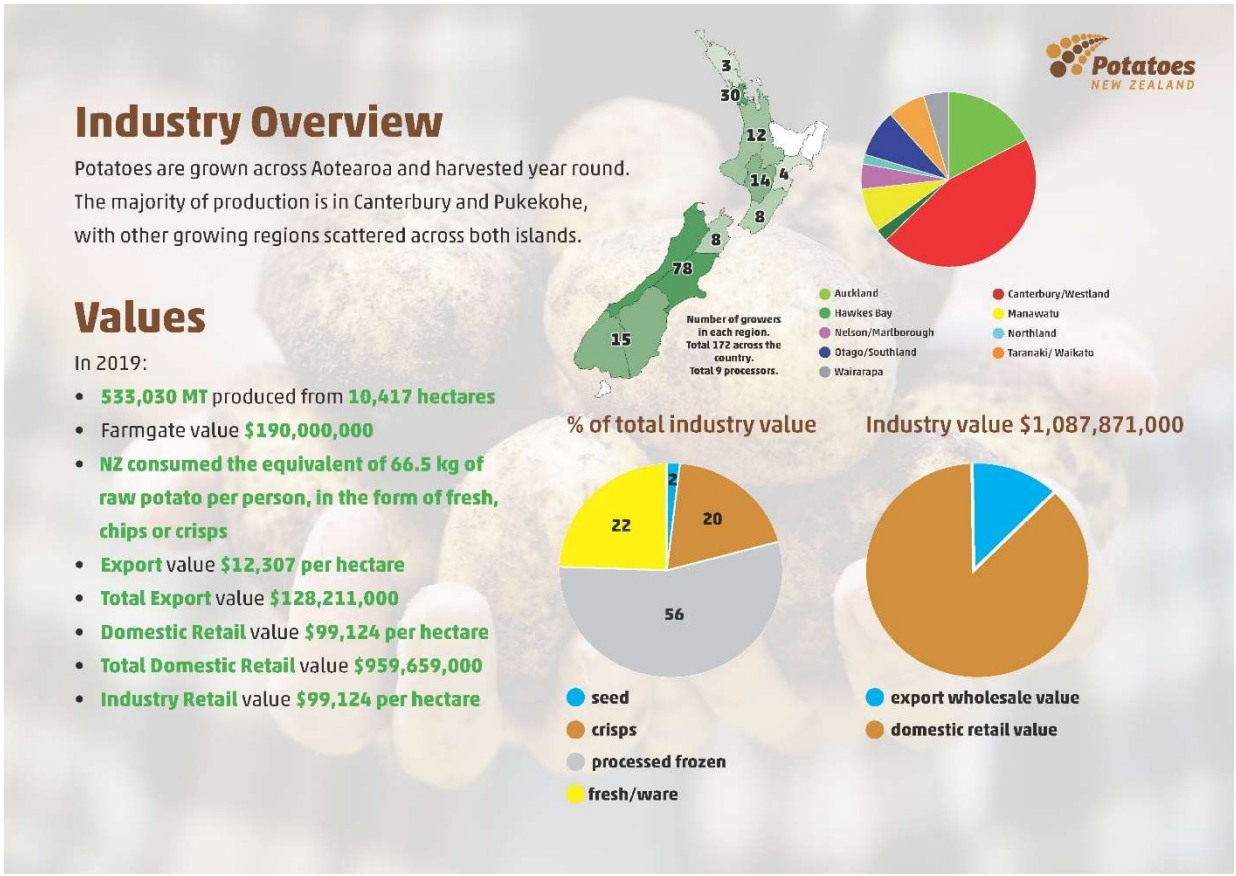


Figure 2: Industry overview PNZ

2019 Potato Industry by Volume

	Total 2019	Seed 2019	Table 2019	Processed 2019
Area (ha)	10,417	1,117	3,300	6,000
Production (MT)	533,030	21,230	151,800	360,000

Seed (MT)	2019
Export	27
Domestic Sales	21,203
Total	21,230
% of total Grown	4%

Table Potatoes (MT)	2019
Export	20774
Domestic Sales*	105,000
Foodservice*	5,000
Total	130,774
% of total grown	25%

* assumed

Crisps (MT)	2019
Raw Potatoes	58,457
Domestic Mfg	12,860
Import	887
Total	13,747
Export	837
Retail	12,910
Total	13,747
% of total grown	11%

Frozen/Fries (MT)	2019
Raw Potatoes	301,543
Domestic Mfg	156,289
Import	18,606
Total	174,895
Export	77,062
Retail	27,423
Total	174,895
% of total grown	57%

Notes: 2018 & 2019 figures have been updated as of July 2020.

Potatoes NEW ZEALAND

2019 Potato Industry by Value

	Total 2019	Seed 2019	Table 2019	Processed 2019
Area (ha)	10,417	1,117	3,300	6,000
Production (MT)	533,030	21,230	151,800	360,000

Seed ($000)	2019
Export	$25
Domestic Sales	$16,962
Total	$16,988
% of total Grown	2%

Table ($000)	2019
Export	$20,774
Domestic Sales	$192,325
Foodservice	$30,000
Total	$243,099
% of total grown	22%

Crisps ($000)	2019
Export	$5,781
Retail *	$211,779
Total sold	$217,561
% of final industry value	20%

*assume extra 10% value above Scan Data

Frozen/Fries ($000)	2019
Export	$101,631
Retail*	$86,130
Food Service	$422,462
Total Sold	$610,223
% of final industry value	56%

*assume extra 10% value above Scan Data

	2019
Domestic	$959,659
Export	$128,211
Total Industry Value ($000)	$1,087,871

2019 Total Industry Value: $1,088 million p.a.

Notes: 2018 & 2019 figures have been updated as of July 2020. Currency is NZD.

Potatoes NEW ZEALAND

Figure 3: Potato Industry value & volume

13. Data source

In the different process steps several data sources and systems are used. The systems are not connected or synchronized. Mainly the grower data is provided in ca. 80% of the cases via email (or even via fax) with dedicated templates, forms or spreadsheets to e.g. PNZ, IVA and MPI.

As an example: The majority of farm and field maps provided hand drawn, which are scanned and emailed to the next part of the process step.

14. Data handling, forms and field definitions

There are many different templates and forms in the industry. For example from “Germplasm to seed potato to commercial growers” up to nine different forms are used to document and execute this workflow.

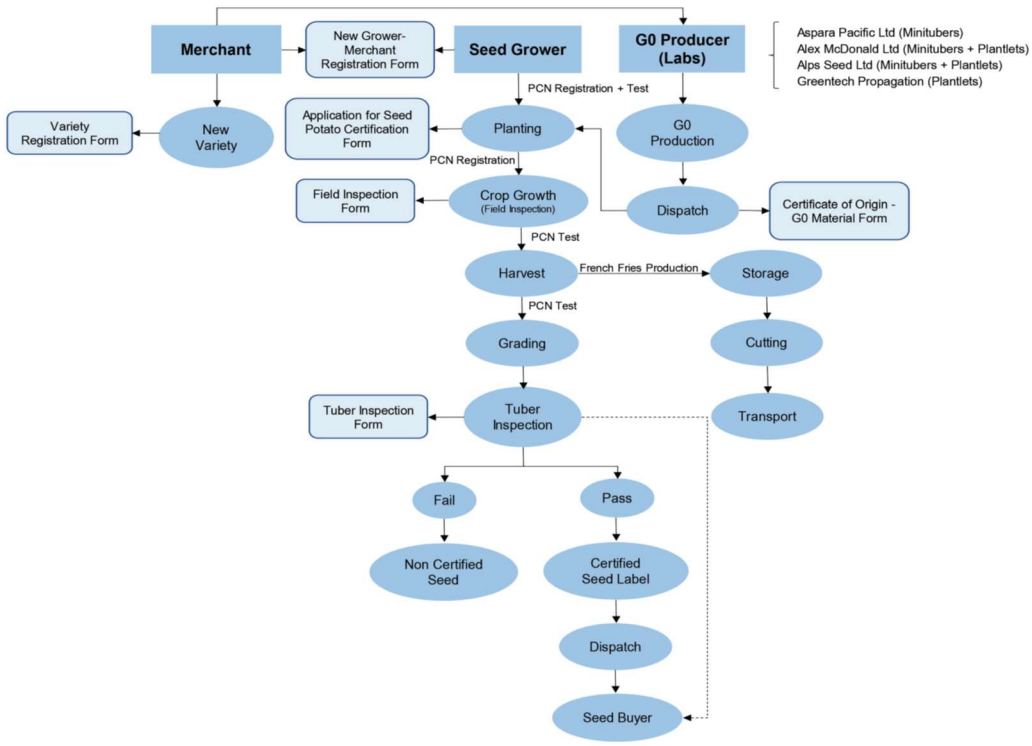


Figure 4:Source: Flow chart of Seed Certification Scheme

14.1.1. FORM 4: Application for Seed Potato Certification

Each seed line must be registered annually by the grower at NZ Seed Certification Authority. Five key elements are mandatory to be eligible for registration:

