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Current Status and Potential Economic Effects of Food Traceability in Australia[1]

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Abstract

Australian Governments and agricultural industries are advocating for a wider use of food traceability to assure domestic consumers and food importers that our products are safe, clean and sustainable. Improvement in traceability functions will need to be driven by financially sound commercial reasons. The role of Government in this regard is relatively limited. Two illustrative case studies have highlighted the potential economy-wide benefits of the widespread use of food traceability. They have shown that the benefits of an avoidable loss of productivity growth of labour in the Australian economy of 0.1 per cent due to improved food safety (resulting from increased adoption of food traceability) could potentially lead to an estimated rise in GDP of 0.06 per cent relative to what would otherwise be the case. These effects are expected to result from widespread adoption of traceability reducing the incidence of foodborne illnesses. Furthermore, an assumed expansion in Australian farm exports by 1 per cent over the medium term from the widespread adoption of traceability technology along the food supply chains could potentially lead to an estimated rise in GDP of 0.11 per cent relative to what would otherwise be the case.

***Key words*:** food traceability, food safety, market access, economic effects, GTAP model

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Introduction

Drought and other disruptions adversely affect Australian farm output, exports, and profits. Historically, these variables have shown volatility due to seasonal variability and fluctuations in global market conditions. Less volatile supply of agricultural output to export markets, in quantity and quality, helps in maintaining export trade, with benefits throughout the agricultural value chain, from the final consumers to producers. Enhancing the 'brand name' *Australian farm sector as a reliable and trusted exporter of premium food and agricultural products*, implies several attributes of the term 'trust'. The 'brand name' is advocated and promoted by the Australian Government together with the industry to assure our trading partners of our world-leading sustainability credentials supported by enhanced food traceability[2].

The 'trust' attributes include food safety and quality, and reliability in meeting seasonality gaps and disruptions, quality assurance, consumer experience characteristics and food integrity and guaranteed provenance of farm supply and exports. These 'trust' attributes are characteristics of a product that are neither verifiable by simple inspection, nor consumption, of the product. Collectively, knowledge of these attributes is facilitated and increased by 'traceability'. Food traceability has been defined as the ability to track any food through all stages of production, processing, and distribution (including importation and at retail)[3].

The Australian Government recently developed a national food traceability framework[4] and this work is continuing. This has been complemented by similar initiatives at State levels, for example in Victoria[5].

Agriculture Victoria[6] points out that the need for traceability in a farm business can be explained using six key drivers. These drivers include food safety, biosecurity, market access, provenance, certifications and product attributes, and supply chain efficiency and quality. These drivers fall into three broad categories, namely compliance and regulation, brand building, and production (see Figure 1).

According to Dodd (2021, pp. 11-12), there are numerous reasons why businesses seek to utilise traceability, including:

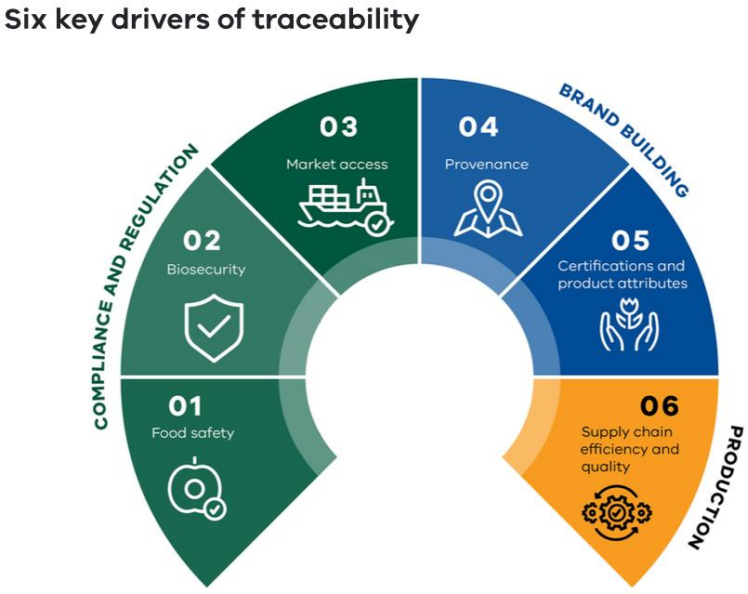
- 'mitigating business risks, ensuring national and international importance to the "Australian" brand, strengthening trading partnerships (both domestically and internationally),
- addressing concerns about human rights in supply chains, ensuring regulatory compliance including "due diligence" and "truth in labelling,"
- ensuring sustainability certification, including carbon footprint, facilitating market access using export certificates and meeting importing country requirements,
- providing better access to product information, that can also be in real time, ensuring product auditing and certification,
- ensuring supplier selection and supplier relationships for securing quality product supply, achieving operational efficiencies and process consistency,
- strengthening product claims (e.g., species, standard fish name, country of origin labelling (CoOL), provenance, gluten free, good source of/high in omega 3), ensuring food safety and

