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Preventative measures to combat food fraud and actively protect our New Zealand brand

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INTRODUCTION

This research report is a literature review of the current climate and future sociopolitical environment prevalent in New Zealand's food sector today. Specifically the possibility of food fraud on international and domestic produce is highlighted. The current actions that producers and companies are employing to prevent such adulterations or fraudulent activities along their supply chains is also explored.

Food exports, Year End 2017, accounted for \$30b of a total of \$76.3b of New Zealand's Gross Domestic Produce (New Zealand Trade and Enterprise, 2018) and as such is a link to our country's 'Taste Pure Nature' (Beef and Lamb, n.d.) image internationally. Ramifications and negative economic impact across the whole food and fibre sector in New Zealand is a possibility if incurrences of food fraud attached to a New Zealand product is detected.

Ultimately this research report aims to identify potential weaknesses or emerging risks and the resultant opportunities in our domestic and export food sector supply chains so as to avoid or limit food fraud opportunities. Understanding the increasingly complex natures of food supply chains and any current premeditated practices to mitigate food fraud is of high importance in our country's current food market. A further understanding of the many differing types of food fraud is imperative in understanding what producers and exporters are currently facing. Therefore this report looks in to preventative measures to combat food fraud and how the food and fibre sector, alongside government can actively protect our New Zealand brand.

METHOD

This report is a literature review which looks into recurring themes of food fraud and preventative measures. By analysing research articles, journals and past food protection conference transcripts main ideas were both compared and contrasted. As part of my research I talked to a number of primary industry representatives from Horticulture NZ, Beef and Lamb, A2 Milk, Oritain, Primary Sector Council, Plant and Food Research, trade representatives and envoys, Winegrowers and Agresearch.

This research report is divided into four sections, Part One highlights the current climate of New Zealand's food market and defines the multi faceted nature of food fraud. Part Two is a continuation of the current food climate including protection of food and leading into the future with recommendations if incurrences of fraudulent activity occurs. The latter sections combine to look at international and domestic case studies which aims to provide a suggested course of action or toolbox to mitigate and future proof a food producer or food business from possible food adulteration.

Part One: New Zealand's Current Food Climate

1.1 History to Present Day

Humans have altered the state of food for centuries to extend longevity or to improve taste characteristics. In Ancient Rome and Athens a litany of wine adulteration took place as it was mixed to enhance flavours and colours. Dating back to 1AD "The Romans even had a state system to prevent food fraud and root out poor quality ingredients" (Delgado, 2015, p.224)

With the trade of valuable spices, the act of adulterating food for economic gain began to gain traction as merchants diluted the spices with inferior substitutes such as ground nutshells. (Schumm, 2019)

In 1757 the Westminster Parliament drafted the first piece of public health legislation in England to "punish persons who shall adulterate meal, flour or bread" Scally (as cited in Lotta & Bogue, 2015, p117). In 1906 the first widespread commercial food law was passed by USA Congress the 'Meat Inspection Act' and the original 'Food and Drugs Act' prohibiting the manufacture and interstate shipment of adulterated and misbranded foods and drugs.(Schumm,2019)

In New Zealand one of the first recognised and reported food regulations dates back to 1882 where the Tea Examination Act sought to make mandatory 'the selling of pure tea, rather than that adulterated with sawdust or other additives.' (Dalley, 2013)

The first all encompassing New Zealand Food and Drug Act 1908 followed the U.S. a mere two years later.

With limited resources, the Department was restricted in its ability to fulfil its responsibilities under the 1908 Food and Drugs Act. Under the terms of this Act any departmental official was empowered to seize any item which appeared to be 'unwholesome or deleterious to health'. The peddling of patent medicines, in defiance of the 1908 Quackery Prevention Act, was a perennial problem, as was the adulteration of both food and drink. Disqui-

(Source: Dow, D.A. (1995). Safeguarding the public health: A history of the New Zealand Department of Health. Wellington, NZ: GP Print)

Today with the prevalence of and potential impact of food fraud being far reaching, an overwhelming international response to food fraud incidents has led to new regulation. Regulatory and industry co-operation in the form of public-private partnerships and innovative authenticity testing from dynamic companies worldwide has culminated to meet new food industry challenges.

Alongside The Fair Trading Act 1986, Commerce Act 1986 and the Australia New Zealand Food Standards Code 2014, the following current legislation pertains to food fraud and the safety of food produced in New Zealand-

- Food Act 2014
- Wine Act 2003
- Animal Products Act 1999
- Agricultural Compounds and Veterinary Medicines Act 1997



Food and Agriculture Organization of the

United Nations (FAO) The Future of Food Safety (2019)

While times have changed, the goal to protect the consumer is the same. (FAO,2019). The above legislation has two purposes, first and foremost to protect public health and secondly to facilitate trade including the all important access to overseas markets.

1.2 Food Fraud Defined

There are many differing definitions of food fraud due to the multi-faceted and constantly evolving nature of new threats arising. Turning to our European counterparts in a draft report the European Union (EU) “acknowledges that combatting food fraud is a relatively new issue on the European agenda” (Lotta & Bogue, 2015, p. 115)

The US Food Protection and Defense Institute (FPDI) adopted a working definition of food fraud as ‘Economically modified adulteration’(EMA). Further description of EMA by the United States Food & Drug Association (FDA) is “fraudulent, intentional substitution or addition of a substance in a product for the purpose of increasing the apparent value of the product or reducing the cost of production, i.e. for economic gain” . This definition is maintained by the Michigan State University ‘Food Fraud Initiative’ as “illegal deception for economic gain using food.”

Spink (2011, p.157) provides a more prescriptive definition whereby “Food Fraud is a collective term used to encompass the deliberate and intentional substitution, addition, tampering, or misrepresentation of food, food ingredients, or food packaging; or false or misleading statements made about a product, for economic gain”.

The above definition is all encompassing and agrees with the FPDI, Food Fraud Initiative and FDA definitions that all incorporate economic motivation and premeditated intent. It also further explains food fraud as non-compliance of food quality and food law.

We must also touch upon food adulteration-which according to the Merriam-Webster dictionary is a corrupt, debase or make impure by the addition of a foreign or inferior substance or element (as cited in Spink et al. 2011, p.1) as food adulteration and food fraud are used side by side and interchangeably.

1.3 Drivers of food fraud

Today, the food industry is struggling to make sense of new technology, climate changes, and uncertain economic times. It is responding to consumer demands for healthier food at lower costs for more people. (Metcalf, 2019, p.155)

These are among several factors which contribute to food fraud incidents alongside-

- **The growing length and complexity of today's supply networks-** Stepping into many supermarkets today, out of season fruit in the southern hemisphere is readily filled with imported goods. As Ho (2011) states "With globalization, goods and products can flow freely between regions, and countries. Therefore the food safety (and food fraud) problem is no longer a regional or national issue, but rather a global one."

Businesses must carefully choose who they wish to build a trusted relationship with, as geopolitical considerations of different countries come into play in every day business operations.