14.1.1.1. Each seed line must be confined within one field
14.1.1.2. A minimum of 5 harvest seasons is required from when the last potato crop was grown in the field.
14.1.1.3. Farm numbers and field letters are required on entry applications for paddock identification.
14.1.1.4. A property map must be supplied. When a farm number has not previously been issued the Administrator will issue a unique farm number and paddock identification letters for the property.
14.1.1.5. A plot map must be supplied with all the lines marked clearly including variety name, harvested generation and seed sown reference number.5

Content of the form:
Trading Name: Registered name of the business.

Postal Address:

Email:

Primary Contact:

Phone:

Mobile:

Fax:

Seed line: Seed potatoes, including tissue culture plantlets, of a single variety that when grown are confined within one field and for which a unique reference number has been issued by the Authority.

Plot: Is the area of land used to plant a specific seed line (one).

Crop Reference Number: ID for a particular seed line from planting until it is replanted in the following season. Issued at crop registration once all data has been checked and verified (e.g. Season 2020-2021 G0 planted - G1 harvested (Crop Reference No: P20210001); next season 2021 -2022 the New Crop Reference No. for that seed line G1 planted – G2 harvested will be P20220001).

Seed Sown Reference No: Is the ID for the seed line **used** to plant a current season crop. Therefore, it is the Crop Reference No. from the previous season seed crop.

	2019-2020	2020-2021				2021-2022				2022-2023			
	G0 Labs	Planted	Crop Growth	Harvested	Storage	Planted	Crop Growth	Harvested	Storage	Planted	Crop Growth	Harvested	Storage
Generation	G0-G0	G0-G1				G1-G2				G2-G3			
Crop Ref. No	P20200001	P20210001				P20220001				P20230001			
Seed Sown Ref. No	Not Recorded	P20200001				P20210001				P20220001			

Figure 5: Example: Seed Sown Reference No

[5] Source: NZ Seed Potato Certification Scheme, Certified Seed lines

ROP No: An alphanumeric code assigned by AsureQuality to a defined farming area. The first letter determines the general region followed by numbers (e.g. A1012).

Paddock Letter: A code assigned to each paddock within a specified Region of Production.

Date Planted: The date that the seed line is planted.

Variety: Name of a particular cultivar or clone of that variety, assigned by the breeder or the breeding company.

Generation: One growing cycle of a potato crop.

Generation Planted: The generation of the seed used to plant a specific seed line.

Generation Harvested: The generation of the seed once it has been planted in the ground.

Type – Group/Pyramid: Pyramid is a seed potato multiplication programme starting with tissue culture or minitubers. Tuber numbers are increased through successive field generations until it reaches certified seed class. The maximum permitted number of generations in the pyramid scheme is 6. Group is a seed potato multiplication program where there is no limit on the number of prior field generations.

Inspection Body – SGS/AQ: contracted inspection service providers.

Paddock Area: The total area of a current paddock where the potatoes will be or have been planted.

Crop Area: The total area planted with one specific seed line.

Contract Merchant: Commercial entity managing the multiplication of seed potatoes for seed potato certification.

IVA for PCN/Wart Survey: Independent Verification Agency (SGS-AsureQuality) authorized by MPI to deliver the PCN/Wart survey.

NZGAP No: New Zealand Good Agricultural Practice Number.

Paddock History: The list of crops that have been grown in that paddock over the last five years.

Farm Map: A map of a farming property, which is defined by an ROP.

Plot Map: A map/site plan denoting the layout of seed lines within an individual paddock.

14.1.2. FORM 5: Field Inspection Report

All seed lines entered will have two field inspections. The first inspection should be carried out before row closure and it is the grower's responsibility to get the inspector in, and the second inspection should be between flowering and haulm destruction in order to spot any diseases. The authorised inspectors (e.g. SGS) must complete a 'Field Inspection Form' and submit the completed form to the Administrator.[6]

[6] Source: NZ Seed Potato Certification Scheme, Certified Seed lines

Content of form:

Trading Name: Registered name of the business.

Mobile:

ROP No: An alphanumeric code assigned by AsureQuality to a defined farming area. The first letter determined the general region followed by numbers (e.g. A1012).

Paddock Letter: A code assigned to each paddock within a specified Region of Production.

Paddock Name and/or Location and/or Address: GPS coordinate of the approximate centre of the paddock to be inspected.

Primary Contact: Name of the seed grower.

Variety: Name of a particular cultivar or clone of that variety, assigned by the breeder or the breeding company.

Generation Planted: The generation of the seed used to plant a specific seed line.

Date Planted: The date that the seed line is planted.

Crop Reference No: ID for a particular seed line from planting until it is replanted in the following season. Issued at crop registration once all data has been checked and verified (e.g. Season 2020-2021 G0 planted - G1 harvested (Crop Reference No: P20210001); next season 2021 -2022 the New Crop Reference No. for that seed line G1 planted – G2 harvested will be P20220001).

Crop Area: The total area planted with one specific seed line.

Generation Harvested: The generation of the seed once it's been planted in the ground.

Date Actual: Date when the inspection is done.

Inspector Name: The name of the registered inspector who is responsible for carrying out the field inspection.

Pass: The seed line has met the standards defined on the Certified Seed lines & Rulebook.

Fail: The seed line has not met the standards defined on the Certified Seed lines & Rulebook.

Provisional: The seed line has not met the standards defined on the Certified Seed lines & Rulebook on the first inspection but the field inspector has allowed the seed grower to rectified the fault, permitting a follow-up inspection.

Comments: Summary of the condition of the crop related to each category (viruses, bacteria, etc).

Counts - %: The percentage of the fault within the seed line.

Biosecurity Suspected SRO: Notifying the presence of any sector risk organism found in the seed line.

Test Lab: Name of the laboratory where the SRO samples have been sent.

Date: The date when the field inspection is carried out.

Comments: Summary of the condition of the crop.

14.1.3. Seed Certification Labels (Bin Tags)

The Seed Certification Labels (Bin Tag) are the "licence to sell". An approved authority e.g. SGS, is entitled on behalf of the Seed Authority to issue the labels as per the example below. This confirms all requirements of the scheme have been met including MPI PCN compliant status. The bin tags must be attached to the containers before selling. The Authority is obliged to withdraw or recall the certification. [7]

Content of the form:

Variety: Name of a particular cultivar or clone of that variety, assigned by the breeder or the breeding company.

Size: Size range in millimetres of the seed lot been inspected (e.g. 40-55 mm).

Crop Reference No: ID for a particular seed line from planting until it is replanted in the following season. Issued at crop registration once all data has been checked and verified (e.g. Season 2020-2021 G0 planted - G1 harvested (Crop Reference No: P20210001); next season 2021 -2022 the New Crop Reference No. for that seed line G1 planted – G2 harvested will be P20220001).

