United Fresh
New Zealand Incorporated

Sustainable Farming Fund Project Literature Review

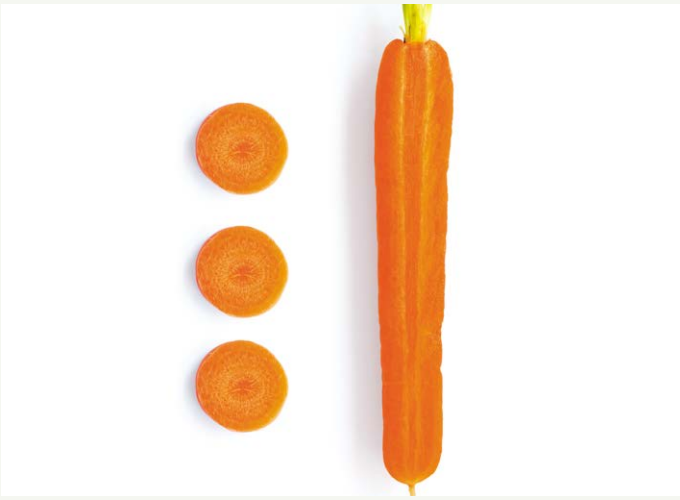
Effective Fresh Produce Traceability Systems
Project Number: 405482

November 2018

Contents

ACRONYMS

Acronym	Meaning
ADB	Asian Development Bank
BRC	British Retail Consortium
CDC	United States Centre for Disease Control
Codex	Codex Alimentarius
CPMA	Canadian Produce Marketing Association
FAO	United Nations Food and Agriculture Organisation
FMCG	Fast Moving Consumer Goods
FPSC	Fresh Produce Safety Centre (Australia)
FSSRC	New Zealand Food Safety and Science Research Centre
GLN	Global Location Number
GTIN	Global Trade Identification Number
HACCP	Hazard Analysis and Critical Control Points
IFPS	International Federation for Produce Standards
MPI	New Zealand Ministry for Primary Industries
PLU	Product Look Up Code
PMA	Produce Marketing Association (USA)
PMA A-NZ	Produce Marketing Association Australia-New Zealand Limited
POS	Point of Sale
RTE	Ready-To-Eat
SFF	Sustainable Farming Fund
TAG	United Fresh Technical Advisory Group
WQA	Woolworths Quality Assurance Programme
WTO	World Trade Organisation



1. INTRODUCTION

Traceability is increasingly important in ensuring the safety of domestic and international food supply chains.[1] Currently, Traceability in the New Zealand domestic fresh produce supply chain is not working to a common standard.[2,3] Every produce supply chain in New Zealand varies in its management of internal Traceability and external Traceability, with external Traceability working well in some cases, or not at all in extreme situations.[4] The objective of this project is to assist the growers, packers, marketers and retailers in the domestic produce supply chain to understand how to improve their own Traceability, whilst also contributing to a more robust external Traceability framework that extends the length of the supply chain.

Past experiences have shown that if a particular fresh produce item is linked to a food safety concern, then regardless of the link's accuracy, the product is side-lined by the consumer. This leads to producers potentially facing economic hardship or ruin.[5]

This literature review examines current Traceability practices in domestic and global produce supply chains, the attitudes, behaviours and perceptions of the supply chain participants, and the road-blocks and obstacles to industry-wide Traceability.[6]

The 2013 Fonterra whey protein scare relating to Botulism and subsequent Traceability problems highlighted the need for effective industry systems.[7] As a consequence of this incident, the Food Safety Law Reform Bill 2018 enshrined effective Traceability into law.[8] The Bill makes improvements and enhancements to three Acts governing the food safety system (Animal Products Act 1999[9], Wine Act 2003[10], and the Food Act 2014[11]).

This literature review is the start of a 3-year project that combines desk-based research, qualitative surveys, industry trials, and industry feedback & knowledge sharing. The project aims to bring the New Zealand produce industry together to achieve the common goal of effective Traceability in a transparent fashion, allowing rapid & easy traceback of product in the event of foodborne illness outbreaks.

This project is led by the produce pan-industry body United Fresh New Zealand Incorporated (United Fresh), and managed by The AgriChain Centre Limited (AgriChain), with technical guidance on international Traceability system standards by GS1 New Zealand (GS1). The project is funded by the Ministry of Primary Industries (MPI), with cash and/or in-kind contributions from United Fresh, AgriChain, GS1, Strawberry Growers New Zealand Incorporated, Vegetables New Zealand Incorporated, and Foodstuffs New Zealand.

2. PROJECT RATIONALE

Fresh produce is a great source of vitamins, minerals, and nutrients.[12,13] Produce is perceived to be a relatively safe food product by the New Zealand consumer, and can be consumed with minimal or no further processing.[14] This means that if produce is contaminated with pathogens anywhere along the supply chain ("paddock to plate") and subsequently consumed, these pathogens have the potential to cause illness or death.[15,16]

The incidence rate of foodborne illnesses attributed to fresh produce is steadily rising worldwide.[17,18] Due to recent domestic and global high-profile foodborne illness outbreaks linked to fresh produce (e.g. Hepatitis A, E. coli and Salmonella), consumer awareness and confidence has been impacted. This typically translates into changed buying behaviour, i.e., less produce purchased. Whilst this direct financial consequence is generally of concern to the entire value chain, of greater importance is the need to ensure that if fresh produce is a suspected source of contamination, the suspicion can either be confirmed or ruled out, with confidence and within an acceptable timeframe.

The industry already understands that food safety is not negotiable for the entirety of the fresh produce value chain. The establishment of the New Zealand Food Safety and Science Research Centre (FSSRC) hosted by Massey University and the Fresh Produce Safety Centre (FPSC) sponsored by PMA Australia-New Zealand (PMA A-NZ) located at the University of Sydney are therefore welcome additions to the wider industry network.[19,20] Nevertheless, industry itself needs to take responsibility for its own practices.

One of the key challenges for the produce industry is that a substantial percentage of its outputs are sold loose. Of those, some are

identifiable via Product Look Up codes (PLU) and/or DataBar labels, e.g. apples, but other product is no longer truly traceable once it is put on display at retail, e.g. heads of lettuce or loose kumara. Pre-packed produce should be no different to other Fast Moving Consumer Goods (FMCG) product categories, where the packaging typically carries barcodes which in turn can carry coded Traceability information. However, the consumer is sending mixed messages in terms of wanting the convenience and portion control of pre-packed produce but also wishing to keep an increase of packaging pollution at bay, whilst looking for assurances that the produce purchased is 'farm fresh' and safe to consume.

3. PROJECT OBJECTIVES & GOALS

The Project supported by this literature review is an MPI Sustainable Farming Fund Project (SFF). MPI funds SFF for the purpose of aiding "community-led projects that build productivity and resilience in the primary industries. Projects are led by farmers, growers and foresters who come together to tackle shared problems or develop new opportunities".[21]

This project aims to:

- identify the gaps in both external[22] as well as internal Traceability[23] in the produce industry, through pilot schemes based on loose (lettuce) and prepacked (strawberries) produce. This will enable the industry to make an informed decision on future Traceability options and determine the most effective methods of implementing Traceability requirements in the domestic market.
- increase knowledge of Traceability systems and external Traceability principles through the industry, to encourage uptake and following of Traceability Best Practice.[24]
- assist growers, packers, marketers and retailers to understand how they can improve their internal Traceability systems while being a part of a more robust streamlined external Traceability framework at the same time. The overarching goal is to understand the challenges and barriers that compromise effective Traceability in the domestic fresh produce industry.

Once completed, this project hopes to have encouraged and enabled the New Zealand Produce Industry into implementation of a robust, fit-for-purpose Traceability system, that is accurate, quick, and usable by all members of the produce industry, through formal, informal, loose, and pre-packed supply chains.