- **Regulation Controls-** it has been widely noted in many articles, the unintended consequence of raising tariffs against a country, can facilitate subversion of food products as false declarations of origin are made. This is used to ultimately evade tariffs and taxes. There is also "the belief that international criminal gangs are diversifying from drug trafficking and armed robbery into fraudulent foods. It is the realisation by these individuals there is money to be made in counterfeit food and the sentences associated are traditionally much lighter." (Hines, 2016, p.20)
- **Consumer Driven market expectation on price-** Consumers have become accustomed to variety and access at low cost, with marginal profit for suppliers, who are constantly engaged in reducing costs and maximizing profits'. (Lotta et al. 2015)
- **Economic Pressure-**The awareness of food fraud increased in 2009, as several cases (Fonterra-Sanlu melamine scandal 2008) and the General Office of Accountability report on seafood fraud that year, the FDA also had its first meeting on economically motivated adulteration. (Spink et al, 2011)

"As a consequence of the [2008] economic crisis, both consumers and businesses are focusing predominantly on price. Consequently for some consumers, quality and safety considerations are less important, increasing the opportunity for product counterfeiting". (Lotta et al, 2015 p.114) This is evidenced in European markets Coldiretti, the Italian Farmers Association has seen a fourfold increase in olive oil fraud since the worldwide economic crises of 2008. (Lotta et al, 2015 p.117)

- **Ever-changing technological advancement-** With the rapid development of technology, opening new channels and tools to criminals to covertly transact illegitimate deals. These innovations including refrigerated transport and warehouse systems that allow long distance distribution and long-term storage of perishable products often aid inter continental illegal supply chains.
- **Situational aspects-** These contributing factors, and many others, pose some very real challenges for the industry. And can be heightened in times of crises i.e. natural disaster or a poor cropping season where an ingredient is in short supply, triggering the motivation to substitute one input for another.

A comprehensive summary as denoted in the Elliott Review (2013), which was commissioned after the 2013 horsemeat scandal in the United Kingdom and EU shows the recent rise in food fraud is due in part to-

“Austerity; more criminals moving into the food arena; globalisation in supply chains multiplying the information needed for assurance and creating more opportunities for unscrupulous behaviour; increased diversity in our tastes as a nation; improved audit and testing information revealing incidence.” (Elliott, 2013,p.16)

With increasing drivers of food fraud, now more than ever, food fraud requires preventative and proactive action by all global market participants, consumers and producers alike.

New Zealanders leading by example

With an increasing prevalence of food fraud globally, a portfolio of countermeasures against food fraud including quality assurance testing and isotope testing is also on the rise. The following proactive people and companies are taking the lead and have adopted some unique and cutting edge technology.

Abacus Bio is a genetics company that investigates interactions between nutrition and genetics and the resultant impact on phenotype. This has the added benefit of genetic improvement. Abacus Bio has done numerous work with a honeybees, sheep, beef, dairy and finned fish industries.

Having recently partnered with Gemnetics, together they hope to provide software for animal and plant breeding. (Genetics forms alliance with AbacusBio to Enrich Breeding Software, (n.d.))

Companies such as Oritain and Agresearchs Rapid Evaporative Mass Spectrometer Ionisation Tool (REIMS) are also looking at molecular phenotype, which produces a unique fingerprint which can be attributed to the environment the animal was raised in. (Fulton, 2019)

All of the above companies can then prove origin of a food product, which is a key safeguard measure, considering New Zealand's high reputation of food and fibre production in the global agriculture sector.

Another effective strategy for food fraud mitigation is serialisation. "Serialisation is the process of "putting a unique mark on each product and packaging level to enable traceability." (Dingley, 2018) Common examples of serialisation are QR Codes and unique identifier codes, such as those stamped on some eggs in NZ as part of an initiative 'trace my egg' piloted by the NZ Egg Federation.

The visibility of such codes "facilitates authentication to assure consumers the product is genuine and protect the brand integrity." (Dingley,2018)

Increasing coverage of global food crime has highlighted the need to mitigate against vulnerabilities in food fraud supply chains. The use of unique codes, specific tests and audits all begins to add to deterring fraudsters away from products with these visual attributes proudly emblazoned on packaging as it increase their production costs.

1.4 New Zealand- the land of milk, honey and sauvignon blanc

"Despite the lack of a general definition of food fraud, the identification of the main features of each type of food fraud is an essential step in prevention. Each type of food counterfeiting provides unique challenges for business development and product protection" (Lotta, 2016, p. 117)

Below are examples of New Zealand food fraud-

Dairy

The most widespread New Zealand food fraud scandal on an international stage was the Fonterra Co-operative Group Limited and Shijiazhuang Sanlu Group Company Limited (Sanlu) joint venture in 2005.

Melamine was added to infant formula milk to increase protein levels. This led to a large public health threat as melamine can lead to the formation of crystals in children kidneys causing kidney failure. Tragically six infants died and a further 330,000 were affected. Monetarily Fonterra ended with its \$200 million investment in the Sanlu Group Company being written off. (Hargreaves, 2019)

Fonterra also pledged \$8.4 million as a donation for health in rural Chinese communities. Untold reputation damage to Fonterra and New Zealand, with a loss of consumer trust in one of New Zealand's largest food producing brands which can lead to unintended long term loss to other genuine New Zealand brands and food producers. (Fonterra pays \$8m to charity, 2009)

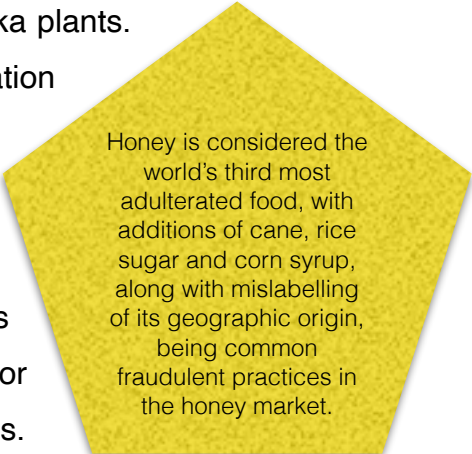
Honey

A comprehensive Macquarie University study noted a substantial mismatch between the amount of Manuka honey produced in New Zealand each year - 1700 tonnes - compared to the 10,000 tonnes sold. (Taylor,2018) Some of our international trading partners also raised concerns about the authenticity of New Zealand mānuka honey. The New Zealand Government responded with an extensive, three year, science programme. This resulted in a Government mānuka honey science definition to provide confidence that N e w Zealand mānuka honey is sourced from New Zealand mānuka plants.

(Mānuka honey sold in New Zealand: is further regulation needed?, 2018)

Wine

Due to a whistleblower December 2018 saw Peter Yealands prosecuted alongside staff, at his former wine company for adding sugar to wine destined for Europe due to unripe grapes.

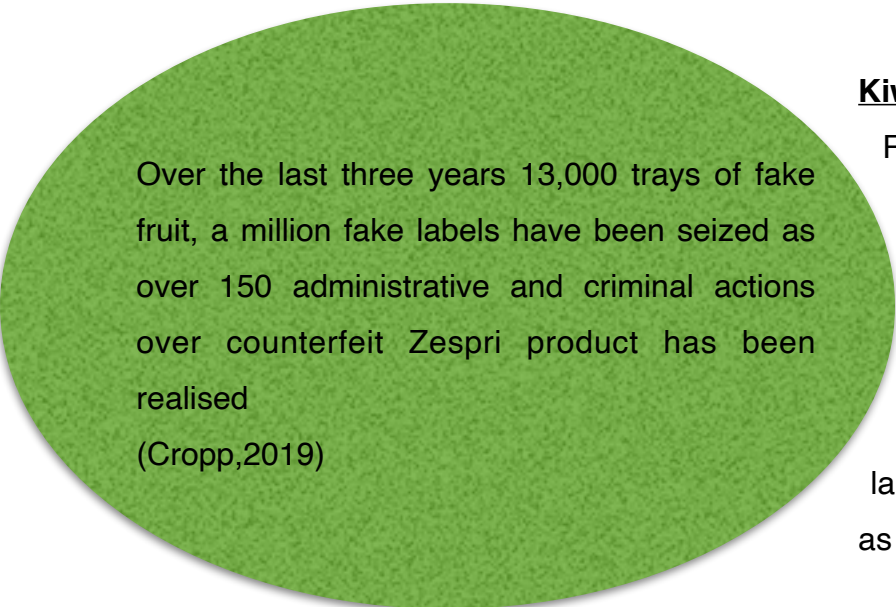


Honey is considered the world's third most adulterated food, with additions of cane, rice sugar and corn syrup, along with mislabelling of its geographic origin, being common fraudulent practices in the honey market.