ROP: An alphanumeric code assigned by AsureQuality to a defined farming area. The first letter determined the general region followed by numbers (e.g. A1012).

Generation: The generation of the seed once it's been planted in the ground (Harvested Generation).

Inspection date: The date when the tuber inspection is carried out.

Grower: Registered name of the Business.

Inspection Authority: Contracted inspection service provider.

Withdraw: Removal of a seed line from the seed potato certification scheme.

Downgrade: Move a seed line to a lower generation as long as it doesn't exceed the tolerance for that generation (e.g. higher G number).

Rejection/ Fail: The seed line has not met the standards defined on the Certified Seed lines & Rulebook.

Upgrade: Move a seed line to a higher generation as long as it does not exceed the tolerance for that generation (e.g. lower G number).

[7] Source: NZ Seed Potato Certification Scheme, Certified Seed lines

Example:

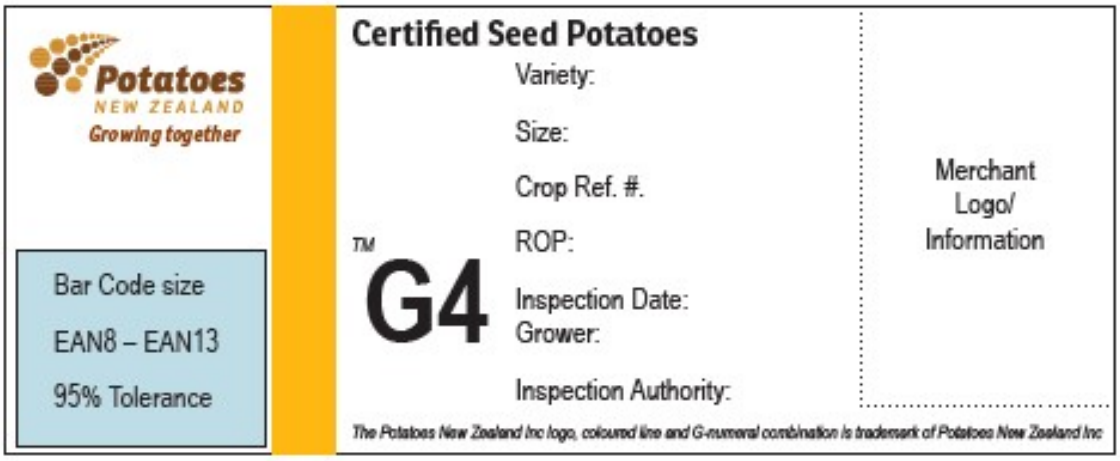


Figure 6: Example of bin tag out by PNZ rulebook

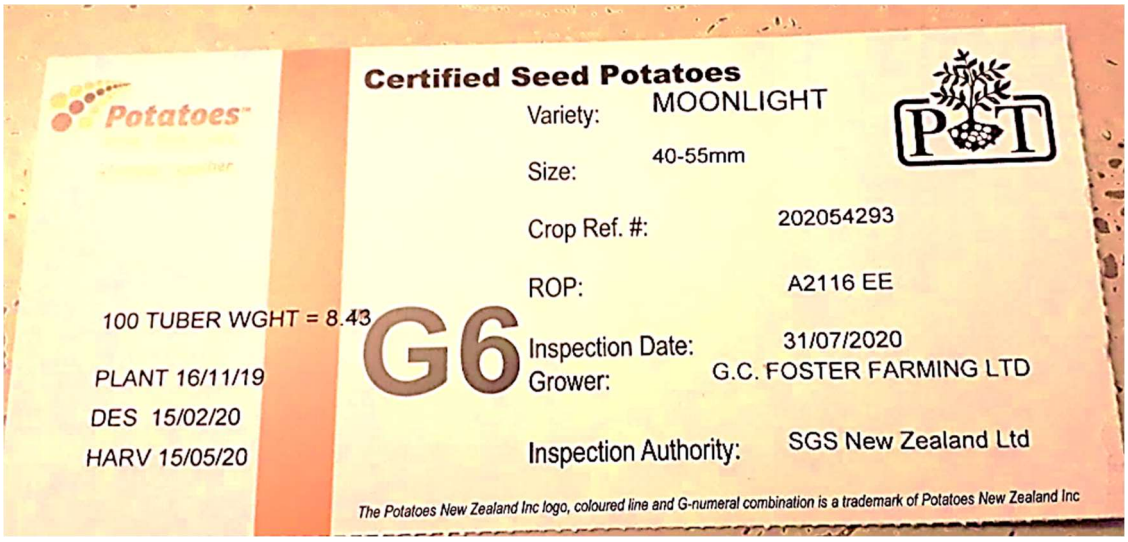


Figure 7: Example of bin tag

15. Results

The main data interoperability challenges are identified and described in the following paragraphs. For each process step a description, the process flow chart, and key findings per individual process step are documented and laid out.

In general the participants are sharing data in different formats & processes between each other within the overall high-level value chain:

Key process steps & stakeholders:

15.1.1. *Producing Germplasm - SASA/EU/NA – not in scope*
15.1.2. *Importing Germplasm – Merchant – not in scope*
15.1.3. *Producing tissue culture or minitubers - Generation G0 lab – not in scope*
15.1.4. **Seed production/Sourcing - Growing seed potatoes- Seed grower – detailed as an example**
15.1.5. Commercial growing "commercial potatoes" - Commercial grower
15.1.6. Food Processing - Processing potatoes / producing chips & french fries for retail & hospitality – Potato processor
15.1.7. **Exporting** seed potatoes**, fresh potatoes,** processed potatoes **- Exporters/MPI – detailed as an example**
15.1.8. Selling domestically seed potatoes, fresh potatoes - Retailer, Food services
15.1.9. **Levy collection** - domestic levies via Buyer Created Invoice and Export levies - PNZ - **detailed as an example**
15.1.10. Retail/Food Service - Buying fresh potatoes (packed & bulk) and processed potato - Consumer

16. Process steps

16.1.1. High level process overview

In the below diagram you will find the value chain mapping within the potato industry, from seed potato production up to the retail process. Following the Business Model Framework SCOR[8] (Supply Chain Operation Reference) which follows the structure of Plan, Source, Make, Deliver and Return process steps, we have adjusted the steps as follows:

- Seed production
- Commercial growing
- Food processing
- Exporting
- Levy collection
- Retail/ Food Services

[8] www.apics.org

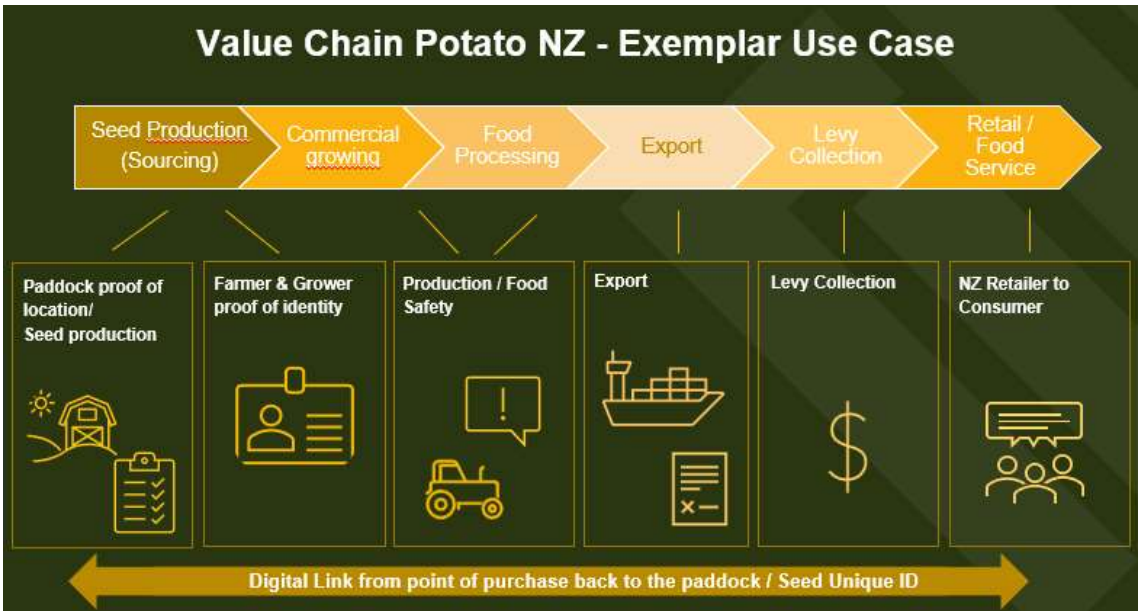


Figure 8: Value Chain from paddock to plate

As a reference the diagram below will give an overview of who are the participants and which process steps are required in the workflow.