It is the intention of the project to achieve several key outcomes for the produce industry, involving a unified industry approach, safeguarding reputation, transparency, and improved systems.

Unified Industry Approach: The industry understands that a unified approach to Traceability is required, but until now has not been able to decide on a unified system, due to the variety of bespoke systems entrenched in the produce industry. The produce industry covers thousands of growers[25], hundreds of products[26], multiple merchants, traders and brokers, and a multitude of retailers[27], and as such, the perception had been that a united industry approach on this issue could well be impossible.

Safeguarding Reputation: Both the global and New Zealand produce industries have in recent years had to deal with foodborne illness outbreaks associated with fresh produce.[28,29,30,31] It is critical when such an event occurs to safeguard the consumers interests through being able to quickly identify and withdraw the offending product. Equally as important is safeguarding the reputation of the produce

industry at large, by ensuring that every control point through which the offending product has travelled to reach the consumer is identifiable, and available for examination and, where necessary, intervention can occur to ensure the identified problem cannot reoccur.

Transparency: This is becoming an increasing need for supply chains. Consumers have no trust in a system's outputs if they have no confidence in the system itself.[32] Therefore, any Traceability system must also be transparent to consumers, to enable consumers to accept the accuracy of a system's outputs. A lack of transparency in a Traceability system will impede trust in the overall system, impacting uptake and effectiveness. Transparency will help maintain customer and consumer confidence in the upstream supply chain, meeting their expectation that all food reaching them is safe and acceptable quality has been maintained throughout the entire supply chain.

Improved Systems: Worldwide, a variety of systems are being considered and implemented.[33,34,35,36] The project's intention is to understand what the New Zealand domestic fresh produce industry requires in a Traceability system, and to identify potential compatible systems and implementation partners so that the future New Zealand Fresh Produce Traceability System is aligned with global best practice.

4. UNITED FRESH

United Fresh has acted as the only produce Pan-Industry organisation for almost 30 years.[37] Its Mission is to connect the fresh fruit and vegetable value chain by providing services and representation to industry.[38] United Fresh lodged its bid for this SFF project because it brings together the interests of all parties involved in the fresh produce supply chain in relation to food safety and Traceability.

United Fresh has over 90 members including growers, retailers, wholesalers, research organisations, and service providers.[39] This mix of supply chain partners forms the basis for being able to take a whole of chain approach covering the fresh produce value chain from seed to retail shelf.

Horticulture New Zealand is a United Fresh Member and CEO, Michael Chapman is a grower representative on the United Fresh Executive Committee.

United Fresh has several international affiliations, one of these being membership of the International Federation for Produce Standards (IFPS).[40] IFPS is a global produce industry body, dedicated to improving the efficiency of fresh produce supply chains through developing, implementing, and managing harmonised international standards. United Fresh is the New Zealand representative on the board of IFPS.

United Fresh's work on industry Traceability systems commenced in 2014, as a consequence of the Yersinia pseudotuberculosis outbreak.[41] This food safety event highlighted a significant gap in industry knowledge and behaviours and United Fresh formed what is now known as its Technical Advisory Group (TAG).[42] The group analysed the incident and its aftermath from an industry perspective and generated an industry focused report[43], which led to the United Fresh Strawberry Traceability proof of concept project in 2016.[44]

United Fresh's role in this SFF project is one of leadership to assist the fresh produce industry across the entire supply chain to understand the critical importance of fresh produce Traceability and to lay the ground work for future industry wide systems. One recent example of United Fresh's collaborative approach was a United Fresh/FPSC presentation entitled "The Fresh Produce Safety & Traceability Challenge"[45] at the Horticulture New Zealand Conference in 2017.

5. THE AGRICHAIN CENTRE

The AgriChain Centre is an agribusiness and fresh food supply consultancy, with particular expertise in the fresh produce industry. The AgriChain Centre provides services and advice on matters relating to Biosecurity, Food Safety & Traceability, Fresh Produce Inspection and Value Chain Management.[46]

The AgriChain Centre is a member of United Fresh and one of the company's Directors, Dr Hans Maurer, is an elected member of the United Fresh Executive Committee and represents United Fresh as the New Zealand Director on the IFPS board. Dr Maurer chairs both the United Fresh TAG and the IFPS Chain Information Management Committee.

The company is contracted to United Fresh as Project Manager of this SFF Project. The Project Director is The AgriChain Centre's Managing Director, Anne-Marie Arts, to ensure a degree of separation between Dr Maurer's roles for United Fresh and the delivery of this Project. Dr Maurer will however act as an internal peer reviewer as the project unfolds.

The AgriChain Centre has 18 years' worth of experience managing various fresh produce Traceability projects on behalf of retailers, wholesalers and MPI.[47] Its expertise in that area will be brought to bear in this Project.

6. GS1 NEW ZEALAND

GS1 is a global not-for-profit standards body that develops and support international standards that enable data identification of products, places and things, automatic data capture, and data sharing.[48,49] GS1 created the ISO retail "barcode" standard and the identifying number it contains (the Global Trade Item Number – GTIN) but additional GS1 standards exist throughout the supply chain.[50] GS1 was founded in 1974[51], and has 1.5 million business customers in 112 countries, including New Zealand.[52]

GS1 has developed a Global Traceability Standard (GTS)[53] to assist organisations and industries in the design and implementation of Traceability systems. The GTS provides key insights and knowledge for organisations and industries that are developing long-term Traceability goals.[54]

For this project, Owen Dance from GS1 New Zealand is acting as the technical expert for Traceability systems and standards, as GS1 is an internationally recognised body that develops and maintains Traceability Standards applicable to the food industry.[55]

Throughout this project, the Project Team will be using several GS1 guidance documents to help determine the optimal outcomes on Traceability options. These documents will include: The Fresh Foods Management Solution Standards Application[56], the Critical Tracking Events and Key Data Elements Document[57], and the GS1 Barcodes and Applications Guidance Document.[58]

GS1 has also produced a number of globally applicable produce industry specific documents, typically in collaboration with the produce industry. These include the GS1 Fresh Fruit & Vegetable Labelling Consumer Units Guideline[59], the Traceability for Fresh Fruits and Vegetables Implementation Guide[60], the Fruit & Vegetable Master Data Attribute Implementation Guide[61], and the GS1 Fruit & Vegetable GTIN Assignment Implementation Guideline.[62]

GS1 New Zealand has been a United Fresh member since 2014.

7. FOODBORNE ILLNESS OUTBREAKS

Foodborne illnesses have become a part of our reality, as well as part of a changing media landscape.[63] Our increasing digital connectivity has the potential to create greater impacts than ever before. Information, as well as mis-information, about possible foodborne illness can rapidly spread on-line through social media, at the push of a keyboard button.[64]

The occurrences of foodborne illnesses are not isolated events, and food related outbreaks are more likely to increase rather than decrease.[65] This is in-part due to complexities related to centralised production and distribution, the advent of factory-farming, the increase in the range of processed fresh produce, and matters relating to availability, quality, and usage practices of water.[66,67,68]

7.1 New Zealand Significant Outbreaks

In the period of 2000–2018, New Zealand has had several outbreaks of foodborne illnesses with produce identified as a likely infection vector.[69,70,71,72,73] These have covered multiple sectors of produce, from unprocessed loose

vegetables to processed, bagged, frozen berries. Additionally, these outbreaks often occurred with delays between identification of an outbreak occurring, and identification of the infection vector, if a vector was indeed identified. Research in 2006 found that only around 80% of foodborne disease outbreaks had a suspected origin, and only 46% had a confirmed origin.[74] This makes maintaining Traceability an important aspect in helping identify potential infection vectors to increase confirmation rates.

In September 2014, an outbreak of Yersinia pseudotuberculosis affected 334 people.[75] The infection vector was never confirmed despite investigations by MPI and others, however official media reports suggested carrots and/or lettuce.