EU rules make it illegal to add sugar to wine in post-fermentation. Yealands and his colleagues knew this but went ahead, with staff covering up the fraud and falsifying winemaking records for about 3.8 million litres of wine.

Yealands Estate Wines was fined \$400,000 under the Wine Act, and Yealands himself received a \$30,000 fine (Griffin, 2019).

False claims of provenance- Imported buffalo meat from India was falsely declared as beef from Australia and New Zealand: Imports of this kind of meat to the EU are forbidden because the food-and-mouth disease virus is endemic in Indian buffalos. (Buttice, 2006)



Over the last three years 13,000 trays of fake fruit, a million fake labels have been seized as over 150 administrative and criminal actions over counterfeit Zespri product has been realised
(Cropp,2019)

Kiwifruit

Recently six people were jailed in China for counterfeiting offences. Offenders operated a printing plant that made counterfeit packaging, and a group of traders in a major fruit wholesale market selling fake labels so local fruit could be passed off as imported. (Cropp, 2019)

Seafood

According to KPMG Consumer Trends 2019 seafood is one of the easiest frauds, given the complexity of the supply chain, the limited amount of testing in many countries and the consumer's relative ignorance. New Zealand's burgeoning aquaculture scene could be safeguarded in the future with isotope testing. Companies such as Abacus Bio are monitoring fish for genetic improvements and this phenotype profiling can aid in safeguarding against aquaculture related crime.

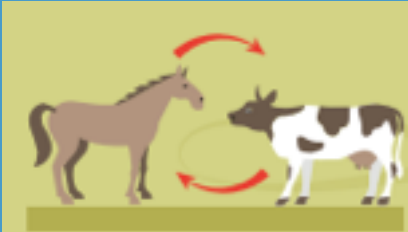

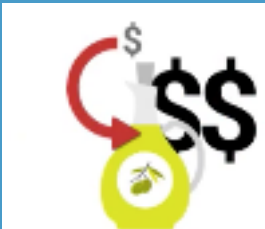

As demonstrated, the deliberate act of fraudulent adulteration of food is varied in nature and can yield complex unintended results from economic to tarnished reputation. Although






New Zealand is isolated geographically, our export driven market relies heavily on access to international food supply chains. Hence it is increasingly important that consumers and producers alike are educated and vigilant about food fraud.

1.5 Food Fraud Incident Type

Food fraud encompasses a wide range of deliberate fraudulent acts to food. Alongside food fraud examples in New Zealand and abroad we must understand the different types of adulteration to be able to respond proactively.

Figure 1- Overview of Food Fraud Incident Types

Fraud Type	Definition	Example
SUBSTITUTION 	Substitution of high value product with a lower cost commodity	Substitution of an entire fish fillet i.e. yellow fin tuna is a common example
ADDITION & Artificial Enhancement 	Addition of lower value ingredients, including unapproved enhancements(Adding unknown and undeclared materials to food products to enhance the quality attributes)	Melamine Scandal 2008
DILUTION 	Watered down products	Marketed as olive oil-when in actuality 93% canola oil and 7% olive oil
CONCEALMENT 	Hiding the low quality of food ingredients or product	Poultry injected with hormones to conceal disease

Fraud Type	Definition	Example
MISLABELLING 	Expiry, provenance (unsafe origin)	Mislabeled recycled cooking oil Refreshing a product expiry date
COUNTERFEIT 	All or some aspects of the fraudulent product are replicated	Lewis Road Creamery chocolate milk replicas with the same food safety assurances Kiwifruit with fake Zespri labels
ILLEGAL MARKET PRODUCTION: 1) THEFT 2) DIVERSION 	Legitimate product is stolen and passed off as legitimately procured	Cargo theft, could up label or origin-launder Sale of excess unreported product i.e. Chinese honey through Malaysia
FALSE CLAIMS 	False claims about a product for economic gain	Manuka Honey medicinal health benefits
ADULTERATION 	A component of the finished product is fraudulent	Yealands wine, where sugar has been added post fermentation

Source: Adapted from Food Fraud Quick Bites How Food Fraud Happens Retrieved from: (Everstine, 2011)

PART TWO: FROM FOOD ADULTERATION TO FOOD POISONING: The consequences of food fraud

2.1 The Distinction between Food Fraud and Food Safety-

In many studies participants food safety concerns were highlighted when describing examples of food fraud. Hence it is important to distinguish that many consumers may not distinguish the difference between the risks posed by food fraud and food safety incidents arising from non fraudulent activity. (Kendall, 2018)

Figure 2- Food Protection Table

Food Quality (a product that is saleable and generally meets the specifications of the consumer)	Food Fraud (economically motivated adulteration)	Motivation Gain: Economic
Food Safety (unintentional contamination of food ingredients)	Food Defence (encompasses the food systems resilience to intentional attacks designed to cause harm)	Harm: Public health, economic or terror
Unintentional	Intentional	
Action		
Source: Adapted from Spink and Moyer, 2011 (as cited in Food Protection Strategies- A New Zealand Approach, 2016 p. 5-7)		

As outlined below in the Food Risk Matrix, food fraud risk and food quality risk align with the motivation being economic gain, hence the common fraudulent activity of passing off food as a higher premium or valued product. Conversely we see Food Safety risk and food defence risk as a public health threat, as a nefarious act designed to inflict terror or economic harm. These risks are not motivated like food fraud or food quality by economic gain.

“Food protection is the overall concept that includes prevention, intervention and response for incidents in food quality, food safety, food fraud and food defence” (Spink, 2011,p. 3)

Food Protection can include protection from attacks, safety hazards, damage, from fraud, counterfeiting and protecting the continuous supply of products. (Spink, 2011)

Traditionally and most widely acknowledged is that food safety policy has been the highest priority on regulators agendas. It is only in recent years that food fraud has been recognised in food regulation guidelines, audits and subsequent control measures. This is consistent with Jo Goodhew's (Minister of Food Safety 2015) message acknowledging the notion of food safety, food defence, and food quality all coming into play when looking at an integrated food protection approach.

2.2 Food Security

In addition to the four subcategories of the Food Risk Matrix, there are many factors that contribute to the opportunity to commit fraud including Food Security. Food security and food safety are often used interchangeably. It is important to clarify the definition of food security as it holds a vastly different meaning to food safety which generally is denoted as the “unintentional contamination of food ingredients.” (Spink & Moyer, 2011).

Many definitions in multiple studies make the distinction between household food security, relating to purchasing power potentially due to a lower level of income right through to national and global food security as a whole.