The process starts from germplasm, then import over seed potatoes, commercial potatoes, then processed potatoes, to end consumer in domestic and international markets.

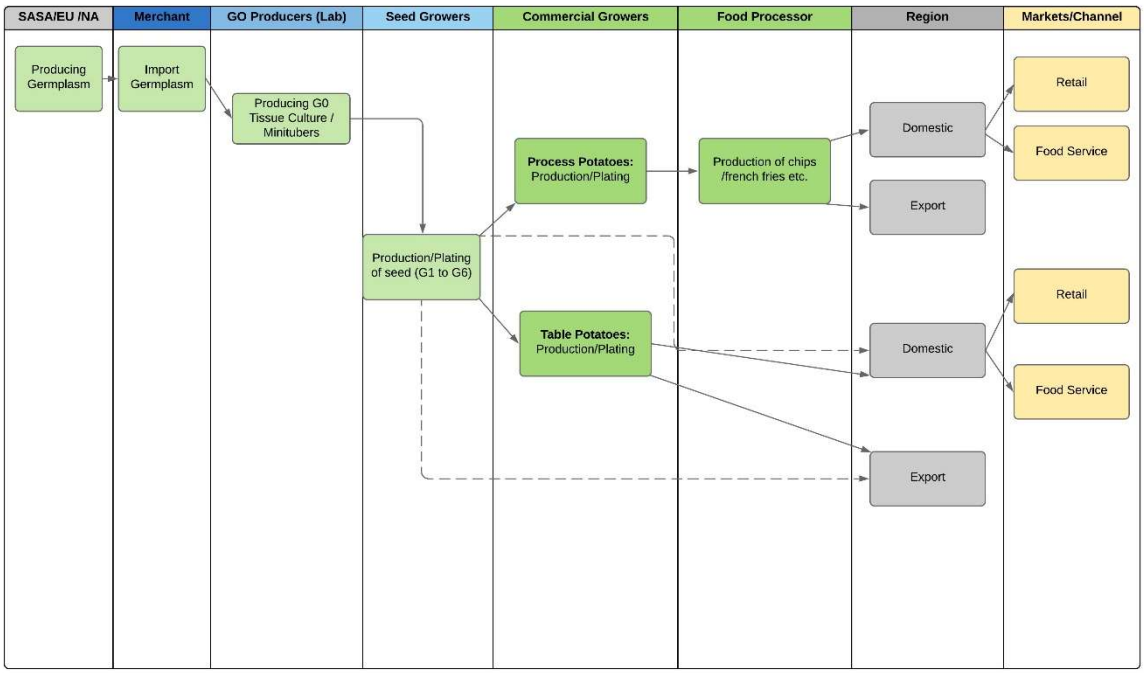


Figure 9: Process "Seed to plate"

16.1.1.1. Key findings

It was found that there were three critical areas to discover more in details within the overall process flow:

1. Identity e.g. farmer & grower (user or landowner) as a person
2. Location e.g. paddock, plot, shelf etc.
3. Critical control points & transactions e.g. KPI for biosecurity, compliance

The graph below shows the data interoperability aspect. At the beginning of any value chain it is key to firstly prove the identity of the person with whom you are engaged with; who is sharing data with whom?

Secondly, the proof of location is essential. What is the source of origin of the produce? Where does it come from and how to provide transparency and evidence? These are the key mandatory criteria.

Thirdly, we have discovered that the critical data control elements and the dedicated transactions are the following area to determine. These points need to be investigated to continue building a proper working data sharing framework. Why are these elements so critical? When these data attributes are not captured and shared in a correct and timely manner the subsequent process steps face difficulties, which could lead to business and environmental risks.

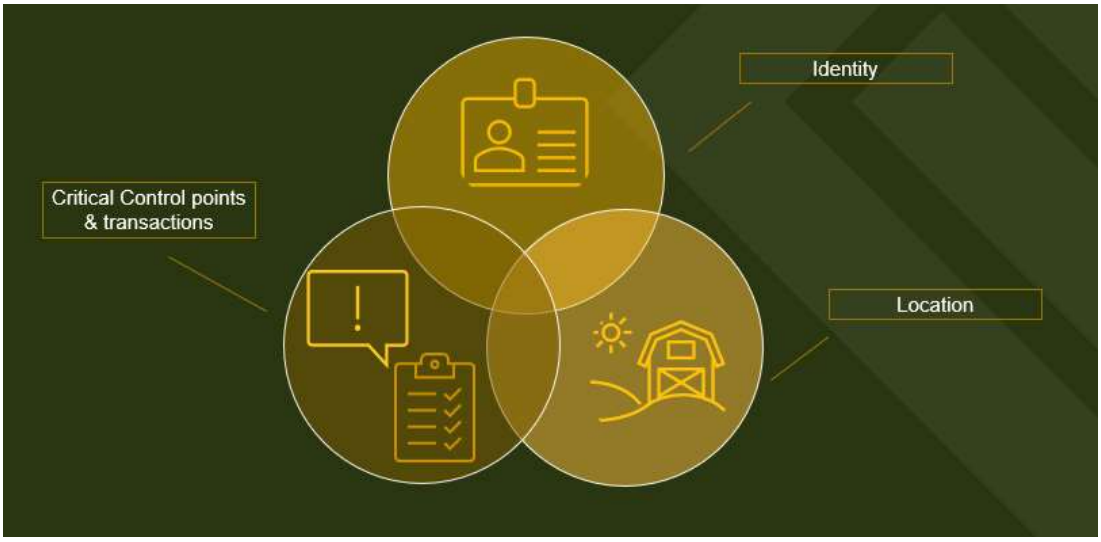


Figure 10: Key critical elements for unique identifier attributes

16.1.2. Growing seed potato from minitubers or tissue culture to commercial grower

In the process step "Seed Production/Sourcing" the result of the analysis was alarming. At a glance we have identified fourteen process steps at this stage. These are mainly compliance activities generating a lot of paperwork.

> *"I want to grow potatoes in the best way I can, that's why I am a grower. I hate to do the inefficient amount of admin and paperwork. Why do I have to give the same data several times to a different person, isn't there another easier way to do that? "* [9]

Eight different stakeholders are capturing, providing, sharing or managing different data elements. Up to nine different templates / forms (some are not digital yet) are required for various purposes e.g. compliance, biosecurity, proof of location/paddock. The data included around 180 data fields with up to 30% redundancy of information. Ca. 7,000 data elements for only 34 seed growers are being processed in a very inefficient way. More than 75% is still paper based.