In December 2015, frozen imported berry mix packets were found to have been potentially infected with Hepatitis A during processing in China, prior to shipment to New Zealand and Australia.[76] Records show 4 people in New Zealand and 19 people in Australia had fallen ill. Similar frozen berries were found to be the infection vector for outbreaks in 2013 and 2016 in the United States and Canada with 72 hospitalisations.[77]

In August 2016, Hastings experienced a Campylobacter outbreak, thought to be one of the world's largest foodborne illness outbreaks, infecting over 5,500 people.[78] Initial speculation was that locally grown mushrooms were the vector; however, it was concluded the outbreak was linked to the water supply.[79]

In July 2018, contamination of Bell Farm frozen vegetables with Listeria at the processing plant in Hungary led to a recall of the product in New Zealand[80], Australia, and Europe. To date, 47 cases of illness have been reported, including 1 Australian and 9 European deaths.[81] This shows the increasing difficulty in managing and controlling outbreaks where contamination may occur in multiple countries and the importance of effective Traceability across borders.

Carrots were tentatively identified as the vector for Salmonella enterica "Saintpaul" in the 2005 Auckland outbreak, although confirmation could not be established.[82] This outbreak infected 19 people, 11 of whom were children.

This list is not an exhaustive list of outbreaks, and quite possibly is missing events that were not significant enough to be detected or reported.

7.2 Worldwide Significant Outbreaks

In April 2018, the United States Centre for Disease Control (CDC) began investigating an E. Coli outbreak that had initially infected 17 people.[83] Further investigations identified Romaine lettuce as the most likely cause of infection. By the end of the outbreak, 210 cases of infection were identified, 96 hospitalisations had occurred, and 5 patients had died.

In June 2011, Europe suffered the third largest foodborne illness event ever recorded, when almost 4,000 fell sick with E. Coli, and 53 died.[84] Initially, cucumbers from Spain were thought to be the culprit[85], but the outbreak was later traced back to fenugreek sprouts[86] sourced from Egypt[87] and grown in Germany.[88] The effects of this outbreak were calculated to be in the region of USD$2.8 Billion from medical impacts and lost work.[89]

In many of these cases, the outbreaks spread far beyond the region or country of production. This is characteristic for fresh produce due to its complex and far reaching supply chains. Modern produce supply chains now stretch across the globe to meet consumers' desire for fresh produce of all types for as much of the year as possible, which contributes to any outbreak occurring in an export supply chain being very likely to impact multiple countries.

8. TRACEABILITY

Traceability and the extent to which it is being achieved has always been a topic for discussion in produce supply chains.[90] Traceability systems are not a new idea, originating in Europe during the mid-1930s, "when some European countries wished to prove the origin of high-quality food, such as French Champagne".[91] Traceability has evolved as products, regulatory and consumer demands have changed.

A number of motivating factors for businesses to improve or achieve Traceability exist. They range from pure economic and market related factors and the need for purchasers to understand for commercial reasons how their product has been sourced, to the need to meet regulatory requirements and retailer specifications. For the purposes of this project, this literature review focuses on Traceability in the fresh produce supply chain as it relates to food safety matters. It will however be necessary to consider Traceability related perceptions[92] to gain a better understanding of underlying factors impacting on advancing industry adoption of Traceability concepts.[93]

The Geneva-based UN International Trade Centre published a bulletin in 2015 entitled "Traceability in Food and Agricultural Products.[94] It discusses the importance of Traceability in the food and agricultural sectors, as well as effectiveness of Traceability systems, and Traceability tools. Although not produce specific, it is a good starting point for anyone needing to upskill in the Traceability area.

GS1 USA and McKinsey & Company published a white paper in 2013, entitled "Integrated Traceability in Fresh Foods: Ripe Opportunity for Real Results".[95] The paper is written for a business audience, and uses several produce related examples and mini-cases to illustrate benefits that result from taking an integrated approach to Traceability.

In New Zealand, there are several food safety related regulatory and commercial compliance standards with a Traceability focus, such as the Food Act 2014 and the Food Safety Law Reform Bill 2018. New Zealand has been a member country of Codex Alimentarius (Codex) since 1963. Codex is a set of international food safety standards, originally developed by the Food and Agriculture Organisation of the United Nations (FAO).[96] Codex standards are not mandatory but voluntary. Member countries are able to develop national legislation that is more stringent than Codex but may be required to provide science-based evidence for such a move. The World Trade Organisation (WTO) encourages Codex member countries to harmonise national legislation with Codex standards. New Zealand's Codex representative is MPI.[97]

In addition, there are commercial standards such as GlobalGAP[98] / NZGAP[99], Woolworths Quality Assurance Programme (WQA)[100], British Retail Consortium (BRC)[101] and others that growers, packers and retailers can align with. The Traceability requirements of these systems generally include product identification, record keeping (typically "one step up, one step down"[102]) both externally and internally, internal monitoring and audits and standards-based management of all required inputs. However, Traceability data and recording methodology standards are typically not specified within such documents. As such, implementation may differ between supply chains, or within supply chains.

Figure 1 shows a typical Traceability Layout related to commercial best practice standards.

It also noted that, with the exception of NZGAP, commercial standards in use in New Zealand typically have their origin in one or more of the countries New Zealand trades with. WQA is an Australian system, BRC has its origin in the United Kingdom. As a fresh produce

exporting nation of note, New Zealand's export produce industry, e.g.; kiwifruit, apples, onions, avocados, etc., are out of necessity typically early adopters of whatever quality management systems their overseas customers wish to implement.