Defra (2006) defines levels of food security as: “individual or household food security relating to purchasing power, which is determined by income, access to resources, and affordability of food; regional food security where regions are dependent on key distribution routes for food; national/trading block food security relates to the ability of a country or trading block to assess sufficient foodstuffs, even in the face of severe disruptions to the supply chain; and global food security,

that is, the ability of the world's food producers to meet global demand, and ensure the efficiency and effectiveness of global trading and distribution systems.”

One definition presented at The State of Food Insecurity 2001 defined food security as existing “when all people, at all times, have physical, social and economic access to sufficient, safe, nutritious food that meets their dietary needs and food preferences maintain for an active and healthy life.”

Looking to a New Zealand definition in a 1999 Ministry of Health research paper, food security “encompasses the ready availability of nutritionally adequate and safe foods, and the assured ability to acquire personally acceptable foods in a socially acceptable way” (Russell, Parnell & Wilson, 1999).

From above the addition of ‘socially acceptable’ is explained by the USDA (as cited in Gibson, 2012) as “without resorting to emergency food supplies, scavenging, stealing, or other coping strategies.”

2.3 Risks and Consequences of Food Fraud

Food fraud scandals have rocked the world transnationally. It can be from just one food fraud breach that resultant risks and often unintended consequences, that cause widespread fear which can affect how consumers view an industry as a whole.

Public Health Risk

As mentioned earlier food safety risk can be an unintended consequence and a first point of call when determining what remedial actions need to occur. There are three types of public health risk as follows-

1. Direct food safety risk “occurs when there is an immediate or imminent risk to the consumer, such as the inclusion of an acutely toxic or lethal contaminant.” (Spink, 2018 p.1)

2. “Indirect food safety risk occurs when the consumer is put at risk through long-term exposure, such as the build up in the body of a chronically toxic contaminant through the ingestion of low doses.” Health Risks from this can be pronounced due to the length of exposure. (Spink, 2018, p.1) The omission of beneficial ingredients can result in the same long term health risks.

3. Technical Food Safety Risk described by Lotta (2016, p120) is a non material risk where “consumers may be exposed because of the incorrect or misleading indication of ingredients and allergens”. Essentially the company cannot guarantee the safety of its product.

Aside from public health risks, two consequences of note that can result from food fraud are economic and sociopolitical.

Economic Consequences

Remedial costs of a food fraud incident can include food recall or traceback costs i.e. . “including advertising, stock retrieval, write off and destruction—and general loss of business. If consumers can switch to alternative, competing sources of supply or to substitute products, this may not represent a significant overall economic loss to society.” (Gadiel, 2010).

From a business perspective food fraud can also limit fair competition among enterprises, especially if fraudsters are constantly producing inferior products at a lower price point, with the same perceived quality. This can lead to competing businesses being pushed out and eventually shutting down.

Metcalf (2019) elaborates that food fraud and food safety “incidents share the same characteristics of the resultant cost of resource loss to the environment, cost of human lives from a spectrum of death to concern, fear and dread and the impact of the financial viability of food supply chains and individual organisations.” Hence food fraud costs can cause significant long term memories and taint public perception from just a single occurrence.

Sociopolitical Consequences

Unintended consequences of food crimes can be far reaching, even to the point of affecting trade partnerships. This is especially important for New Zealand due to our export driven primary sector.

This can extend to being problematic with joint business ventures in other countries. Take for example the botulism scare in 2013, where a possible harmful bacteria meant Fonterra had to do a product recall of infant formula in several countries. To approximate the many millions due to remedial costs is quantifiable. However, it is the unique social networks - guanxi in China - that could be as hard hitting financially and act as a barrier from future business ventures for Fonterra and other New Zealand businesses. (Trevett, 2014)

Guanxi “relates to the importance of relationships and loosely translated means 'you are who you know'. It is critical in China both socially and in business.” Mr Bill English says “guanxi is the reason why Prime Minister John Key's visit to China to meet its leaders is also critical to put to bed the string of scares relating to New Zealand milk.” (Trevett, 2014)

Why is understanding food fraud risks and consequences so important?

Once businesses have gained an understanding of the mechanisms, risks and potential consequences associated with food fraud, the natural progression is improved response.

Improved response= understanding and reducing past vulnerabilities(where food fraud may have occurred) and changing the underlying fraud opportunity factor/s. (Spink, 2011)

2.5 SUCCESS STORIES: What is New Zealand is doing to mitigate risks and possible cases of food fraud?

The more levels in a food supply chain or ‘hands’ the more opportunity for fraud. Narrowing the amount of hands a product goes through is one way of mitigating fraud. A second way can be to invest in science or technology as a preventative measure.

Collaboration, education and technology are needed to create a new, trusted food system. As Spink (2011) summarises, due to the multifaceted nature of food fraud, a multidisciplinary approach to combat it must be adopted.

Consequently and increasingly an entire market has grown around the implementation of traceability systems and food authentication as measures to counter food fraud. Beyond this are the benefits of these innovations from deploying food taste characteristics identified in food to specific markets with a preference for a certain flavour or characteristic.

Looking to New Zealand innovations from four different companies in this space-

ORITAIN

Forward thinking companies such as Lewis Road Creamery realised they had to employ Oritain to address fake Lewis Road Creamery products. They did this by creating a fingerprint of their product that represents its origin. Using forensic science Oritain's 'fingerprint' characterizes the unique properties of the product that exist due to its specific environment and this in turn can prove where your product was grown or manufactured. (Cochrane,2016) as cited in ("Food Fraud-the \$71 billion dollar question", 2016)

Ultimately you can then test any product in market or in the supply chain against this fingerprint to determine if it is genuine.

AgResearch's Rapid Evaporative Ionisation Mass Spectrometer (REIMS) Instrument

The REIMS instrument vaporises food products, including liquids using an electronic knife and measures the resulting vapour and over 2000 molecules per sample with a mass spectrometer. This testing then detects the 'molecular phenotype' of a sample and it is this unique 'fingerprint of molecules' resultant of genetics and the environment which has wide potential.

One of the potentials for food marketers is providing quality assurance of produce with detailed data that could be used for authentication, including incorporation into blockchains so that there is chemical as well as digital traceability to prevent food fraud. "We think this

will be a major opportunity for the NZ food sector ...generating robust data on provenance and could save NZ millions of dollars through early detection of quality problems and prevention of false labelling” Dr. Alastair Ross of AgResearch.

Aside from food fraud this data could be fed back into breeding programs to produce foods with certain characteristics. “We’re also finding that we can link the fingerprint to other factors such as consumer liking so in the future it can be possible to ensure that New Zealand agricultural products are not only guaranteed in terms of provenance and quality, but also will go to the market which best matches their desired flavour profile.” (Fulton,2019).

SAGITTO

Hamilton based Sagitto, tackles the issue of raw product quality with a hand held near-infrared spectrometer. Manuka oil makers use this scanner to test for quality. Kava growers in the Pacific Islands also use this to scan dried kava powder before blending and exporting.

Laboratory tests are used to create models for each type of organic material. The hand held scanner compares the producers food with the information already gathered about these food types. (Griffin, 2019)

TRACEMYEGG.CO.NZ

Innovations and traceability do not need to be made complicated as demonstrated by the Egg Producers Federation tracemyegg.co.nz scheme. This is to prevent caged eggs from being sold as free-range or organic, which sell for \$3 to \$4 more per dozen. Producers stamp a five-digit code on an egg’s shell. Two of the digits signify how they were produced — “FR” for free-range, “CG” for caged — the last three digits identify the individual farm. It’s a simple food-tracing system that is back up with annual and random checks on farmers. (Griffin, 2019)

What the above innovations enable New Zealand businesses to achieve is future growth due to a level of integrity in the food supply chain. This is due to the transparency with proven origin and quality authenticity which ultimately builds trust in a business brand.