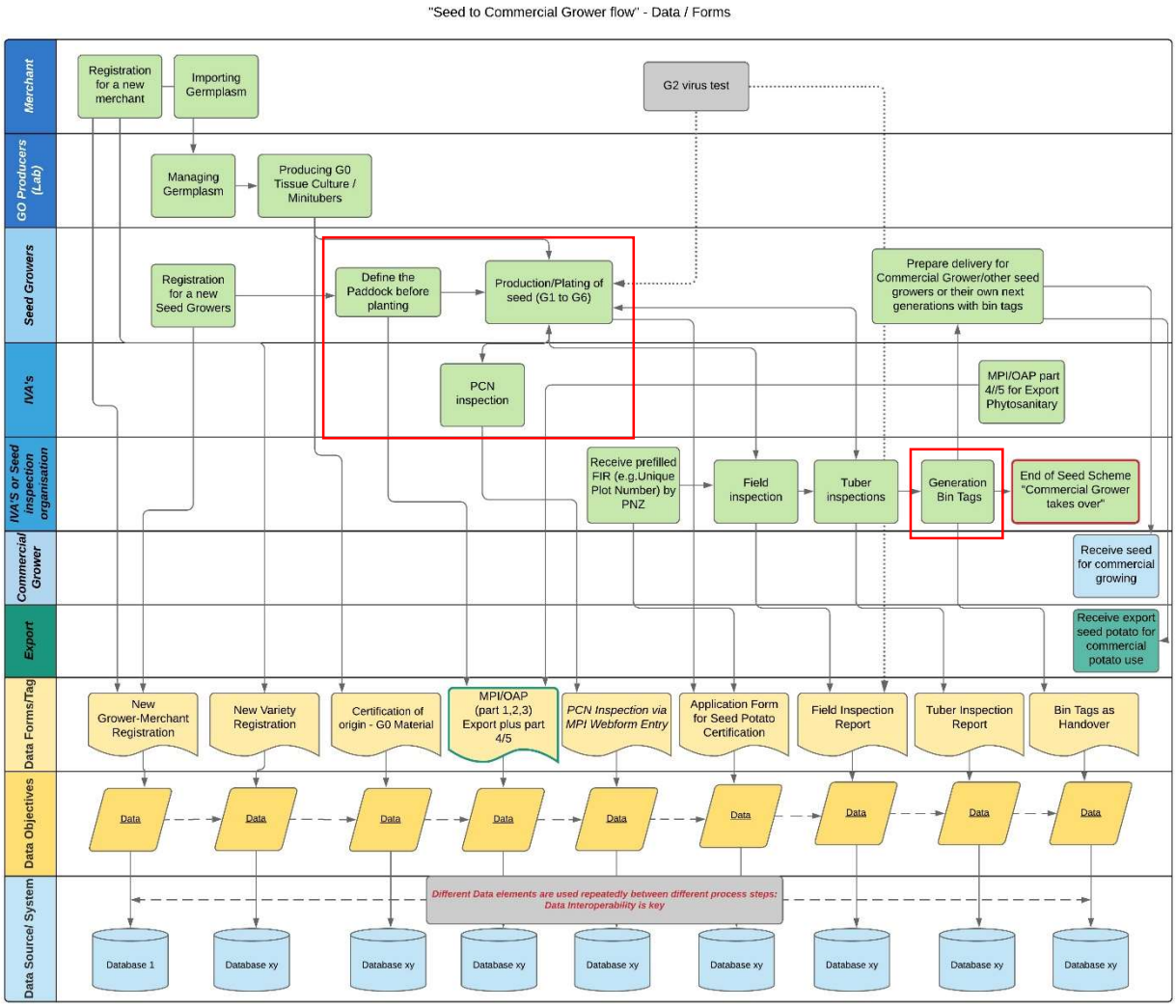


Figure 11: "Seed to commercial growers"

[9] Live interview of a grower in Ashburton on 14.07.20

16.1.2.1. Key findings

The major data interoperability gap starts with a missing national wide geospatial "paddock" location identification system i.e. a link between a businesses and a location to be able to track historical data for environmental and compliance requirements of a piece of land.

The farmers are handling their paddock mapping data in different styles and formats e.g. manual drawings, farm maps, Google data with different data objects/data types with/without GPS.

AsureQuality is currently operating as a contractor for farm map auditing e.g. ROP, paddock letter checking, cropping history. As a pilot PNZ mapped out the paddocks for 31 seed growers with SHP files. The categorising of the ROP (Region of Production) and paddock letter, plus the relevant data elements e.g. grower name, landowner name/farm name, cultivar, area, are associated with the geospatial data of the paddock and documented in BELIS System at PNZ. This process has to be renewed for every growing season.

16.1.3. Growing commercial potatoes - Commercial grower

The process of growing commercial potatoes is very similar to growing seed potatoes. Seed potatoes are delivered with bin tags and all relevant information (for details see Bin Tag section) to commercial potato growers. The grower is taking care of the compliance procedures. In addition, retailers and food processors are requesting individual quality procedures, checks and KPI's, which have to be fulfilled.

16.1.4. Exporting fresh potatoes from commercial grower to overseas incl. export levies

The overview of the export process and the dedicated levy payment process of fresh potatoes is documented in the below process diagram. It starts with registration application for exporters and sub agent and it covers the compliance process with IVA and MPI e.g. MPI phytosanitary Assurance Programme for potato cyst nematode and potato wart. Additionally, the export levy plus the fee collection is illustrated and explained.

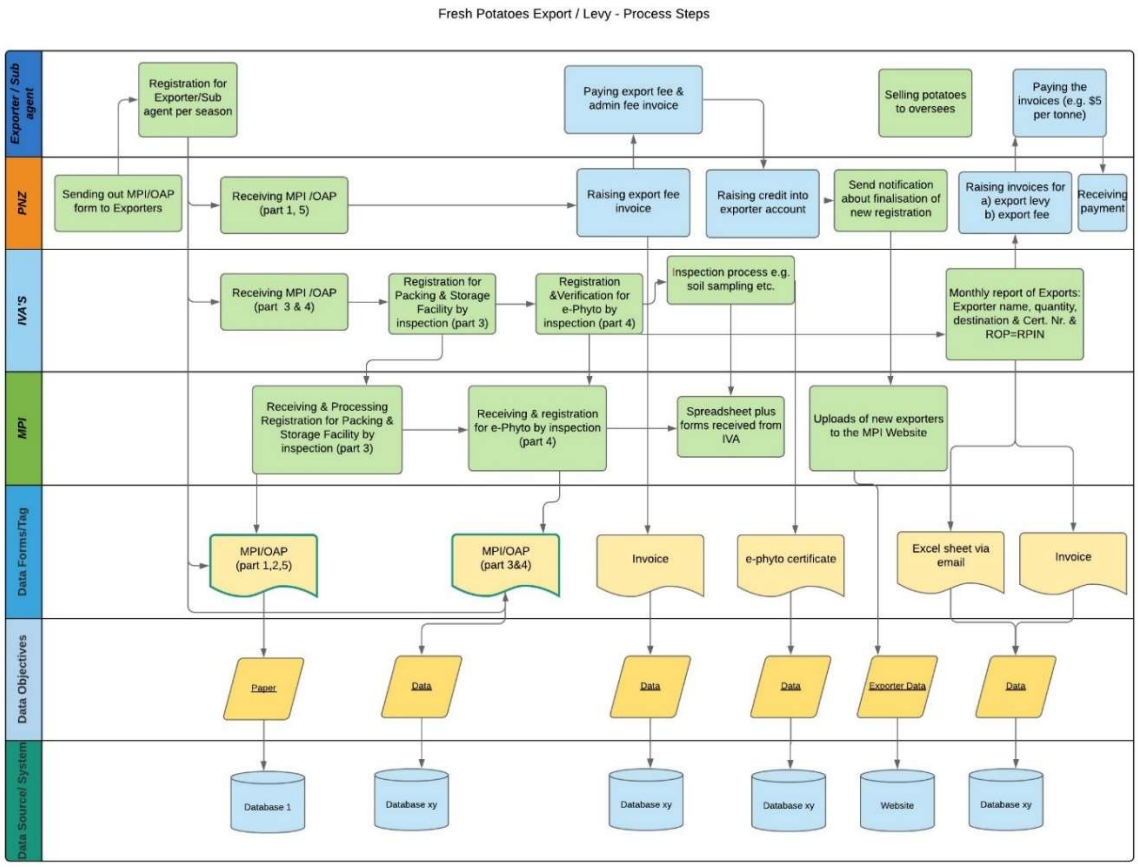


Figure 12: Fresh potato export process and levy collection

16.1.4.1. Key findings

The e-phytosanitary certification process is managed by official forms and processed further with spreadsheets. The inspection is mainly managed by IVA's and the results e.g. e-phytosanitary certificates, are shared after finalisation with exporters and industry bodies for the subsequent process steps e.g. licence to export and shipping potatoes abroad and levy collection.