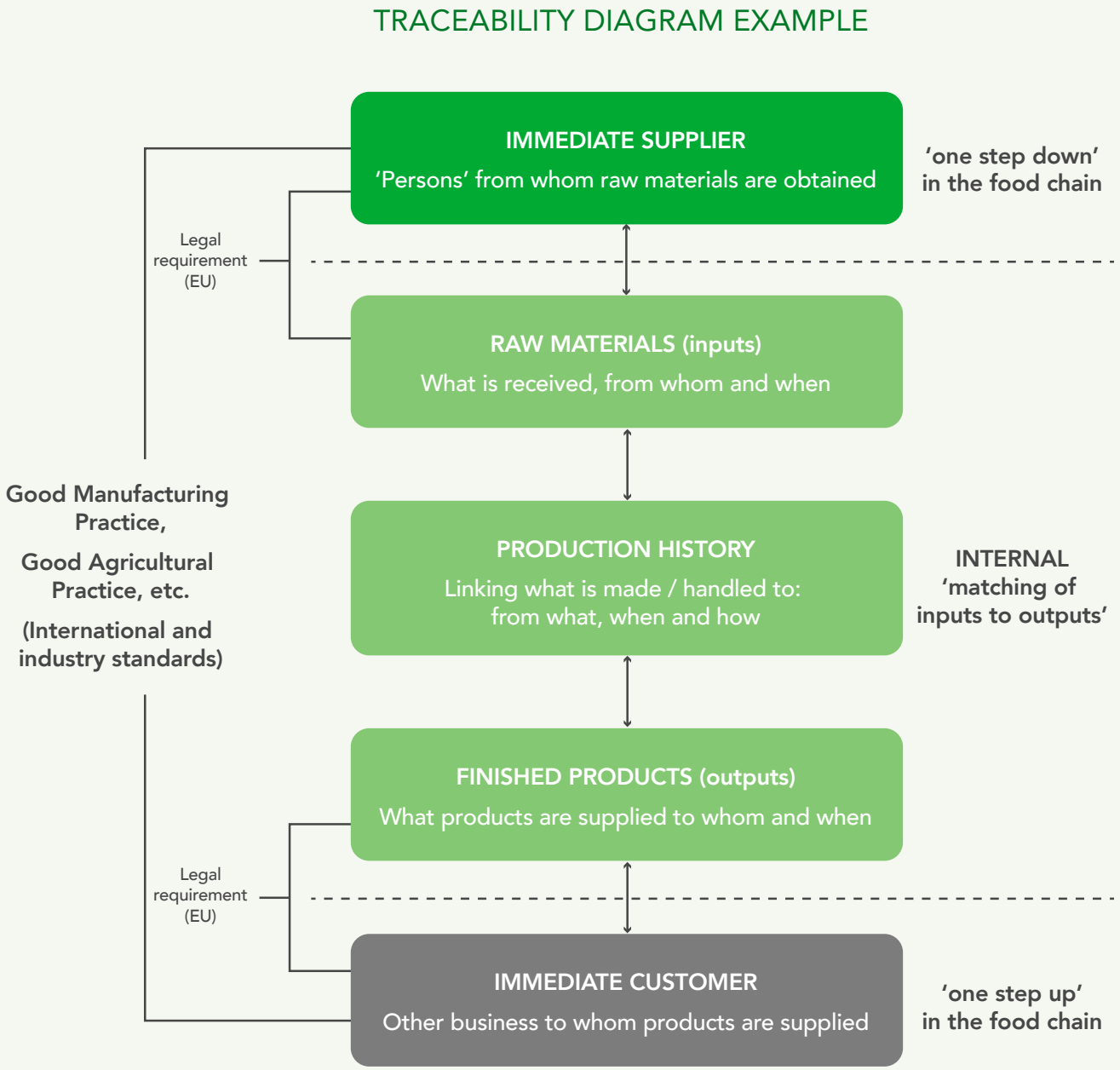


Figure 1: *Source: Campden BRI Guideline 60 – Traceability in the food and feed chain.*[103]

8.1 Traceability Challenges

Traceability has several challenges in the produce industry. These include that

- Produce sold loose cannot easily be traced once it is removed from its wholesale packaging and placed on retail display.[104]
- Packaged produce such as Ready-to-Eat (RTE) salads can contain components sourced from multiple producers. Whilst the packaged produce unit can be traced with relative ease as it typically includes a barcode, tracing the individual components is not as easily achieved.[105]
- The journey a shipment of produce takes from producer to retailer is not always a straight forward one and can involve more than one consolidation point, adding Traceability complexity.[106]
- The pace at which highly perishable produce such as green leafy vegetables, for example, needs to move through the supply chain can exceed the flow of corresponding information via conventional pen and paper or one-dimensional information systems.[107]
- A structured approach to implementing Traceability systems requires a structured business model in the first place.[108] Not every produce grower has the aptitude or inclination to integrate a Traceability system into his or business processes, and alternative solutions need to be found.[109]
- The profit margins earned by commodity producers can severely fluctuate between season and the fresh produce industry is no exception. A natural reluctance therefore exists to add any costs to an already fragile business model, particularly when the need for such a move is not entirely understood.[110]
- Perception is often described as being "nine tenths of reality" and this is certainly the case for Traceability in the produce industry. Achieving Traceability is perceived by many to be a cumbersome, time consuming, margin draining, over-engineered control driven non-core activity that has no place in the daily produce supply chain routine.[111]
- The New Zealand produce industry is not one homogenous body. The national grower body, Horticulture New Zealand has twenty-one affiliated product groups ranging from Kiwifruit to Boysenberries. Each product group has its own governance structure, represents crops with in many cases entirely different production and risk profiles and fruit and vegetable growers come from all ethnic population elements represented in New Zealand. Horticulture New Zealand reports there are 5,500 commercial growers in New Zealand, across 100 crops.[112] Other produce groups that can be found on our retail shelves but are not affiliated with Horticulture New Zealand are mushrooms and tree crops, such as walnuts, chestnuts, hazelnuts, etc.

8.2 Traceability Drivers

There are several key drivers impacting on Traceability scope and opportunity. These include:

- Consumer expectations
- Supply chain evolution
- Technology advancements
- Industry globalisation
- System complexity & speed
- System and Information fragmentation
- Crop type and packaging style
- Industry structure
- Paradigm shifts in attitude towards fresh fruit and vegetables

Consumers expect to find produce of the right quality, in a convenient purchase format and at an attractive price, whenever they wish to exercise their purchase option[113]. Within the quality expectation, several separate strands that contribute to this segment are found. These strands include the expectation that the produce is safe, sustainable, and that information related to origin and/or growing methods is available and correct.[114]

The pathways produce can take to reach the consumer are growing at a rapid pace.[115, 116] Traditional supermarkets are offering on-line shopping as a matter of course these days, with options to have groceries delivered to the home, picked in store or transported to a easily accessible transfer point such as a wharf locker. Non-food on-line distributors such as Amazon have been attracted to the FMCG industry and have launched perishable foods specific business models, e.g.; Amazon Fresh[117]. Another example of supply chain evolution is the emergence of home meal solution providers such as My Food Bag.[118]

The advance of technology solutions such as GPS, scanning, 4G (and beyond) mobile communication networks, the Internet of Things[119] and Blockchain[120,121,122] technology is either already well understood and implemented or at the cusp of opening new found opportunities.

Supply chains are increasing in complexity.[123,124] Where supply chains may once have been tied to a single region of a country, and producers may have had one supply chain and customer, modern supply chains may have dozens of growers, packhouses, logistics companies, wholesalers and retailers involved. These supply chains may reach through multiple countries or even across continents. Complexity can be most explicitly observed in the increasing prevalence of RTE salads.[125] These behave similarly to perishable processed foods in other fresh food industries (delicatessen, meat, dairy, etc.), having undergone additional processing and handling steps where Traceability needs to be maintained.

Another serious system challenge is the speed at which produce is handled and moved through the supply chain.[126,127] Time pressure[128] and the low level of processing increase the necessity for effective Traceability as any contamination in the supply chain is unlikely to be managed with a Hazard Analysis and Critical Control Points (HACCP) based kill-step[129] such as heat treatment. Contaminated produce can often have moved through the entire supply chain to the consumer's plate well before contamination is detected and confirmed.

A supply chain is often comprised of multiple parties, who each require information from upstream and downstream supply chain partners[130] in order to be able to ensure effective external[131] Traceability.[132] In-house company systems can work well at enabling internal[133] Traceability of a product, yet without the ability to transfer information to other parties, the ability for external Traceability along the supply chain is compromised[134] or delayed. Product cannot be considered truly traceable if product information[135] is not available in time, inaccurate, or incomplete, to parties that require the information.

New Zealand's systems for Traceability[136] of fresh produce[137,138] range from pen and paper and simple spreadsheet documents, through to customised electronic databases, in-house barcode-based label systems and GS1 based systems.[139]

Crop type and packaging method can play a huge part in the Traceability of produce.[140,141] Providing Traceability information using current systems often relies on physical labels being attached to the produce.[142] This limits labelling on smaller items and reduces the area for effective Traceability information to be contained. Small size crops such as berries require a package for labels to be attached, as individual berries are smaller than the labels. Bananas and apples can accept labelling on individual units, due to size, consumption options and skin consistency, but potatoes and other root vegetable skins are not suitable for standard labels, despite their suitable size.

Industry participants can typically develop internal Traceability systems and achieve a usable Traceability system for their own purposes.[143] Yet the external Traceability between supply chain partners may be lacking.

Traceability models in the produce industry are typically based on the "one step up, one step down" principle.[144] This represents a solid start but still does not deal with Traceability issues that occur when unmarked produce is sold in loose format or strawberry punnets are bereft on any identification[145], whether they are sold in-store or by a roadside stall vendor.