As Proudfoot (2018, pg.17) states “Consumer behaviour indicates a preparedness to pay premiums for products with verifiable provenance and the attributes they consider important”. It is these cues of authenticity that are used by consumers to support decision making and ensure the integrity of the food they purchased and consumed is up to standard.

Innovations such as temperature trackers are getting increasingly cheaper and more accessible to smaller businesses. Real time data trackers are increasing, meaning technology can trace food back more efficiently through the supply chain to make a possible recall quicker and more targeted. This is important as many multinationals can go straight to the source of the problem and not recall many food items from their sometimes hundreds if not thousands of suppliers.

PART THREE: What lessons can New Zealand learn from overseas?

All recent memories and incursions of food tampering, misbranded foods and active ag terrorism encompass fraudulent activity which can send a brand, let alone a country into a tailspin. Here we look to two business case studies, one international and the other in New Zealand-

3.1 INTERNATIONAL CASE STUDY: Reputation risk ‘Brand Ireland’

Dubbed widely as ‘horsegate’ the Horsemeat Scandal of 2013 was centered in the European Union (EU) and was initially found by the Food Safety Authority of Ireland (FSA). The below case study outline is drawn from a recording of Alan O’Reilly presenting at a 2015 Food Protection conference in Wellington-

Fact Timeline

-In 2012 FSA started doing an authenticity study or emerging risk analysis for horse DNA in processed meat products.

-15 January 2013 it was reported that the FSA had identified horse DNA in frozen beef burgers sold in both British and Irish supermarkets.

-By late January it was ascertained that this scandal was not just limited to the UK, as 4.66% of processed beef products in the EU market contained greater than 1% horsemeat.

-European countries were implicated as the supply chain was traced initially from a processor in Luxembourg, who had bought it from France, the French broker had bought it from a broker in Cyprus which in turn had been purchased from a broker in the Netherlands and had been bought from Romanian abattoirs.

-Investigations suggested the adulteration was not accidental, but the work of criminals.

Food Fraud Drivers-

-Increasing prices of raw ingredients aided in an economic motive to commit this food fraud substitution. In 2013 it costed £0.99 per kg to process horsemeat vs £4.99 per kg for beef. The lower production costs of horsemeat consequently lead to a direct monetary gain on sale.

-The food chain or 'food maze' as referred to in numerous articles was facilitated by numerous brokers in different European countries. Active traceability and transparency by the end producer of consumer goods was not present in this supply chain.

-In Europe in 2013 horses did not have the same traceability as cattle.

Consequences of the Horsemeat Scandal-

- A public health threat concern was that a drug Phenylbutazone used to treat horses, and harmful to humans, could have entered the food chain. No levels of this drug was found.

-Economic consequences such as- Tesco market value dropped by £300 million overnight when it was announced burger patties in Tescos had tested positive.

-Negative brand impact on 'food brand Ireland'. As Ireland is similar to New Zealand in that it has an exports driven market with over 74% of produce exported. Hence this scandal culminated with the fact Ireland is the biggest exporter of beef in the northern hemisphere, had the potential to have huge economic implications country wide.

Resultant Actions-

-The EU Commission introduced the following five point plan- New measures to combat food fraud, strengthened monitoring programs, EU Database to be developed for horses (similar to beef), an increase in the penalties for food fraud and a new food fraud rapid alert system.

- A food fraud network was established by the then Directorate-General Health and Food Safety (DG SANTE) alongside the installation of a dedicated IT tool for food fraud related information exchange among Member States (Administrative Assistance and Cooperation System), the organisation of Coordinated Control Plans, dedicated training under the Better Training for Safer Food programme and the creation of the Knowledge Centre for Food Fraud and Quality. (First technical meeting of the Knowledge Centre for Food Fraud and Quality, 2018, p.4)

Key Learnings-

-Although a business may be managing a crisis, the need to balance responsibilities is paramount particularly as former CEO FSA Ireland states '**if you do not put consumers at the top of your decision making tree- you are failing your consumers**'

-In order for brand Ireland to regain some of its reputation they **maintained one or two points of contact** as their main crises communicators. This allowed for **consistent messaging**, in a time when news reporters were camped outside for six weeks wanting new information every day

-This case highlighted more than ever, the **need for traceability** in today's ever increasing food supply chains. Technology was very important as one manufacturer had thousands of customers.

-This case also highlighted the importance of a **food crisis management plan**, which Ireland had already formulated

-To combat food frauds multifaceted nature as highlighted by the subsequent Government commissioned 'Elliott review'. Professor Elliott introduced **eight pillars of food integrity**:

consumers first, zero tolerance, intelligence gathering, laboratory services, audits, government support, leadership, and crisis management.

-Recommendations in addition to this review refer multiple times to **intelligence sharing** between stakeholders, or the need for collaboration and not to work in isolation. (Minnens, Lucas & Verbeke (2019))

3.2 DOMESTIC CASE STUDY: 1080 laced infant formula-

Fact Timeline-

-In November 2014 a blackmail letter along with 1080 laced infant powder was sent to Fonterra and Federated Farmers stating if 1080 was used in New Zealand after March 27, 2015 “several New Zealand infant formulas and another formula will be released in the retail chain in the Chinese market and one other market with traces of 1080.”

-December 2015- The samples of possible 1080 laced infant powder were confirmed positive.

-February 2015 - Ministry for Primary Industries (MPI) holds meetings with 20 NZ manufacturers of infant formula ingredients about security and possible contamination and informs six international infant formula companies

-March 2015- MPI deputy director general Scott Gallacher and deputy police commissioner Mike Clement explained the blackmail threat to the public at a press conference

-October 2015 : A businessman is arrested and charged with attempted blackmail (Kenny, 2015)

Food Fraud Drivers-

-Economic gain, it was found that the perpetrator had a financial interest in 1080 competitor Feratox. If 1080 was removed from circulation, this aerially spread poison, would mean that Feratox, a ground laid poison would surge in business. (Taylor, 2016)

Consequences of the threat of 1080 laced milk-

-\$37 million was the total economic cost, with \$20 million spent by Fonterra and its insurers. \$5 million was spent on the police investigation, with the remainder spent by Government departments (Taylor, 2016)

Resultant Actions-

- Security was strengthened at retail stores and infant and other formula factories.
- An audit programme was implemented to ensure dairy processing facilities continue to maintain the highest level of security (“1080 blackmail threat”, 2019)
- Milk testing using robust methodology for monofluoroacetate analysis in fluid milk and powdered dairy products was developed and optimized. Between January and July 2015, some 136,000 fluid milk samples were tested using this method. This testing formed one part of a larger program of work by multiple agencies to ensure that consumers could continue to have confidence in the safety of New Zealand dairy products. (Cooney, Varelis & Blendall, 2016)

Key Learnings-

-This case study highlights the challenge of **addressing a food defence incident early** on in the investigation, especially where no existing tests exist to check for the presence of the reported agent in the supply chain. Also the need for police forces to work closely with food businesses early is clear.