[2] https://minister.agriculture.gov.au/watt/media-releases/traceability-grants
[3]https://www.foodstandards.gov.au/industry/safetystandards/traceability/pages/default.aspx#:~:text=Traceability%20is%20the%20ability%20to,point%20in%20the%20supply%20chain.
[4] https://www.awe.gov.au/biosecurity-trade/market-access-trade/traceability-project
[5] https://www.premier.vic.gov.au/traceability-boost-backs-paddock-plate-success-story
[6] https://agriculture.vic.gov.au/export/traceability/what-is-traceability#h2-0)

quality assurance (QA) including mass balance, antibiotics, heavy metals, biotoxins, allergens etc,

- facilitating product recalls / market withdrawals / public health trace-back, ensuring consumer protection, assisting in marketing and promotion, meeting shareholder expectations and requirements, and
- using competitive advantage to be able to comply with any of the above.'

Figure 1. Key drivers of traceability



Source: Agriculture Victoria (2022)

Given this background, the aim of this paper is to briefly describe the status of food traceability in Australia, examine the constraints and challenges associated with the adoption of food traceability and assess two potential economic effects of enhanced food traceability.

The paper is organised as follows. Section 2 provides a brief description of recent examples of the use of traceability in different food sectors. Challenges and opportunities associated with the adoption of food traceability are canvassed in Section 3. Section 4 provides a quantitative assessment of the potential economic effects of enhanced food traceability in two areas. The final section provides some concluding remarks.

Use of Food Traceability: Some Examples

There are many applications of traceability systems in place across a range of farm products in Australia. Many of them are at a pilot stage. The products involved range from citrus fruits, table grapes and apples, to livestock and dairy commodities. Some examples are discussed below.

Citrus

In 2021 the citrus industry undertook a pilot project to use leading tracing technology, isotope testing of Australian fruit (to differentiate place of origin of Australian citrus fruit to prove provenance down to the individual farm and region), cool chain tracking and orchard mapping to enhance traceability. That project traced fruit from Nu Leaf I.P. orchards in Mildura, through the Mildura Fruit Company

(MFC) packhouse[7], and on to international consumers[8]. The project was aimed at expanding into new markets over the longer term, using unique labelling of cartons and bags, so safeguarding the citrus industry from counterfeiters in overseas markets and ensuring the integrity of high-end citrus exports is protected.

Mangoes

A traceability system using blockchain technology has been tested in 2020 as a pilot project co-funded by the Cooperative Research Centre for Developing Northern Australia (CRCNA) in partnership with Trust Provenance (T-Prov), a large mango producer, Manbulloo and industry group Growcom. Using GS1 Australia standard for product ID, real time data (on where a product has come from and how it has been managed along the supply chain), such as time, temperature and location were tracked, transmitted, and uploaded to the blockchain where Manbulloo and other supply chain participants could then access the information which provided instant traceability[9].

Cherries

To achieve product integrity and prevent counterfeiting, Reid Fruits (one of Australia's largest cherry producers and exporters) has applied Laava's patented Smart Fingerprint technology[10] on its cherry boxes for 20 export markets during the 2019–20 season. It used advanced computer vision technology developed in collaboration with CSIRO to produce a unique 'fingerprint' that can be scanned by any smartphone[11]. Benefits of the technology are expected to include prevention of counterfeiting, loss of sales and reputation of the firm, trust and transparency for consumers, and assurance of safety and security for brands.

Melons

In 2022 a collaboration between the New South Wales Department of Primary Industries (NSW DPI), Melons Australia, GS 1, along with the support from SMA Marketing[12], FreshChain[13] and Woolworths developed a traceability adoption framework for the melon industry. Using this framework, seedless watermelons in the domestic supply chain have been trialled in a track and trace pilot involving a Queensland watermelon grower. This traceability effort was aimed at improving melon traceability and supply chain monitoring, as well as assisting to avoid food fraud and engage consumers.