9. GLOBAL PRODUCE TRACEABILITY INITIATIVES

9.1 Netherlands

The Dutch produce industry is the largest purveyor of fresh produce in the world, by way of exporting not only a large percentage of their own produce but also by re-exporting substantial volumes of third country imports. In 2010, the Dutch produce industry established Frug I Com, in an attempt to strengthen the industry's ability to manage data streams within the supply chain, with most of these data streams contributing to Traceability information. The Frug I Com launch was described as follows:

"Frug I Com is a unique framework of cooperation in the chain of fresh fruits and vegetables, Fresh Produce, in the Netherlands. It aspires to increase the use of electronic information in the chain, based on a demand-driven and upstream approach. The partners in the project are Frugi Venta (trade and processing), the Dutch Produce Association (growers), Fresh Produce Center and GS1 Netherlands (standardisation)".[146]

Today the Dutch produce industry is a thought leader in the development of Traceability systems and is the organiser of the bi-annual EU Fresh Info Forum & Round Table event, taking a leadership role within the European Union.[147]

9.2 USA & Canada

In 2008, the US Produce Marketing Association (PMA), the Canadian Produce Marketing Association (CPMA), and the US based United Fresh Produce Association (United Fresh New Zealand Incorporated are honorary members of United Fresh in the US) assembled a group of members interested in identifying a solution to enhance the industry's Traceability capability, following a Salmonella enterica "Saintpaul" outbreak linked to tomatoes that resulted in 2 deaths and 1500 people being taken ill. One of the group's first realisations was the need for a common data management infrastructure. The group's '7 Milestones'[148] plan published later in 2008 was built on GS1's GTIN architecture.

One year earlier, in 2007, industry had established the Centre for Produce Safety[149] and today the Centre is instrumental in guiding industry Traceability initiatives.

9.3 Japan

Japan in 2009 participated in a project funded by the Asian Development Bank (ADB) to establish a Food Traceability System, and to investigate the potential for IT to aid in the management of Traceability data.[150] The project involved the Japan Ministry of Agriculture, Forestry and Fisheries, conducting pilot Traceability projects with mushrooms and poultry. The project also involved development of the "Handbook for the Introduction of Food Traceability Systems" to share knowledge of the project and to facilitate cooperation. This project cost NZD$230,000 in IT systems implementation, but enabled the Oita region in Japan to create a verifiable and auditable Traceability system for packers to verify the origin of Shiitake mushrooms, and the system was scalable and consistent across all participants, preventing data fragmentation or loss.

9.4 Australia

Coles and Woolworths supermarkets have recently introduced GS1 DataBar labels into their supply chains to assist with produce Traceability. DataBar was not designed for the purpose but clearly has some application in the area. Its intended purpose when introduced into the US market in the early 2000s was to improve retailers' ability to understand sales performance via Point of Sale (POS) scanning of individual loose fruit and vegetables. There is some debate about the implementation policies compared to the global intent for that product. GS1 globally works on the principle that the product marketer should generate the DataBar and become the effective DataBar 'owner'. Initially, neither of the two Australian supermarket chains wanted to go with this principle. One of them required their growers to be the DataBar 'owner', with the other one opting to have 'ownership' held at packhouse level.

It appears that the packhouse level ownership has been accepted by both chains, although it has not been possible to authoritatively confirm this at the time of writing. The implications of this departure from the global standard for produce imported into Australia has yet to be fully analysed. Whilst Australia imports relatively little produce compared to New Zealand, New Zealand kiwifruit and avocado, for example, are exported in some volume into the Australian market. New Zealand exporters currently serving the US market are following the global GS1 DataBar standard where the marketer is the "owner of the barcode". Australian exporters using DataBar will obviously need to comply with whatever usage policies their offshore customers require.

9.5 Britain

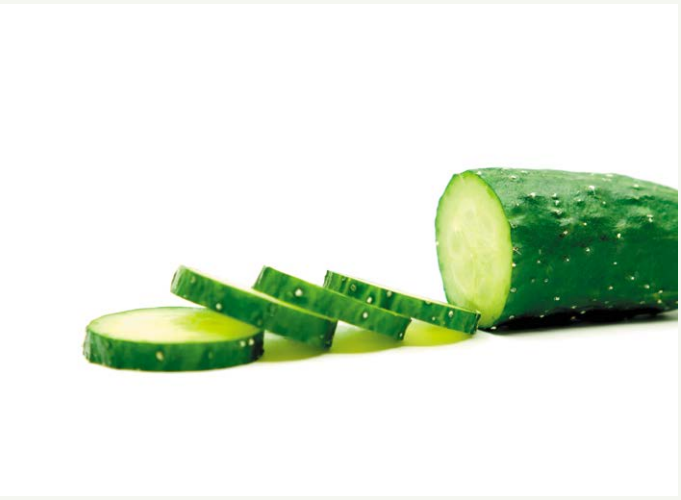
Marks and Spencer in England has since 2015 been implementing a DNA Traceability system on the meat it buys. This enables a per animal Traceability back to the farm of origin for Marks and Spencer.[151]

In July 2018, the British Food Standards Authority piloted a Blockchain based Traceability system in a slaughterhouse to enable transparency and Traceability in the meat supply chain.[152] This pilot focused on examining the data standards involved in Traceability. Further projects are planned to occur.

9.6 China

The Alibaba Group in China has since 2018 been trialling two methods of Traceability for products: QR codes, and a Blockchain based Traceability system to track food items through the supply chain. These methods aim to enable the consumer to track from the store back to the field all aspects of the supply chain, to provide verifiability of any information attached to the product.[153,154] One of the initial tests involves Fonterra.

Walmart is also testing Blockchain in its Chinese supply chains.[155]



10. DISCUSSION

The available literature on fresh food and fresh produce Traceability and food safety challenges is extensive. Fresh produce industry bodies in the Netherlands, the USA, and Canada have significantly advanced the level of industry cooperation in the implementation of common data architectures to allow effective and efficient Traceability. This involves developing industry wide mechanisms to ensure consumer food safety concerns are addressed in a proactive manner, and are effectively dealt with when a food safety related illness outbreak occurs.

New Zealand is a food exporting nation, and horticultural crops such as kiwifruit, apples, onions, avocado, pumpkin and blueberries, amongst others, constantly enter global supply chains during their production seasons. New Zealand produce exporters therefore already have to comply with food safety related Traceability conditions, applicable in the countries or within the supply chains they are active in. The fundamental issue this SFF project is aiming to address is to bring the domestic fresh produce industry to the same level of care and best practice competence in food safety and Traceability matters, as we are already affording to our overseas customers via our export supply chains.

The common themes that weave themselves through the literature are these:

A. A common data infrastructure is needed in order for external Traceability to work in an unimpeded way.

B. Attempts to achieve industry-wide Traceability initiatives fail when industry participants are solely focused on their internal needs, without appreciating the relationship between the industry as a whole and its' customers and consumers.

C. Supply chains are becoming more complex, and the advances in new technologies will require paradigm shifts, the emergence of Blockchain technology in recent years being the prime example.

D. Traceability requires an organised and structured approach to business management as well as commitment from business owners, boards and Chief Executives.

Readers will note that this literature review has focused on Traceability rather than Transparency. Transparency is on one hand a function of reliable Traceability systems, but secondly part of the paradigm shift phenomena mentioned above. The adoption of Blockchain technology will lead to transparency potentially being the new "normal", as long as every participant in the supply chain manages data flow to agreed principles and processes, which includes absolute honesty.

At the time of writing, industry has understood that Blockchain technology has the potential to provide smarter solutions, but this technology is in the early testing stage, with full-scale implementation still some time away. The extent of change that Blockchain introduction could potentially represent for the fresh produce industry is still not entirely understood by all parties concerned. The views range on the continuum from Blockchain being the panacea for all problems, to it being nothing other than a complex and shared database, albeit that it will be shared simultaneously amongst supply chain partners. The truth in such a situation as always sits somewhere in the middle, but establishing what is fact and fiction in that thought process is not part of the brief of this project.

As the project evolves over the next three years, any learnings related to Transparency improvements that are technology based will be monitored and reported upon.