-“The extent of **long-term damage** to Fonterra's brand, that of other dairy companies and the New Zealand export market **depended on how sophisticated Fonterra's communication** and marketing was during the recovery.” Due to a delay in telling stakeholders after a media announcement this could be a learning for Fonterra to look at for future incident communication (Brodie, as cited in Walters, 2013)

-A multifaceted approach was adopted here with many Government departments and industry **working together to achieve the desired outcome** of no release of the poisoned infant milk. Information sharing was prevalent in the recovery response.



3.3 Learnings that can be applied to protect brand ‘New Zealand’

Where we find ourselves today, is that “We have the beauty of hindsight and can learn from local and overseas incidents, to develop a protocol and guidance so we know what to do when faced with a food safety(and food fraud) issue.” Mike Chapman, CEO Horticulture NZ

In agreement with the above statement, looking to the 2013 horsemeat scandal and the 1080 laced infant poisoning, both highlight the importance of the following-

1) All countries need a Crises Communication Plan- Below are viewpoints of a plan in peace time or, no crises at present and amid a food fraud crises.

Figure 3- Overview of Food Crises Management Protocol

Food Crises Management in Peace Time	Food Crises Management during a Crisis
	
<p>-It is important to collaborate across agencies and formulate a protocol</p> <p>-This protocol describes points of contact, when and how to share information, reviews, annual meetings</p>	<p>-A developed and tested internal 'Disaster Plan' which facilitates timely actions during an incident</p> <p>-It is recommended to have a dedicated food incident management team e.g. FSAI Task Force was established to: provide advice, facilitate co-operation and share information</p>
<p>Source: Alan O'Reilly Former CEO FSAI,2015</p>	

2) Communication

There have been numerous studies on how to handle crises management and what information to release in a timely manner to the media.

Many studies agree with constant messaging by one or two people, as identified in the 'Inter Agency Protocol for Management in a Food Safety Crises' "It is critical that all agencies involved in the response to a food outbreak adopt a common approach to managing the release of information to the media. If agencies act individually, there is a danger that the message will get confused and that the crisis will be exacerbated as a result."

Consistent with the above, Queensland Health makes the following comments post the Australian food tampering case where needles were inserted in strawberries in 2018. The response needs to be collaborative, consistent and place public safety first. “It is vital that it is clear who is leading communication and careful management of messaging with an acknowledgement that communication out of step can be damaging not only to the industry but to investigations by both food regulators and the police.” (Strawberry Report, 2018 p. 14)

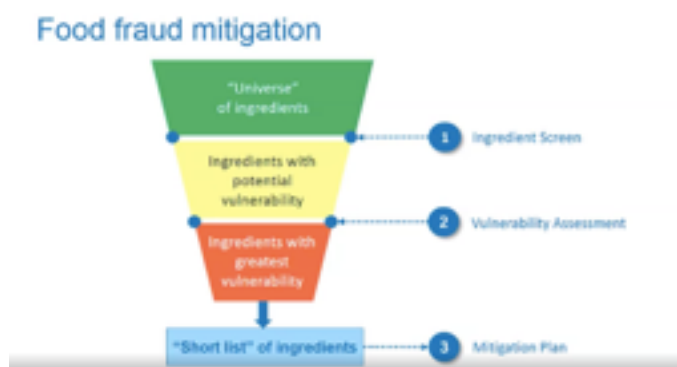
3) Vulnerability Assessments and Traceability Tools-

As highlighted in January 2016 World Food Regulation Review ‘ Ultimately, fraud prevention best practice boils down to due diligence. Food organisations have a duty of care to identify and mitigate any threat to the integrity of the products they sell’.

This is verified by Spink, 2016 who sees that this duty of care represents a proactive shift in focus from risk analysis towards vulnerability assessments to prevent food fraud or to ‘test the process and not the product’ .

Businesses can look to Vulnerability Assessments to identify any food fraud vulnerabilities in their supply chains. This type of assessment is defined by three key elements: opportunities, motivations, and control measures.

Figure 4- Food fraud mitigation and vulnerability assessment tools



By first narrowing down your raw ingredients. A business starts to create a short list of ingredients that will require a mitigation plan i.e. targeted testing, this means a business can start to understand if any weaknesses are present. A full vulnerability risk assessment can then be completed on your subset of the most risky ingredients.

Finally, nine different factors that can



Source: USP Food Fraud Mitigation Guidance

influence vulnerabilities are classified as low to high risk against your identified ingredients and processes and control measures can begin to be implemented.

Pictured is the UPS mitigation guide that provides guidance on assessments. Price Waterhouse Cooper (PWC) have created a free comprehensive online tool for businesses to use.

4) Information Tracking and Sharing

To maintain high standards of food integrity, we can harness technology to provide an added safety layer in our food supply chains. As demonstrated in the 2013 horsemeat scandal the need for a fit for purpose traceability system is essential for many food producers and companies today.

With large supply chains and multiple countries as customers, in order to provide our ultimate consumer with the comfort they are receiving New Zealand produced food we need to demonstrate our vigilance with a traceability system. This will also maintain our reputation as a gold star exporting nation.

An additional benefit of effective food traceability systems involves the improvement in food crisis management through access to integrated data covering:

The origin of ingredients, all stages of the supply chain, resources and actors i.e. brokers used to facilitate product movement.

By knowing where a product is at any given time, allows a business to avoid a blanket recall on all products post a food fraud crises.

Summary

Having an effective crises management plan, effect crisis communication from one or two points for a clear message, using proactive risk analysis and mitigation measures of a vulnerability assessment and traceability system all culminate to provide our food with integrity in the global market. As a by product of these measures we begin to see the development of a food safety culture with integrity at the core of its purpose

Food integrity ensures that food offered for sale is not only safe and of the nature, substance and quality expected but also it capture the aspects of food production, the way

it has been sourced, procured and distributed and being honest about this elements to consumers (Elliott, 2014, pg. 84).

In accordance with Alan O'Reilly's summation that during a crisis putting the consumer first is paramount, with the above premeditated tools and actions in any food company's arsenal a consumer-centric supply chain is gaining widespread adoption.

3.4 Thinking like a fraudster

Another viewpoint food businesses and regulators need to be cognisant of, is the people actually committing the food crimes. Fraudsters can range from single employees or suppliers right through to transnational criminal organisations.

Many studies have acknowledged the need to 'think like a criminal' in order to map your supply chain when completing a vulnerability assessment. This different viewpoint will aid in leading to a vulnerability control plan for the business.

Key stimulus's for fraudsters perpetrating a food crime according to Hines (2016, p. 21) are "two key factors: the motivation and capability of potential fraudsters and the vulnerability of target organisations."

In agreement with this, Shotton (as cited in Doward & Moore, 2014) further investigates the motivation perspective by saying criminal gangs would move into food fraud if they were attracted by one of two factors. "Either a product is high value but low volume and you want to replace certain elements to make more of a profit, or it is low price [but] high volume, where economies of scale dictate that if you can shave a penny off a product and you are selling a million products, you've made a substantial amount of money."

Mueller (2007, para. 5) understands a further incentive for food fraudsters by stating "It has been suggested that the profits from olive oil fraud are comparable to cocaine trafficking but with none of the risks".

Although we do not have a stereotype of a typical food fraudster, their intelligence and high level of deception is maintained by Jo Goodhew (Minister of Food Safety 2015) when she stated at the 2015 New Zealand Food Safety conference “ typically a person connected to the food chain, who knows how to and when to do it and try to deceive others”.