Grapes

A partnership between the Australian Table Grape Association (ATGA) and Agriculture Victoria has led to a pilot project to strengthen table grape traceability for high-value export markets[14]. It aimed to build, diversify, and protect exports by developing producer-to-consumer traceability. This involved a

[7] MFC packs and markets a wide range of citrus varieties from over 140 growers in the horticultural regions of Sunraysia, Riverland and Riverina to destinations around the world. They pack around 3000 cartons per hour.
[8] https://citrusindustry.net/2021/10/14/australia-fruit-traceability-project-for-exports/
[9] https://www.treecrop.com.au/news/blockchain-tech-key-cost-savings-manbulloo-mangoes/ and https://www.crcna.com.au/news/new-sensor-tech-tracks-mango-journey
[10] https://laava.id/cherry-red-reid-fruits-combats-fraud/
[11] https://laava.id/reid-fruits/
[12] SMA Marketing (SMA) represents nine watermelon-growing companies across Australia (see https://www.smamarketing.com.au/)
[13] FreshChain is a paddock to plate assurance system that uses blockchain technology to verify the food you eat (see https://www.freshchain.com.au/)
[14] https://australiangrapes.com.au/atga-secures-major-pilot-project-on-traceability/

traceability process including labelling and integration with cool chain tracking, to help maintain and elevate safety and quality for consumers and leverage the value of Australian export brands.

Livestock

The National Livestock Identification System (NLIS)[15] is a key part of the livestock traceability system for tracing cattle, sheep, and goats. This system is critical to facilitate responses by government and industry in the event of an animal disease outbreak or food safety incident. The current national NLIS system for sheep and goats is based on a mob-based system; and visually readable ear tags printed with a Property Identification Code, movement documentation, and recording of mob-based movements on the NLIS database are used to trace sheep from property of birth through to processing or export. In 2017, Victoria commenced a staged implementation of an electronic individual identification (EID) based system for sheep and goats[16].

Dairy

The Australian Dairy Industry Implementation Guideline was developed in 2021 to help manage and improve traceability for the Australian dairy industry[17]. The traceability guideline outlines a standardised approach for the Australian dairy industry to track and identify product as it runs through the supply chain. Information gathered would then be distributed through a network using a distributed ledger system. The guideline has been developed by the Australian Dairy Farmers (ADF) in collaboration with GS1 Australia, as well as a series of industry supply chain workshops and validation with a global food company. ADF is planning to use a blockchain-based traceability system. This should result in a highly transparent system that ultimately saves money for anybody using it, in addition to allowing for ease of use[18].

Wool

With the increased threat to Australia of Foot and Mouth Disease (FMD) after recent detection in Bali[19], the peak grower body, WoolProducers Australia have indicated their support for a fully integrated national traceability system which meets the National Traceability Performance Standards, and has policy to accept the implementation of individual digital/electronic identification of livestock only when the following system enhancements have been implemented: the establishment of a nationally harmonised traceability system that operates according to nationally consistent business rules; investment in a database capable of handling all farmed FMD-susceptible livestock species; and the creation of an equitable funding arrangement for both the establishment and ongoing maintenance of an enhanced system[20].

Seafood

[15] https://www.nlis.com.au/ , https://animalhealthaustralia.com.au/traceability/ and https://vcm-international.com/wp-content/uploads/2014/09/Australias-Traceability-System-Case-Study-August-2014.pdf
[16] https://sheepproducers.com.au/policies/
[17] https://australiandairyfarmers.com.au/wp-content/uploads/2021/09/Dairy-Traceability-Implementation-Guideline-Sept-2021_v01.pdf , https://australiandairyfarmers.com.au/blockchain-and-real-time-payment-system/ and https://www.dairynewsaustralia.com.au/news/new-traceability-guideline-for-australian-dairy/
[18] https://www.foodprocessing.com.au/content/materials-handling-storage-and-supply-chain/news/dairy-group-applauds-moo-ve-to-adopt-traceability-guideline-1519482186
[19] https://www.theguardian.com/australia-news/2022/jul/12/foot-and-mouth-disease-fmd-australia-government-backs-electronic-tagging-sheep
[20] https://www.woolproducers.com.au/post/woolproducers-australia-calls-for-government-action-on-traceability

In 2020, a Commonwealth Department of Agriculture, Water and Environment grant to ANSTO enabled the development of a portable technique as an advancement of current lab-based methods for determining seafood provenance along the supply chain. It involved developing a technology which was based on a portable scanner that uses X-ray fluorescence (XRF) to identify the elements in a seafood sample, which was then used to confirm its origin. Each type of seafood has a unique fingerprint that relates to the specific environment in which it was bred and fed[21].