While the successful registration process of an exporter is published on the MPI website, there is no active information flow from MPI back to the applicant. It is a pull process rather than a push process, which creates a lot of inefficiency and uncertainty for the applicant and all relevant participants in the process.

16.1.5. Processing potatoes producing chips & french-fries for retail & hospitality - potato processor to retailer / hospitality sector

Individual brand owners are driving product quality criteria, processing standards and food safety requirements. Therefore the data handling between buyers and suppliers varies individually. It could be described as an input & output model per buyer & supplier relationship. Obtaining the data sets for this process step will require a lot more individual analysis with different stakeholders.

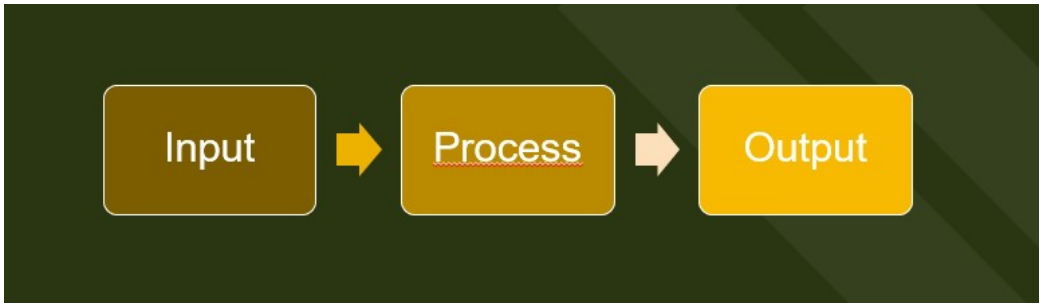


Figure 13: Input & Output Model

16.1.5.1. Key findings

The key data elements and process step are captured in three areas:

1. Acceptance criteria for incoming goods requirements defined by food processors.
2. Conformance & compliance during the manufacturing process.
3. Requirements specified by the buyer (retailer & food service sector) and consumers.

16.1.6. Selling domestically seed potatoes, fresh potatoes Retailer, Food services

The below diagram shows the supply chain of the potato from the commercial grower to the retailer. It is the same for bulk or for packed potatoes.

The seed produce with the bin tag (“licence to operate”) will be delivered via the packing shed to the distribution centre of the retailer. The paperwork for this process step, which accompanies the produce is not standardized and sometimes not existing. The “Good Income” procedure (e.g. incoming goods booking or reporting defect rates) happens in different ways depending on the buyer.

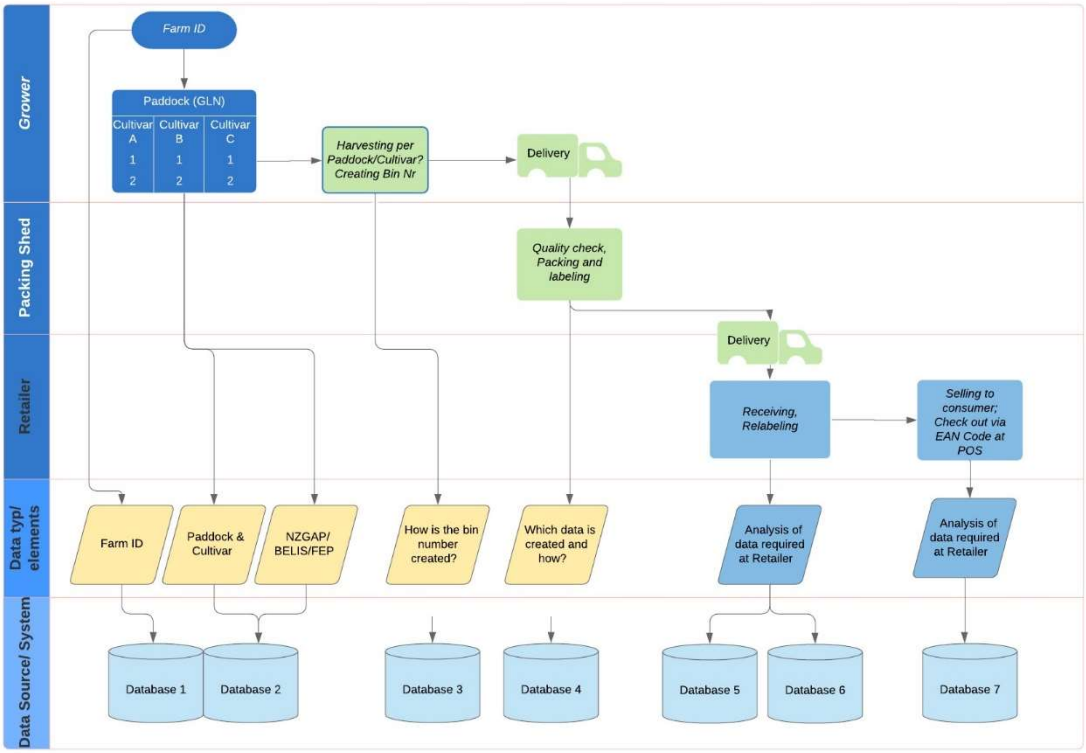


Figure 14: Commercial Grower to Retailer

16.1.6.1. Key findings

Depending on the requirements of the buyer (retailer) and contract agreements between buyer and the commercial grower, potatoes are delivered accordingly as bulk or packed potato. Product quality checks are completed at the weigh bridge at Incoming Goods Distribution Centre. Some shipments are going directly from the grower to the retail store. The linkage between physical goods flow and the dedicated data stream is disrupted. The majority of goods are arriving without any documentation and reference to the produce or contract e.g. not a consistent use of delivery notes incl. crop reference number or batch numbers.

16.1.7. Collecting domestic levies via Buyer Created Invoice (BCI)

Current operation

There is a lack of transparency for the levy payment process. Three parties are involved – the Buyer, Potatoes NZ and the Grower - to process this transaction. The challenges of providing transparency of data and sharing it in a trustful and immutable way are obvious. There is frequently a lengthy delay between goods being delivered to the buyer, being invoiced, the levy reported and the levy payed.

The levy payment for potatoes is compulsory by the Commodity Act 1990. The first point of sale is accountable for correctly and timely reporting of the levy to PNZ. The current levy process is essentially a system which lacks transparency and verification steps are not fully implemented. The processes in place are not automated, reliable, and digitally supported yet.

The PNZ levy is 0.85% of the gross value of the sale. A remaining 0.15% of the value is remitted to Horticulture New Zealand (HortNZ). A total of 1% of the gross value of remittances to the grower is therefore deducted by the buyer before payment is made on the sale of potatoes, being remitted to the two levy bodies in two separate buyer created invoices (BCI's).

An important note is that the levy payment is remitted by the buyer of the potatoes to the levy body on behalf of the grower. The buyer effectively holds the funds in trust on behalf of the grower until they are remitted to the levy body.