"The most surprising aspect is the ingenuity," Stuart Shotton further explains "You've got some very clever people – food technologists; people who are experienced in the industry – who are making decisions and changes on a scientific basis to figure out what they can do to a product to increase its commercial viability."

One such example of an inordinate level of deception is the American Company Sun Up Foods.

Figure 5- Illustrative Food Fraud Example

Illustrative Example—Sun Up Foods and the Secret Sugar Room

From 1985 to 1990, Sun Up Foods, Inc., a processor and wholesaler of frozen juice concentrates in Kentucky, U.S., sold more than \$100,000,000 of "unsweetened" orange juice concentrate that was fraudulently diluted with 10%–20% beet medium invert sugar. Beet sugar was used in this incident instead of cane sugar to make detection of added sugar more difficult. The processing plants involved were cleverly designed and operated to conceal from inspectors the addition of beet sugar to the orange juice concentrate. An electrical control panel was uncovered in this incident (Figure 2) that was used as a secret door into a storage room where holding tanks were used to store the liquid beet sugar. Deliveries of the liquid beet sugar were often accepted under the cover of night when regular production and sales staff were not present. The liquid beet sugar was cleverly invoiced from a broker who billed Sun Up Foods to make it appear that they were buying "orange concentrate" instead of sugar. Additionally a stainless steel piping system was engineered to secretly connect the liquid beet sugar tanks to the seemingly legitimate processing lines by hiding them in the walls and making them appear like part of the sewage system (Figure 3). During inspections, the hidden line carrying sugar could be shut off and an outside pipe closed to conceal the sugar line hidden inside.

In this particular case, numerous pieces of evidence uncovered during the investigation were used to substantiate the fraudulent activities of Sun Up Foods, Inc. This included the equipment and structure of the facility designed to conceal the liquid beet sugar, records uncovering the purchase of the beet sugar, information provided by former employees of Sun Up Foods, and analytical testing results from a customer of Sun Up Foods suggesting that the product was adulterated with beet sugar. This example illustrates the ingenuity and extent of deception used to conceal fraudulent practices.

Source: (United States Pharmacopial Convention (2016), Food Fraud Mitigation Guidance)

The above example sets the scene for food fraud deception 30 years ago. With the advent of technology rising at a fast pace, it lends us to turn ourselves towards computers, artificial intelligence, real time smart trackers to help optimize our increasingly global supply chains.

Further areas of investigation to combat fraudsters have been highlighted in numerous studies by John Spink and Douglas Moyer. (2013 p.34). "Food fraud is a crime of opportunity. Criminology provides a frame for assessing food fraud incidents and

formulating strategies to reduce the fraud opportunity.” Once an incident had occurred, a vulnerability assessment and appropriate control measure, even a minor countermeasure built into the supply chain or food processing system “ can cause potential fraudsters to move on to another target (i.e., crime displacement).” (Spink et al. 2013)

3.5 The tech factor

What will future threats look like to New Zealand?

“Disruption in the agri-food sector is coming from computer scientists,” said Julia Jones. (Opportunities in fast changing agri-food, DairyNews) Although meant in a positive light this statement could not ring more true for hackers alike.

With processing lines incorporating combos (robots that work alongside humans) and black supermarkets becoming more commonplace, looking to the food industry and the industry control systems (ICS's) used to process or manufacture food is vital to ensure security on these often closely guarded systems.

‘Compounding the issue in the food industry is that...many food industry ICS's use outdated operating systems (OS's), (Streng, 2019) . As Food Protection and Defense Institute researchers found, many of these already outdated OS's do not have security adequately incorporated into their design.

Relating to the food industry many companies have intellectual property in the form of recipes embedded in their ICS's, the slow bleed of revenue from copy-cat products could weaken a company.

Further to this, operating technicians on processing lines alongside their employers may know how to operate the processing line. The real threat is that ‘ICS cybersecurity standards although well known, their complexity and volume overwhelm most operating technicians, as they are trained in food safety and production and not cybersecurity.’ (Streng, 2019)

Opportunities for collaboration

Turning to New Zealand we can learn from the Food Industry ICS Security Architecture Development Workshop convened over by FPDl which pointed out that companies and governments agencies too often work in isolation, ignorant of each others efforts. This disconnect handicaps cybersecurity efforts by everyone involved.

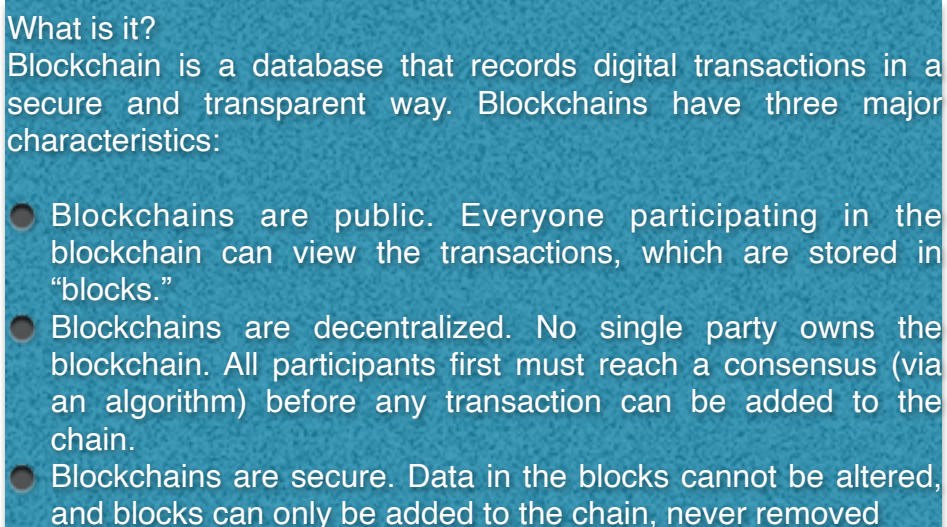
Furthermore by extending your businesses food safety and food defense culture to include cybersecurity. A more cohesive approach across companies could occur if technicians and IT staff can communicate and jointly conduct risk assessments on hardware.

3.6 Blockchain

With the buzzword 'Blockchain' surrounding food supply chains, it is important to look at how many different hands i.e. people or companies a product passes through in its life cycle.

The use of blockchain in the food industry is still in the early stages. Increasingly much research and development is being placed upon this as a form of supply chain management and an almost silver bullet type solution traceability tool.

Figure 6- Overview of Blockchain



What is it?
Blockchain is a database that records digital transactions in a secure and transparent way. Blockchains have three major characteristics:

- Blockchains are public. Everyone participating in the blockchain can view the transactions, which are stored in "blocks."
- Blockchains are decentralized. No single party owns the blockchain. All participants first must reach a consensus (via an algorithm) before any transaction can be added to the chain.
- Blockchains are secure. Data in the blocks cannot be altered, and blocks can only be added to the chain, never removed

(Source: Blockchain for Food Safety: From Pilots to Reality, 2018, 22 January)

However, blockchain is not unsusceptible to attack and has its limitations as attested to by futurist and Professor Robin Metcalfe (2019, p. 149)

“The more open our food system becomes and the more data collected within the supply system which is visible, the more vulnerable our global food system may be to hackers, adulterers and anyone else wishing to stall or bypass our food supply chain.”

Many articles and studies are of the view that we are still in the early days of blockchain. In particular, the food sector has not yet determined the right balance between public and private blockchains. Food businesses therefore need to form the right model before blockchain can reach its full potential for enhancing food safety.