There are number of traceability technology tools/systems being used in Australia[22] and several of them are presented in Box 1.

Challenges and Opportunities

Challenges

Adoption of traceability techniques can be hindered by the lack of connectivity between agents and steps in the food supply chain which results in poor chain coordination. This hiatus has become known as 'chain failure' and is related to (i) a lack of digital literacy among some farmers in the supply chain, (ii) the lack of capital to invest in on-farm Information Technology and traceability systems, and (iii) a paucity of demonstrations to illustrate the value of sharing data using traceability tools. These gaps in traceable supply chains illustrate the importance of improving joint responsibility of sharing of data (see also Zhang et al., 2020).

The key focus of food traceability needs to be at the wider industry level rather than being at the level of the individual farmer. In this regard, it is seen that more robust traceability adoptions have been developed in the areas of the horticulture, vegetables, dairy and livestock Industries. This trend has arisen because the firms at the end of the supply chain are large and economically robust supermarket chains and export markets. These organisations have the capability to promote, design, implement and maintain commercially viable traceability systems, which are necessary to support their desired market reputation as quality product suppliers. In contrast, the likelihood of a similar adoption of traceability systems among Small and Medium Enterprises (SMEs) is relatively low because of lack of understanding behind traceability functions, and the high set-up costs of reliable food traceability systems.

Opportunities

Arising from these observations is the recognition that the adoption of traceability systems is largely a commercial decision underpinned by the associated commercial benefits of traceability. We note that the role of Government in this regard is relatively limited, but this situation may change if there is a nationally serious 'market failure' arising from a supply chain failure, possibly caused by the breakdown of key aspects of traceability along the chain. If there is some form of significant market or information failure along a food supply chain which becomes evident at the market level, then there may be a case for intervention by the Government to prevent significant societal distress. The underlying low adoption of traceability may be due to either ignorance of its importance and/or lack of economic incentive. In the area of food safety, the occurrence of an extreme situation which is seen to require Government intervention may consequently lead to a demand for greater reliability and transparency regarding the food supply chain from the regulators.

[21] https://www.ansto.gov.au/news/funding-supports-seafood-traceability
[22] https://eativitynews.com/traceability-from-paddock-to-plate/

Box 1. Examples of traceability technology systems

Laava Smart Fingerprint[23] technology allows consumers to access immediate verification of a product's authenticity. By scanning the fingerprint on a smart phone, one can find out if the product is what it claims to be, or if it's a suspected fake. The technology has been used for Australian cherries, citrus and seafood traceability projects.

Trust Provenance[24] software bolsters supply chain data with security, authenticity, and transparency. It links growers, farmers, packing sheds, processors, freight, distributors, retailers, and consumers to a data platform that provides real-time information about every step across the supply chain. The software has been used in citrus and mango traceability trials.

FreshChain[25] is a blockchain-enabled paddock to plate assurance system that verifies the food. By scanning the unique serialised QR code on the pack, one can learn where the food came from, the pick and pack date and storage conditions. FreshChain has partnered with AUSVEG since 2019, and has also been used in a rockmelon trial.

Source Certain[26] company's TSW Trace technology is used to determine a chemical profile of a food product. This provides a chemical 'fingerprint', which reflects the geographical location of where a product was grown or the system by which it was produced. It can also verify the integrity of claims like 'organic', 'free range' or 'sustainable'. More recently, it was used in a trial project by Australian prawn producers, who conducted audits across the supply chain to identify any substitution fraud.

Aglive[27] provides evidence-based tracking and authentication of animals through the supply chain from farm to stockyard, feedlot, abattoir, and exporter. It developed the world's first electronic National Vendor Declaration (eNVD) app in consultation with Meat and Livestock Australia. The eNVD app converts the movement of all livestock within the industry to a real-time and completely traceable paperless system.

General benefits of adopting food traceability

The investment in food traceability is expected to encourage the adoption of enhanced traceability and establish credentials to increase the gross receipts from sales/exports and help to mitigate, and assist in managing, biosecurity risk. Overall, one estimate (see Commonwealth Department of Agriculture, Water and the Environment, 2022) is that if agribusinesses achieved a defined level of increase in traceability, the potential benefits could amount to between $0.4-1 billion of additional annual gross value. The benefits are in the form of being better able to verify claims of provenance and/or sustainability than currently is the case using existing systems, and consumers responding accordingly by paying a premium. For example, industry sources are optimistic, suggesting that wider acceptance of certification of 'grass fed' beef by consumers could lead to an additional $1 per kilogram in gross value in some export markets, with provenance delivering possibly an additional 10-15 per cent gross value to hides[28].