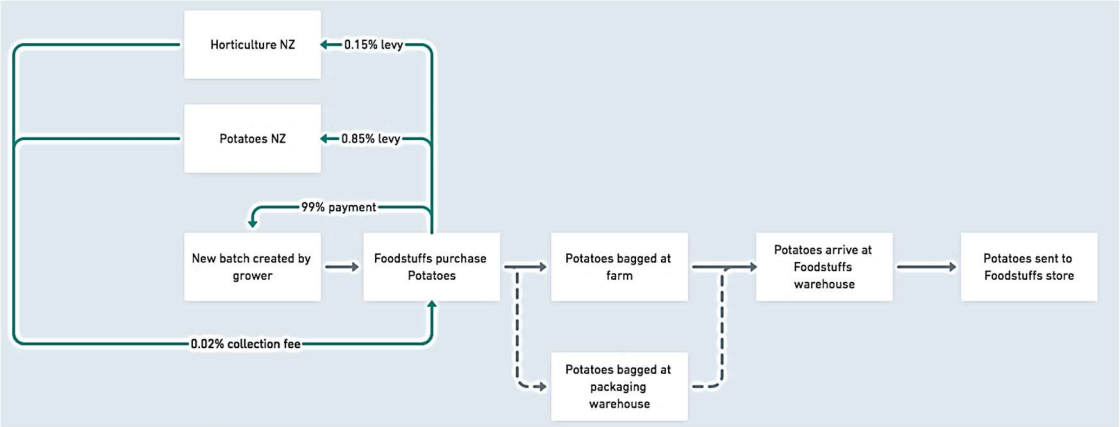


Figure 15: Levy Process flow

16.1.7.1. Key findings

There is not an efficient and comprehensive verification process or control point for the levy collection in place right now. PNZ cannot ensure that the levy is reported and paid accurately and in a timely manner by the buyer. The grower is not able to verify his levy. A possibility to accept or reject the reported BCI does not existing for the grower so far.

The audit process by government is currently performed via the central database managed by PNZ. A digital traceability process backwards from levy to paddock via crop reference number does not exist actually. The recall process is executed manually which takes more time and effort than a digital traceability approach, especially for biosecurity cases.

As an example of how traceability and track-and-trace could work in the potato industry you will find below the diagram. It explains at high level how to trace back a produce via the crop reference number on the Buyer Created Invoice to the individual paddock and seed reference number.

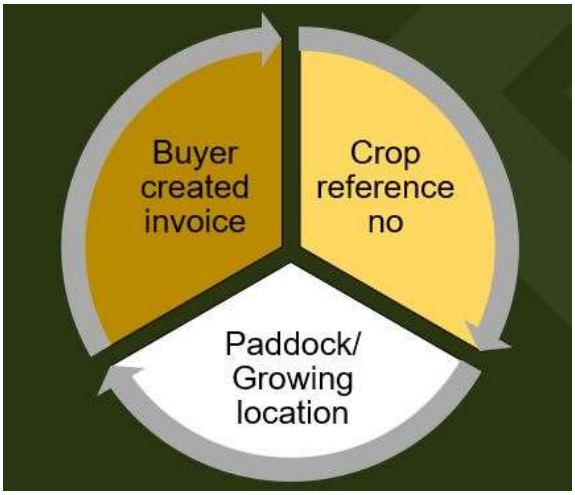


Figure 16: Traceability from paddock to point of sale

16.1.8. Buying fresh potatoes (packed & bulk) and processed potato - Consumer

Fresh potatoes for the domestic market (retailer) are available in a) bulk produce or b) pre-packed SKU's. For bulk potatoes there is no data or information provided to the consumer except cultivar name and price on the shelf. For pre-packed potatoes there is some informational content e.g. nutritional information, weight, growers website, some marketing messaging and variable data: "packed on date", Lot number available on the packaging. For the check out at point of sale in general the standard GS1-13 barcode is used.

16.1.8.1. Key Findings

The opportunity to tell the farmers & growers end-to-end story via the product packaging to the end user is only partly utilised. Right now the grower has no easy option to engage and communicate with their end customer directly. This is a wasted commercialisation opportunity.
A solution could be to provide a QR code on the packaging, than the consumer will be able to scan it with a mobile device and the grower will be able to provide all information, which is beneficial to the consumer via a digital link.

These would give the grower the chance to increase customer loyalty and satisfaction, which will lead to higher income by selling more or higher value product.

17. Procedures and Policies

All procedures for seed management and policies involved are documented and archived at https://www.dropbox.com/home/Seed%20Database%20Project/Seed%20Procedures

18. Data Elements

As an example we analysed the data elements of the seed certification registration process. The sender, the receiver and the purpose were identified and documented per data attribute. The outcome shows, that multiple data sets are repeatedly captured, produced, shared and managed e.g. the following data elements " paddock id and crop reference number" are required up to seven times for different stakeholders.
Please see attached excel file as an example of identification methodology of common data elements:

Figure 17:" Data reconciliation model"

19. Data Systems

19.1.1. Grower Data:

Different farm management systems are in place, which handle the data for the registry processes and biosecurity compliance steps via IVA's, inspectors, PNZ and MPI.

The data handling is mainly through the standardized forms in Microsoft Excel or Word files.

19.1.2. PNZ and The Seed Authority Data:

PNZ and the Seed Authority are digitising the data input from the grower and completing the provided forms. As a next step some forms are pre-filled by PNZ e.g. Field / Tuber inspection, to be completed by the IVA. PNZ is managing the grower metadata, levy information and biosecurity data in the BELIS database (=Biosecurity, Emission, Levy information system).

19.1.3. IVA Data:

Prefilled forms e.g. Export OAP registration are provided to MPI for authorisation and publication as an official authorised fresh potato exporters register on the MPI website https://www.mpi.govt.nz/news-and-resources/resources/registers-and-lists/potato-exporters/

19.1.4. MPI Data:

Received forms are checked, processed and if approved, uploaded to the final register information to the official MPI website for publication to prove authorisation.

20. Data Governance

Areas to be addressed in the next project step. The key challenges are how to permission data elements in a trustful and immutable way between the stake holders. The following elements need to be defined and agreed on.

Figure 18: Source: ITP Data Interoperability

21. Conclusion

Through the scoping project, and especially with the deep dives into the three processes steps, we can confirm and prove a common major challenge within the primary industry:
>>Data Interoperability: Sharing, storing, consolidating, utilising and protecting data between stakeholders<<

To solve the data interoperability challenges within primary industry is key to:

- preserve & enhance the global & domestic competitiveness of NZ's primary industries
- ensure consumers understand & are assured of the provenance of their food
- solve industry issues with regards cost & friction in the market, ensuring value to all participants

…. within the entire value chain.

It means for the farmer & grower the following:

1. Increase profit by selling "more" for more by :
    - Proving provenance and being able to provide to their end customer their brand story
    - Easily engage & communicate with their end customer
    - Provide traceability and transparency to different parties
2. Increase efficiency & productivity by
    - Easily and securely handling and managing all compliance data request/forms and registration by avoiding replicating data within every single process step
3. 100 % traceability & trust through the entire value chain e.g. for biosecurity
    - Mitigating risk for business & environment
    - Improve sustainability through increased transparency e.g. of emissions
    - **Trustful and immutable data sharing, storage, consolidation**

Key areas to be address as an outcome of our scoping project:

- Unique registry for location / paddock mapping is mandatory – to be able to define and identify single source of truth.
- Tracking and linking space and time with metadata is essential for end-to-end traceability within the value chain e.g. paddock ID and associated metadata such as crop history, soil type, water quality.
- Paddock metadata transfer from one season to another and from land owner to a new land leaser needs to be enabled in a digital way to ensure accurate data to manage compliance and policy requirements.
- A general lack of transformation and digitisation at the F&G, IVA's (partly MPI) is being identified and needs to be addressed.

- No digital platform or tool available is currently in place which could be used for secure & efficient data sharing in trustworthy and immutable way between different ecosystem participants.
- Governance rules and policy around data privacy and permissioning.
- The process of capturing, monitoring, managing and using data between different stakeholders is disruptive, inefficient and not secure for the key process steps.
- To set a foundation for rational and real data-based decision making e.g. policies by Government.

Key Take Aways:

1. The primary industry needs a digital platform to **share, store, aggregate and consolidate** data attributes within a trustful framework. Based on an individual permissioning and authorisation model within the network, the data will be utilised for compliance, consent, research, policy setting and/or commercialisation purposes.

   The key stakeholders of the value chain are demanding that data is captured only once, and to have the ability to share data in a controlled and efficient way, where appropriate. Data should be held and controlled by the data owner.