In conclusion, the literature points very clearly towards there being an absolute need for the domestic New Zealand fresh produce industry to adopt common data architectures in order to ensure that supply chain complexities and the resulting commercial advantages are matched by improved ability to ensure fresh produce food safety. It is also fairly obvious from literature that New Zealand can learn, and should be willing to learn, from experiences and knowledge generated by trading partners such as the Netherlands, the USA, and Canada.

As a small trading nation at the edge of the South Pacific, New Zealand is more than capable of boxing above its weight, and we are consistently demonstrating that across a range of business and sporting applications. We do however need to focus on investing in where our strengths lie, and our resources as an industry, and as a country, are not unlimited. It is therefore already clear from the literature that re-inventing the wheel as far as a New Zealand data architecture is concerned, as opposed to adopting the global one that already exists, would not be in our best interests. Instead, the literature points at mechanisms by which we can work with GS1, the global architecture provider, to ensure this architecture works for the New Zealand produce industry.

This literature review has generated a hundred plus very solid references, and we would encourage readers to access some of these key documents, in order to benefit from the learnings generated.

Links to key documents will be available at the United Fresh Website in the the Sustainable Farming Fund Project section. We invite industry feedback to this literature review, and look forward to your responses. Feedback can be directed to Melanie Trotman, Project Manager, at mtrotman@agrichain-centre.com.

ENDNOTES

1 Bosona, T., & Gebresenbet, G. (2013). Food Traceability as an Integral Part of Logistics Management in Food and Agricultural Supply Chain. Food Control, V.33(1), p32-48.

2 Maurer, H., Dolan, M., & Arts, A-M. (2015). The New Zealand Produce Industry Food Safety & Traceability Framework Position Paper. United Fresh.

3 Staff (2016). Strategic Assessment of Food Safety & Traceability in the New Zealand Domestic Fresh Produce Industry. United Fresh Food Safety & Traceability Committee.

4 Staff (2014). Outbreak Source Investigation - Yersinia pseudotuberculosis 2014. MPI.

5 Staff (2011). Lessons Learned from the 2011 Outbreak of Shiga Toxin-Producing Escherichia Coli (STEC) O104:H4 in Sprouted Seeds. Commission of the European Communities.

6 Staff (2016). Strategic Assessment Food Safety & Traceability in the New Zealand Domestic Fresh Produce Industry. United Fresh.

7 Staff (2014). Dairy Traceability Working Group Report A – Proposed Regulatory Requirements for Traceability. Dairy Traceability Working Group.

8 2018, http://www.legislation.govt.nz/bill/government/2016/0135/latest/DLM6845609.html. Accessed 27/08/2018.

9 2018, http://www.legislation.govt.nz/act/public/1999/0093/117.0/DLM33502.html. Accessed 29/08/2018.

10 2018, http://www.legislation.govt.nz/act/public/2003/0114/latest/DLM222447.html?search=sw_096be8ed81756ea3_wine+act_25_se&p=1. Accessed 29/08/2018.

11 2018, http://www.legislation.govt.nz/act/public/2014/0032/latest/DLM2995811.html?search=ta_act_F_ac%40ainf%40anif_an%40bn%40rn_25_a&p=4. Accessed 29/08/2018.

12 Hanif, R., et al. (2006). Use of Vegetables as Nutritional Food: Role in Human Health. Journal of Agricultural Biological Sciences, V.1(1), p18-22.

13 Lampe, J. W. (1999). Health Effects of Vegetables and Fruit: Assessing Mechanisms of Action in Human Experimental studies. The American Journal of Clinical Nutrition, V.70(3), p475-490.

14 Staff (2017). New Research Proves Kiwis Amongst the Highest Consumers of Fruit and Vegetables Globally. 5+ A Day Foundation.

15 Pattis, I., et al. (2017). Foodborne Disease in New Zealand 2016. MPI.

16 McCollum, J. T., et al. (2013). Multistate Outbreak of Listeriosis Associated with Cantaloupe. New England Journal of Medicine, V.369(10), p944-953.

17 Sivapalasingam, S., et al. (2004). Fresh Produce: A Growing Cause of Outbreaks of Foodborne Illness in the United States, 1973 Through 1997. Journal of Food Protection, V.67(10), p2342-2353.

18 Staff (2011). Lessons Learned from the 2011 Outbreak of Shiga Toxin-Producing Escherichia Coli (STEC) O104:H4 in Sprouted Seeds. Commission of the European Communities.

19 2018, https://fpsc-anz.com/. Accessed 27/08/2018.

20 2018, https://www.nzfssrc.org.nz/about. Accessed 27/08/2018.

21 2018, https://www.mpi.govt.nz/news-and-resources/media-releases/new-sustainable-farming-fund-projects-announced/. Accessed 22/08/2018.

22 2018, http://traceabilitytraining.food.gov.uk/module1/overview_6.html#.W4NSi-gzY2w. Accessed 27/08/2018.

23 2018, http://traceabilitytraining.food.gov.uk/module1/overview_6.html#.W4NSi-gzY2w. Accessed 27/08/2018.

24 Staff (2002). CPMA/PMA Traceability Task Force - Traceability Best Practices - Fresh Produce Industry (North America). CPMA/PMA.

25 Staff (2017). Fresh Facts 2017. Horticulture New Zealand.

26 Staff (2017). The Investor's Guide to the New Zealand Produce Industry 2017. Ministry of Business, Innovation and Employment.

27 2015, http://www.nielsen.com/nz/en/insights/news/2015/trends-shaping-the-future-of-grocery-in-nz.html. Accessed 27/08/2018.

28 2018, https://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=12086985. Accessed 27/08/2018.

29 2018, http://www.abc.net.au/news/2018-06-20/salmonella-outbreak-from-sprouts-sa/9891044. Accessed 27/08/2018.

30 2016, https://www.bbc.co.uk/news/uk-scotland-glasgow-west-37279815. Accessed 28/08/2018.

31 2018, https://www.cdc.gov/salmonella/adelaide-06-18/index.html. Accessed 28/08/2018.

32 Hobbs, J. E. (2003). Consumer Demand for Traceability. International Trade Research Consortium. Working Paper 03-1. ISSN 1098-9218.

33 Staff (2002). CPMA/PMA Traceability Task Force - Traceability Best Practices - Fresh Produce Industry (North America). CPMA/PMA.

34 2014, https://frugicom.nl/Portals/20/FIC_2014_2pager_ENG.pdf?ver=2016-02-09-105653-743. Accessed 27/08/2018.

35 2011, https://www.pma.com/~/media/pma-files/supply-chain-standards/pti-what-is-it-50911.pdf?la=en. Accessed 27/08/2018.

36 Staff (2010). GS1 - Traceability for Fresh Fruits and Vegetables Implementation Guide. GS1 Global.

37 2018, https://www.unitedfresh.co.nz/. Accessed 24/08/2018.

38 2018, https://www.unitedfresh.co.nz/about-us. Accessed 24/08/2018.

39 2018, https://www.unitedfresh.co.nz/membership/current-members. Accessed 24/08/2018.

ENDNOTES

40 2018, https://www.ifpsglobal.com/. Accessed 24/08/2018.

41 2014, https://www.nzherald.co.nz/lifestyle/news/article.cfm?c_id=6&objectid=11338459. Accessed 24/08/2018.

42 2018, https://www.unitedfresh.co.nz/technical-advisory-group. Accessed 24/08/2018.

43 Staff (2015). Yersinia pseudotuberculosis Review. United Fresh.

44 Maurer, H. (2016). Strawberry Pilot: Traceability Learnings. PowerPoint Presentation. United Fresh.

45 2017, https://www.unitedfresh.co.nz/assets/TAG/Final---The-Fresh-Produce-Safety-Traceability-Challenge.pdf. Accessed 24/08/2018.

46 2018, http://www.agrichain-centre.com/. Accessed 24/08/2018.