Another claim is that harmonisation of traceability frameworks and regulatory technology could save agribusinesses $225-$325 million per year by reducing staffing and streamlining paper processes.

[23] https://laava.id
[24] https://www.trustprovenance.com
[25] https://freshchain.com.au
[26] https://www.sourcecertain.com
[27] https://aglive.com
[28] https://www.awe.gov.au/sites/default/files/documents/traceability_fact_sheet.pdf

Importantly, enhancements to improve the speed and accuracy of traceability could have benefits in reducing the negative economic impact of a biosecurity outbreak significantly – by 80-90 per cent - over ten years, worth $15-$17 billion[29].

Some of the potential benefits of adopting traceability more widely and more effectively in agribusiness value chains include savings of time and costs while reducing human errors and wastage in tracking and tracing produce. Improved processes along the supply chain are made possible with the costs of duplication associated with each chain partner in the supply chain using their own system to identify and trace product reduced and avoided. A source of significant benefits would be the costs avoided by fewer orders being rejected at each stage of the value chain.

Role of Government

Notwithstanding the Government's preferred arm's length position in the progressing of food traceability adoption, there are nevertheless several areas where Governments can potentially play a key role. The conceptual basis/rationale for the role of government to help accelerate traceability emanates from at least two perspectives.

The first is as a facilitator/enabler role where, in partnership with the industry, Government could engage in correcting information and/or chain failures along the supply chain in the market regarding the use of food traceability related information. This role has continued to occur in recent years in the form of Governments working with industry in partnership to encourage traceability pilot projects in various agricultural sectors. These projects involve selection of practical traceability pilot projects on a competitive basis to provide information and expertise relating to the use of digital traceability tools for specific products with a high likelihood of adoption. The nature of this form of Government role (in partnership with industry) can also be viewed as a role of extension in building technical capacity among farmers to help accelerate the adoption of food traceability.

In this role, the Government could work with industry bodies to provide information and expertise relating to the use of digital traceability tools, disseminate the benefits of using traceability systems, and help share the set up and running costs of pilot projects. Also, Governments may have a role in helping to disseminate relevant traceability information for Small and Medium Enterprises (SMEs), to aid them to better understand the importance and the commercial value of adopting effective traceability actions. The information dissemination aimed at increasing producer awareness of food traceability might be profitably done during regular agricultural field days, as a part of broader farm demonstrations and via information dissemination through the smart farm movement.

The second area relates to food safety, foodborne illnesses, and public health. The link between traceability and preventing foodborne illness is associated with the notion that food traceability systems can help to prevent foodborne illnesses by enabling the rapid identification and recall of contaminated or unsafe food products. By tracking the movement of food products throughout the supply chain, food traceability systems can identify the source of a foodborne illness outbreak and enable the removal of contaminated products from the market. This can help to prevent the spread of the illness and protect public health[30].

[29] https://www.beefcentral.com/news/govt-commits-68m-to-lifting-ag-traceability-performance/

[30] https://www.inecta.com/blog/food-traceability-what-is-it-why-its-important#:~:text=unsafe%20food%20products.-,By%20tracking%20the%20movement%20of%20food%20products%20throughout%20the%20supply,illness%20and%20protect%20public%20health.

Foodborne diseases affect 1 in 10 people and kill around 420,000 people every year worldwide, with one-third of deaths occurring in children aged up to five years (Magalhães et al., 2019; World Health Organization, 2015). The evolution of food traceability technologies is one of the factors for reducing the number of food-borne disease outbreaks in countries that have effective control systems for such outbreaks (Magalhães et al., 2019).

In the United States, about 800 foodborne disease outbreaks are reported annually (Qiu et al., 2021). Chen et al. (2021) point out the interest in Governments in this area from a public health perspective. For example, the US Food and Drug Administration's (FDA's) blueprint for a 'New Era of Smarter Food Safety' emphasises the need to enhance traceability of food back to its source and improve predictive analytics across the entire supply chain to respond more rapidly to public health risks arising from inadequate food supply chains (see Chen et al., 2021; US Food and Drug Administration, 2020).

The main characteristics of the European Union system of food safety include an integrated farm-to-fork approach; the operator responsibility for food safety; a traceability mechanism; the improvement of the food safety regulatory and standardisation system; a risk assessment; and a rapid alert system (see Chen et al., 2015).