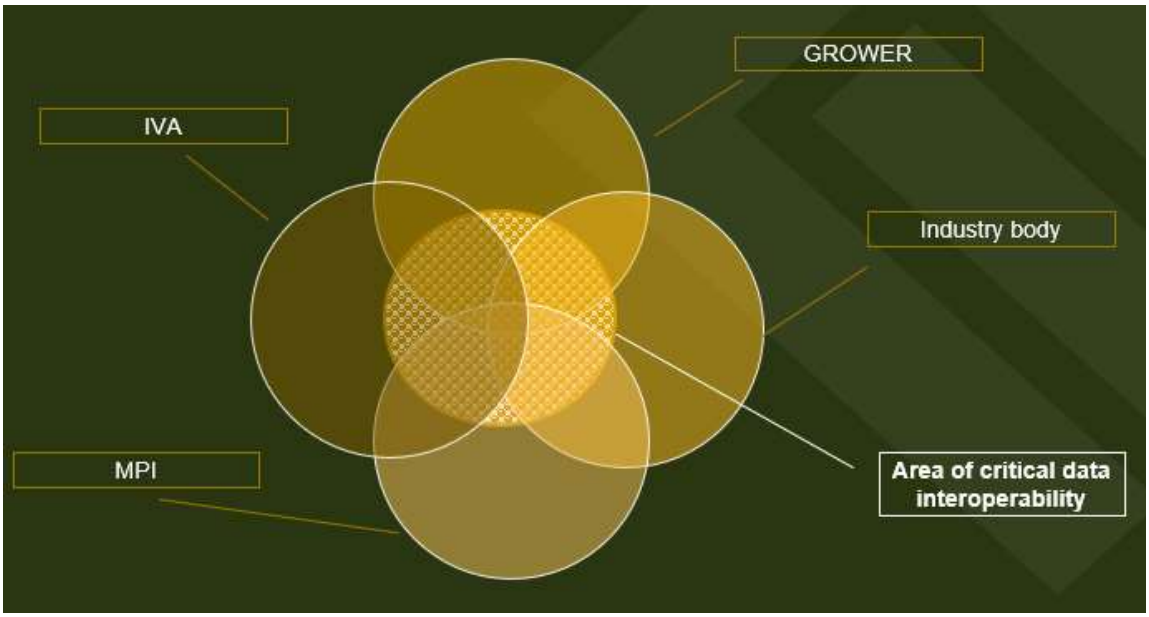


Figure 19: Example of data interoperability for seed growers

2. As a starting point of every value chain it is important to prove identity: who is sharing data with whom. Secondly the proof of location is important. Where is the produce /ingredients coming from? And thirdly, what are the key critical data points and transactions. These are the three critical areas to consider. They are important through the whole value chain and when they are not managed and reported properly to the next steps in the workflow, they cannot operate as they should.

Figure 20: Key areas through the whole value chain

Every potato grower (seed and commercial potato) has an NZBN, this number could be used as a source of origin and proof of identity as a first instance. A unique ID e.g. digital identity in a grower App could prove the identity of the grower. To identify the location in our case the paddock, which needs to be registered and approved by PNZ, will have a unique ID and is submitted as proof of location. On the potato package e.g. a QR code will be supplied with a unique ID or a batch ID to prove provenance and enable the grower to tell their story to the consumer.

This would mean as a next step a nationwide paddock location system with unique ID will be required to enable the primary industry to have a proof of location. Managing and sharing the geospatial data with the associated data attributes will be possible in an efficient way.

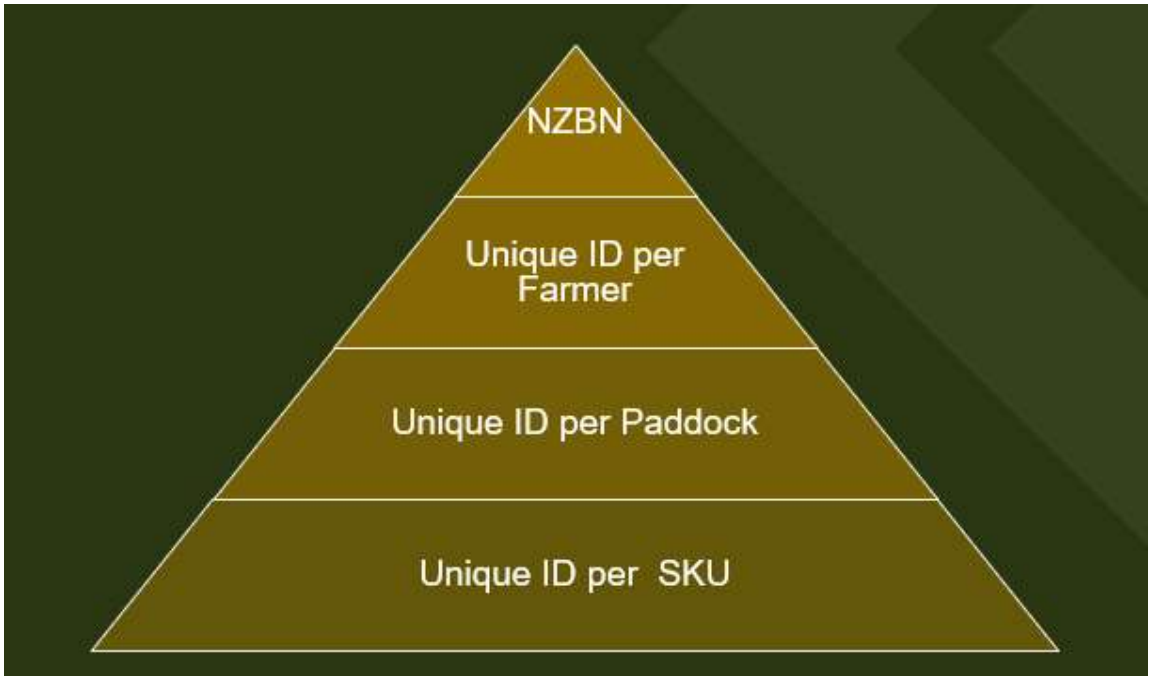


Figure 21:Example of data hierarchy for Unique Identifier

3. The aspect of reverse traceability is very important for the grower and the whole primary industry sector. The ability to track and trace the journey of product back to e.g. a single seed line. The diagram (see page 27) explains high level how traceability could work:
When the buyer submits his Buyer Created Invoice incl. the crop reference, the grower will be able to trace the crop reference number back to the individual paddock and seed line. With this information an optimisation of yield rates by improved growing performance and reduction of defect rates will be achievable.

22. Glossary

Term	Description	Details
GLN	Global Location Number	Global Location Number (GLN) can be used by companies to identify their locations, giving them complete flexibility to identify any type or level of location required.[10]
IVA	Independent Verification Authority	e.g. SGS, AsureQuality or AgriChain
PNZ	Potatoes NZ	Industry body
ROP	Region of Production	Used by PNZ and IVA
SHP	Shape file	SHP is the file extension for one of the primary file types used for representation of ESRI Shapefile. It represents Geospatial information in the form of vector data to be used by Geographic Information Systems (GIS) applications. The format has been developed as open specifications in order to facilitate interoperability between ESRI and other software products.[11]
SKU	Stock Keeping Unit	In the field of inventory management, a stock keeping unit is a distinct type of item for sale,[1] such as a product or service, and all attributes associated with the item type that distinguish it from other item types. For a product, these attributes could include manufacturer, description, material, size, color, packaging, and warranty terms. When a business takes inventory of its stock, it counts the quantity it has of each SKU. SKU can also refer to a unique identifier or code that refers to the particular stock keeping unit. These codes are not regulated or standardized. When a company receives items from a vendor, it has a choice of maintaining the vendor's SKU or creating its own.[2] This makes them distinct from Global Trade Item Number (GTIN), which are standard, global, tracking units. Universal Product Code (UPC), International Article Number (EAN), and Australian Product Number (APN) are special cases of GTINs.[12]

[10] Source: www.gs1.org
[11] Source: www.fileformat.com
[12] Source: www.wikipedia.com