47 2018, http://www.agrichain-centre.com/projects/. Accessed 24/08/2018

48 2018, https://www.gs1nz.org/. Accessed 24/08/2018.

49 2018, https://www.gs1nz.org/about-us/our-sister-organisations/. Accessed 24/08/2018.

50 2018, https://www.gs1nz.org/standards/. Accessed 24/08/2018.

51 2018, https://www.gs1.org/about/how-we-got-here. Accessed 24/08/2018.

52 2018, https://www.gs1nz.org/. Accessed 27/08/2018.

53 2018, https://www.gs1.org/docs/traceability/Global_Traceability_Standard.pdf. Accessed 24/08/2018.

54 Staff (2017). GS1 AISBL, GS1 Global Traceability Standard Release 2.0. GS1 AISBL.

55 2018, https://www.gs1.org/traceability. Accessed 27/08/2018.

56 2018, https://www.gs1us.org/industries/retail-grocery/standards-in-use/fresh-foods/fresh-foods-management-solution. Accessed 27/08/2018.

57 2018, https://www.gs1.org/sites/default/files/docs/traceability/GS1_Global_Traceability_Standard_i2.pdf. Accessed 27/08/2018.

58 Staff (2008). GS1 General Specifications. GS1 Global.

59 Staff (2015). GS1 Fresh Fruit & Vegetable Labelling Consumer Units Guideline. GS1 Global.

60 Staff (2015). Traceability for Fresh Fruits & Vegetables Implementation Guide. GS1 Global.

61 Staff (2017). Fruit & Vegetable Master Data Attribute Implementation Guide. GS1 Global.

62 Staff (2016). GS1 Fruit & Vegetable GTIN Assignment Implementation Guideline. GS1 Global.

63 Harris, J., et al. (2015). Health Department Use of Social Media to Identify Foodborne Illness — Chicago, Illinois, 2013–2014. Morbidity and Mortality Weekly Report, V.63(32), p681–685.

64 Chapman, B., et al. (2014). Potential of Social Media as a Tool to Combat Foodborne Illness. Perspectives in Public Health, V.134(4), p225-230.

65 Käferstein, F. (2003). Actions to Reverse the Upward Curve of Foodborne Illness. Food Control, V14(2), p101-109.

66 Beuchat, L. R. & Ryu, J. H. (1997). Produce Handling and Processing Practices. Emerging Infectious Diseases, V.3(4), p459–465.

67 McIntyre, L., Cressy, P., & Lake, R. (2010). Scientific Interpretive Summary - Discussion Document on Pathogens in Fruits and Vegetables in New Zealand. NZFSA.

68 2017, https://www.odt.co.nz/lifestyle/food-wine/news-features/produce-contamination-increasing-problem. Accessed 27/08/2018.

69 Staff (2017). Foodborne Disease in New Zealand 2016. MPI Technical Paper No: 2017/46. MPI.

70 2017, https://www.mpi.govt.nz/food-safety/food-safety-and-suitability-research/human-health-surveillance/foodborne-disease-annual-reports/. Accessed 27/08/2018.

71 Staff (2009). Annual Report Concerning Foodborne Disease in New Zealand 2009. ESR.

72 Staff (2008). Discussion Document on Pathogens in Fruits and Vegetables in New Zealand. ESR.

73 Calder, L., et al. (2002). An Outbreak of Hepatitis A Associated with Consumption of Raw Blueberries. Auckland District Health Board.

74 Staff (2009). Surveillance for Foodborne Disease Outbreaks - United States, 2006. Report published in Morbidity and Mortality Weekly, 12 June 2009. CDC.

75 Staff (2015). Yersinia pseudotuberculosis Review. United Fresh.

76 2015, https://www.mpi.govt.nz/news-and-resources/media-releases/further-recall-of-fruzio-frozen-berries/. Accessed 27/08/2018.

77 2016, https://www.fda.gov/food/recallsoutbreaksemergencies/outbreaks/ucm518775.htm. Accessed 28/08/2018.

78 Staff (2016). Hawkes Bay District Health Board - Havelock North Campylobacter Outbreak Update.

79 2016, https://www.dia.govt.nz/Government-Inquiry-into-Havelock-North-Drinking-Water-Report---Part-1---Overview. Accessed 27/08/2018.

80 2018, https://www.mpi.govt.nz/food-safety/food-recalls/recalled-food-products/various-frozen-vegetable-products/. Accessed 27/08/2018.

81 2018, https://www.efsa.europa.eu/en/press/news/180703. Accessed 24/08/2018.

82 Staff (2015). Understanding the Gaps: A Food Safety Literature Review. Fresh Produce Safety Centre.

ENDNOTES

83 2018, https://www.fda.gov/food/recallsoutbreaksemergencies/outbreaks/ucm604254.htm. Accessed 27/08/2018.

84 2011, https://www.ncbi.nlm.nih.gov/books/NBK114499/. Accessed 27/08/2018.

85 2011, https://www.reuters.com/article/us-germany-ecoli/germans-pin-e-coli-outbreak-on-spanish-cucumbers-idUSTRE74P3ND20110526. Accessed 27/08/2018.

86 2011, https://www.theguardian.com/world/2011/jun/10/e-coli-bean-sprouts-blamed. Accessed 27/08/2018.

87 2011, https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6250a3.htm. Accessed 27/08/2018.

88 2011, https://www.theguardian.com/uk/2011/may/31/e-coli-deaths-16-germany-sweden. Accessed 27/08/2018.

89 2013, http://www.foodpoisonjournal.com/foodborne-illness-outbreaks/german-e-coli-o104h4-outbreak---284-billion-in-human-damage/. Accessed 24/08/2018.

90 2018, https://worldagnetwork.com/food-supply-chain-traceability/. Accessed 27/08/2018.

91 Staff (2014). BSR - A Guide to Traceability. BSR.

92 Van Rijswijk, W. & Frewer, L. J. (2008). Consumer Perceptions of Traceability: A Cross-National Comparison of the Associated Benefits. Food Quality & Preference, V.9(5), p452-464.

93 Belanger, B. (1980) Traceability – An Evolving Concept. ASTM Stand. News V.8(1), p22-28.

94 Staff (2015). Traceability in Food and Agricultural Products. International Trade Centre.

95 Staff (2013). Integrated Traceability in Fresh Foods: Ripe Opportunity for Real Results. GS1 USA and McKinsey & Company.

96 2018, http://www.fao.org/fao-who-codexalimentarius/en/. Accessed 28/08/2018.

97 2018, http://www.fao.org/fao-who-codexalimentarius/about-codex/members/detail/en/c/15648/. Accessed 28/08/2018.

98 2018, https://www.globalgap.org/uk_en/. Accessed 30/08/2018.

99 2018, https://www.newzealandgap.co.nz/. Accessed30/08/2018.

100 2018, https://www.wowlink.com.au/wps/portal/!ut/p/c1/04_SB8K8xLLM9MSSzPy8xBz9CP0os3izQB8jJydDRwMDA2djA6Mg_zDHsNBgYwN3U6B8pFm8n79RqJuJp6GhhZmroYGRmYeJk0-Yp4G7izEB3eEg-5BU-FuaAVU4-Z6upgAWc5mEHl85oPkDXAARwN9P4_83FT9gtwIg8yAdEUARibKaQ. Accessed 30/08/2018.

101 2018, https://brc.org.uk/. Accessed 30/08/2018.

102 Staff (2012). Scientific Information Bulletin (SIB) March 2012 - Food Traceability. International Union of Food Science and Technology.

103 Staff (2009). Guideline 60 - Traceability in the Food and Feed Chain: Requirements for System Design and Implementation. Campden BRI.

104 2016, https://www.producebusiness.com/produce-traceability-remains-complex-challenge/. Accessed 28/08/2018.

105 Wunsch, E. (2014). Major Technological Trends Within the Fresh Produce Supply Chain - An Industry Talent Initiative PMA A-NZ Career Pathways Project.