Part Four: REAL WORLD PRACTICE

As Jo Goodhew (MP Food Safety 2015) recognised the “ Embracing sense of protection that we must bring into our food that puts the consumer at the forefront of everything we do....technical advances and globalisation have had profound impact on production and supply chains, our response must be defined by co-operation.”

The Elliott Review (2013, pg. 18) strengthens this by stating-

“I have found there to be general agreement that in modern markets, legal requirements, although important, should not be regarded as the first line of defence against food crime. Prevention of food crime needs to become an industry wide culture.”

This above research and case studies lend credence for the need to build a proactive toolbox. This toolbox should encompass cross agency collaboration to address food fraud mitigation opportunities with an integrated protection approach which leads to high food integrity.

4.1 Current procedures for food safety and food fraud in New Zealand

Regulators are supporting food businesses with the following:

Ministry for Primary Industry's (MPI) New Zealand Food Safety website provides a wealth of information on:

- How to become a food safety officer, establishing Food Control Plan templates and verification guidelines
- Food Safety Registers- Find details of operators, businesses, and individuals that are registered, recognised, approved, or listed under laws administered by MPI
- MPI Hazard register and recalled food products register
- Developing a Food Recall Plan. In addition to this, MPI may decide to make a privileged statement in conjunction with a recall, to further inform the public.
- Having learnt from doing business in China, MPI has also released a guide for New Zealand business on how to operate in China. It includes joint ventures in a Chinese market and contacts to help your business

- Smart and adaptable regulation. The new Food Safety Prevention Strategy Draft released September 2019 is a step in the right direction in dealing with Food fraud, Safety, Security, Defence and Quality

- International Collaboration-Food Standards Australia and New Zealand (FSANZ) is making huge strides in this area looking to Codex Alimentarius Commission international food standards, and being a part of many International Liaison Groups (Asia Pacific Economic Cooperation Food Cooperation Safety Forum and the Joint FAO/World Health Organisation Expert Committee on Food Additives)

At industry and business level New Zealand businesses can:

- Look at FSANZ's Food Safety Hub**

-**Foster co-operation** a recurring theme in this report has been the need to address cross-agency communication and coordination and enhanced information sharing and transparency

-Subscribe to MPI's Food and Science Research, be aware of new incursions on the hazard register and **know who to contact and how to report any food fraud** to minimize breaches and incurrences when they happen

-Provide stringent training and ensure adherence to your companies Food Control Plan

-**Partner with companies such as** Oritain and AgResearch so as to set up transparency of your supply chain through innovative food science testing

-Look to resources such as SSAFE Price Waterhouse Coopers (PWC) free food fraud vulnerability assessment toolkit.

-**Partnering with food safety certification providers** such as BSI audit. BSI audit is recognised by MPI to verify:

Custom Food Control Plans

National Programmes

Template Food Control Plans

-Or **look to international standards such as Global Safety Food Initiative (GSFI) Certification**. Companies such as SGS offer an independent audit service to audit your food safety systems to get them certified against GFSI standards, thus allowing the benefits of enhancing entry into new offshore markets

4.2 Conclusions

Food fraud is increasing in prevalence worldwide. It is of particular concern to the primary industry given New Zealand's reliance on access to overseas markets. By educating producers and consumers alike, as to the multi-faceted nature, risks and mitigation options of food fraud we can gain an understanding of what food producers and exporters are currently facing.

Further understanding the differing levels or types of food fraud incidents, alongside the key distinction that not all food fraud has a public health risk attached, enables us to see what efforts need to be put into place to further safeguard our food supply chains.

As highlighted in January 2016 World Food Regulation Review ‘ Ultimately, fraud prevention best practice boils down to due diligence. Food organisations have a duty of care to identify and mitigate any threat to the integrity of the products they sell’. This type of stewardship of our food production, necessitates a corporate social responsibility for companies to proactively look at and manage vulnerabilities in their own food supply chains.

Understanding the drivers of food fraud including globalisation, economic motivations of single or transnational criminal organisations allows businesses is imperative. By utilising traceability tools and conducting vulnerability assessments as part of daily business operations enables an improved response to mitigate a potential food fraud opportunity, this in turn, begins to foster a food protection culture.

Fit for purpose countermeasures, such as real time data trackers and isotope testing in food supply chains, lends credence to food integrity, as transparency and traceability culminated with education, produce an integrated food protection strategy. Robust regulation and discussion is needed to facilitate food fraud mitigation standards.

A recurring motivation in this research, was the need for businesses and separate industries to avoid working in isolation. With the aid of Public-Private partnerships alongside industry bodies and government collaborations , companies can further protect our nations food and fibre sector. In addition to this, as a nation, we need to learn and combine with our overseas partners to engage and be part of food incident reporting databases and working groups.

4.3 Recommendations

An integrated Food Protection Strategy in a supply chain does not need to be complex or resource intensive if there is a focus on optimizing current activities. (Lotta, 2016). With

this in mind, in order to develop a fully integrated food protection strategy and enhance food safety culture to combat food fraud in New Zealand, the food sector needs to:

1. Take accountability for their supply chain and the resultant actions that are deemed harmful against consumers. Meaning businesses big and small, engaging in proactive assessment measures regularly and actively mapping their process supply chain end to end.
2. Build upon current research and development, both in public and private sectors. With the view to complete an extensive review of a food fraud vulnerability classification matrix for New Zealand food producers and their unique products.
3. One of the first steps to enable this is to create a task force or working group. This group can oversee possible policy development, vision for a strategy, and an implementation plan. The strategy should consider current and possible resources that can be mobilized to focus on this issue of food fraud.
4. Encourage industry bodies and government agencies to conduct regular Emerging Risk Analysis on New Zealand food products such as FSAI has done
5. Looking to food defence culture, businesses need to implement specific strategies and action plans in their specialised business situation. For example if your food manufacturing business is heavily reliant on computers, implement cyber security measures that can be understood by relevant staff
6. For efficient and effective food fraud prevention, Public-Private Partnerships are becoming increasingly important. An important first step – as Michigan State University Food Fraud Initiative and MPI did for 2015 Food Protection Conference where stakeholders were gathered and a central working document was created as a result.
7. Inform and communicate effectively to consumers the complexity of the food system, the challenges of a new environment and how we are meeting them through innovation. We need to take the consumer on a journey with us. By communicating internationally on New Zealand's position on food fraud i.e. food protection of the physical food exported we

start to foster a visible food defence culture which creates trust in our already highly regarded food system.

8. As a bold nation New Zealand companies and government agencies need to make a commitment to truly daring moves to track the movement of food, such as those made by food logistics organisations tracking food to disaster relief sites during natural disasters and military conflicts (Metcalf, 2019)

9. And finally: Become involved. The food industry needs more representation. Of course underpinning all of the above is innovation and behind this is our people. Food production and the primary industry is facing unprecedented disruption. By investing in our people this will aid in New Zealand's contribution internationally and help develop pan sector and international co-operation to food fraud problems.

How New Zealand adds to and strengthens our competitive advantage in the international food market is through food protection and the development of a strong food defence culture which identifies food integrity at its core. **There is a huge amount of work on the ground already, that we can build on collaboratively. We cannot afford to get this wrong.**

Today food is produced in greater volumes and distributed over greater distances than ever before.

As a consumer-your tastes and preferences shape what food producers grow. Widespread collaboration and contributions of all actors across the food supply chain is imperative...

'Food Protection is everyone's responsibility.' FAO, 2015

Will you come on the journey with us?

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