106 Staff (2017). HortNZ – New Zealand Domestic Vegetable Production: The Growing Story.

107 2016, https://www.logisticsbureau.com/7-things-that-matter-most-to-fresh-supply-chain-leaders/. Accessed 28/08/2018.

108 Bosona, T., & Gebresenbet, G. (2013). Food Traceability as an Integral Part of Logistics Management in Food and Agricultural Supply Chain. Food Control, V.33(1), p32-48.

109 Staff (2014). USDA - Traceability in the U.S. Food Supply: Economic Theory and Industry Studies.

110 Park, K. (2016). Smart Marketing - Produce Industry Procurement Study Results, Part I: Describing Retail and Wholesale Produce Buyers. Cornell University.

111 Zhu, L. (2017). Economic Analysis of a Traceability System for a Two-Level Perishable Food Supply Chain. Sustainability, V.9(5), p682.

112 Fresh Facts 2017. Horticulture New Zealand.

113 2018, https://www.foodsafetymagazine.com/enewsletter/the-future-of-food-traceability/. Accessed 28/08/2018.

114 Sidali, K., et al. (2016). Consumer Expectations Regarding Sustainable Food: Insights from Developed and Emerging Markets. International Food and Agribusiness Management Review V.19(3).

115 2018, https://www.cbi.eu/market-information/fresh-fruit-vegetables/channels-segments/. Accessed 28/08/2018.

116 2018, http://www.fruitnet.com/eurofruit/article/174254/fresh-produce-supply-in-the-digital-age. Accessed 28/08/2018.

117 2016, https://www.businessinsider.com/r-amazon-launches-amazonfresh-food-service-in-parts-of-london-2016-6?IR=T. Accessed 29/08/2018.

118 2016, https://www.stuff.co.nz/business/industries/85495813/Waterman-Capital-invests-in-My-Food-Bag-ahead-of-sharemarket-listing. Accessed 28/08/2018.

119 Verdouw, C., et al. (2016). Virtualization of Food Supply Chains with the Internet of Things. Journal of Food Engineering, V.176, p128-136.

120 2018, http://www.fruitnet.com/eurofruit/article/175909/blockchain-myth-or-salvation. Accessed 28/08/2018.

121 2018, https://thenewstack.io/walmarts-blockchain-program-may-transform-the-way-we-use-data/. Accessed 28/08/2018.

ENDNOTES

122 2018, https://www.fonterra.com/nz/en/our-stories/articles/fonterra-begins-block-chain-technology-pilot-with-alibaba.html. Accessed 28/08/2018.

123 Wunsch, E. (2014). Major Technological Trends Within the Fresh Produce Supply Chain - An Industry Talent Initiative PMA A-NZ Career Pathways Project. PMA-ANZ.

124 Staff (2018). Disruption in Fruit and Vegetable Distribution. Fruit Logistica.

125 Lugg, J., Shim, M., & Zilberman, D. (2016). Establishing Supply Chain for an Innovation: The Case of Pre-packaged Salad. Giannini Foundation of Agricultural Economics, University of California.

126 Charlebois, S., et al. (2014). Comparison of Global Food Traceability Regulations and Requirements. Comprehensive Reviews, V.13(5), p1104-1123.

127 2016, https://www.rentokil.com/blog/globalisation-food-safety/#.W4S28ugzY2w. Accessed 28/08/2018.

128 2018, http://www.hortnz.co.nz/news-events-and-media/mikes-blog/does-complexity-produce-quality/. Accessed 28/08/2018.

129 2017, https://foodsafetymastery.com/2017/07/25/on-the-kill-step-and-leftovers/. Accessed 29/08/2018.

130 Ahmad, M. M., & Fehér, P. (2010). Supply Chain of Fruits and Vegetables and Correlated Impact of Managing the Quality. Proceedings of SKIMA 2010.

131 Unknown, http://traceabilitytraining.food.gov.uk/module2/overview_1.html#.W4WxX84za00. Accessed 29/08/2018.

132 Khanal, M. P. (2012). Information Structure and Coordination in Vegetable Supply Chains. Doctoral Thesis, Lincoln University.

133 Unknown, www.Traceabilitytraining.food.gov.uk/module2/overview_2.html#.W4WwHegzY2w. Accessed 29/08/2018.

134 Narsimhalu, U., Potdar, V., & Kaur, A. (2015). A Case Study to Explore Influence of Traceability Factors on Australian Food Supply Chain Performance. Procedia - Social and Behavioral Sciences V.189, p17-32.

135 Vaché, D. (2010). Produce Traceability - Needs and Solutions. PowerPoint. United Fresh Produce Association of America.

136 2017, http://www.foodstandards.govt.nz/industry/safetystandards/traceability /pages/default.aspx. Accessed 29/08/2018.

137 Maurer, H., Dolan, M., & Arts, A-M. (2015). The New Zealand Produce Industry Food Safety & Traceability Framework Position Paper. United Fresh.

138 Bennet, R., & Maurer, H. (2017). The Fresh Produce Safety & Traceability Challenge - Current Reality, Emerging Trends and the Road Ahead. PowerPoint.

139 Staff (2015). GS1 - Traceability for Fresh Fruits and Vegetables Implementation Guide. GS1 Global.

140 Shinkfield, M. (2016). Food Safety and Traceability Across the Fresh Produce Supply Chain - PMA-ANZ Career Pathways Report, June 2016.

141 Staff (2015). Fresh Produce Safety Centre - Guidelines for Fresh Produce Food Safety.

142 Ruiz, J., & Ahern, J. (2004). Optimal Fresh-Produce Packaging: Cost/Production Analysis of Packing Styles in the Salinas Valley. Journal of Food Distribution Research, V.35(1), p169-175.

143 Staff (2017). Coriolis - The Investor's Guide to the New Zealand Produce Industry 2017. Report for the New Zealand Ministry of Business, Innovation, and Employment.

144 Staff (2012). Scientific Information Bulletin (SIB) March 2012 - Food Traceability. International Union of Food Science and Technology.

145 2018, http://www.daviddelpino.com/en/cambio-de-paradigma-en-las-frutas-y-hortalizas/. Accessed 28/08/2018.

146 2014, https://frugicom.nl/Portals/20/FIC_2014_2pager_ENG.pdf?ver=2016-02-09-105653-743. Accessed 27/08/2018.

147 2018, https://eufreshforum.com/. Accessed 27/08/2018.

148 Staff (2008). The Produce Traceability Initiative – 7 Milestones to PTI Implementation. CPMA/GS1 USA/PMA/United Fresh Produce Association.

149 2018, https://www.centerforproducesafety.org/Fgs1 . Accessed 30/08/2018.

150 Staff (2009). Food Safety and ICT Traceability Systems: Lessons from Japan for Developing Countries. Asian Development Bank.

151 2018, https://corporate.marksandspencer.com/media/press-releases/2018/m-and-s-raises-the-stakes-with-unrivalled-new-british-beef-Traceability-campaign. Accessed 27/08/2018.

152 2018, https://www.food.gov.uk/news-alerts/news/fsa-trials-first-use-of-blockchain. Accessed 27/08/2018.

153 2018, http://www.producereport.com/article/walmart-china-unveils-consumer-traceability-initiative. Accessed 27/08/2018.

154 2018, https://iegvu.agribusinessintelligence.informa.com/CO218428/Fonterra-trials-dairy-traceability-in-China. Accessed 27/08/2018.

155 2017, https://rctom.hbs.org/submission/digital-pork-bringing-blockchain-to-wal-mart-chinas-supply-chain/. Accessed 30/08/2018.

United Fresh
New Zealand Incorporated

Search United Fresh New Zealand Incorporated to connect with us on LinkedIn

www.unitedfresh.co.nz info@unitedfresh.co.nz 0800 507 555