In Australia, Food Standards Australia New Zealand (FSANZ), in its 'Australia's Foodborne Illness Reduction Strategy 2018-2021 +', has highlighted the need for strengthening food safety and traceability throughout the food supply chain from paddock to plate to lower the incidence of foodborne illness[31].

Analysis of Potential Economic Effects

Two key drivers of food traceability are food safety and market access for food exports[32]. Here we provide a quantitative assessment of the potential economic effects of enhanced food traceability using two case studies focusing on food safety and market access for food exports.

Case study 1: food safety

In the context of food safety, safe food is food that is produced, stored, and prepared in such a way that consumers are not affected, when they use the product, by acute or chronic adverse effects. Unsafe food means food that is contaminated with a physical, microbiological, or chemical hazard which can result into adverse effects to human health. Food contamination can lead to economic losses related to production and trade when recalls are instigated or in the case of food safety incidents. Food safety hazards, including food-borne illnesses, can result in high losses for consumers as well and for the agri-food industry, including farmers, processors, and retailers (Focker and van der Fels-Klerx, 2020).

It is noteworthy that food-borne illness is a major cause of morbidity and loss of productivity in developed nations (Newman et al., 2015). Food Standards Australia New Zealand (FSANZ) (2022) estimates that up to 3.2 million cases of foodborne illness a year are likely linked to potentially hazardous food. Their analysis attributes the current cost of illness from potentially hazardous food consumed to around A$ 1.5 billion per year, including medical costs and productivity losses. This is a substantial, somewhat 'hidden' burden on the Australian economy and society.

[31] https://foodregulation.gov.au/internet/fr/publishing.nsf/Content/51D7B1FFFCAD05C5CA2582B900051DDD/%24File/FORUM-AUS-FBI-RS-2018.pdf

[32] https://agriculture.vic.gov.au/export/traceability/what-is-traceability

Scenario 1: Avoidable labour market effects of improved food safety from the use of food traceability systems

It is important to recognise that specific data needed to estimate the costs of food safety incidents are usually lacking and researchers have to use plausible hypothetical and illustrative scenarios, focusing on, for example, the potential economic consequences for labour productivity in an economy of a productivity-increasing change such as efficiencies in food tracing.

In this scenario, it is assumed that widespread use of food traceability systems in Australia will help reduce the incidence and cases of food-borne illness likely to be linked to potentially hazardous food. This lowering of the incidence and cases of food-borne illness will have favourable effects on the health of the consumers and hence on the overall Australian labour force, mitigating the cost of losses of working days and the associated labour productivity losses, relative to what would otherwise be the case.

In this context, to estimate the potential avoidable labour market effects of improved food safety, the impact of an assumed labour productivity increase of just 0.1 per cent over the medium term (10 years) in the Australian economy was simulated. This impact is assumed to result from the widespread adoption of food traceability hence lowering the incidence and cases of foodborne illness.

The assumed labour productivity growth rate is illustrative only, to give a sense of proportion, and an order of magnitude. Recent trends in the annual growth in productivity in Australia indicate that average annual growth in productivity is slowing. According to Reserve Bank of Australia analysis, over the decade to 2014, growth in labour productivity averaged 1.2 per cent per year (Lowe, 2022). In recent years, annual growth in productivity of labour has been less than this decadal annual average. In contrast, annual growth in labour productivity was more than 2 per cent per year during much of the 1990s. A similar pattern in labour productivity is evident in many other advanced economies (Lowe, 2022). Importantly, in the context of these historical trends in labour productivity, the premise here is that it is plausible to assume that, because greater and more widespread adoption of food traceability in Australia would reduce the incidence and perhaps severity of illness from food-borne contaminants, and hence will enhance labour productivity by reducing avoidable losses of productivity relative to what would otherwise be.

Case study 2: market access and food exports

The Australian farm sector is regarded as a sufficiently reliable and trusted exporter of premium food and agricultural products to consistently sell most of the production in overseas markets. Australia currently exports around 70 per cent of its agricultural production[33]. Access to export markets is critical. The 'trust' attributes include food safety and quality, reliability in meeting seasonality gaps and disruptions, quality assurance and food integrity and guaranteed provenance of farm exports. Strengthening these 'trust' attributes by greater adoption of food traceability provides extra assurance to trading partners and allows interventions aimed precisely at the site(s) of biosecurity and/or food safety incidents in the export supply chain pathway. For consumers, trusted and full information gives greater confidence that they actually are buying the premium product with the features that they desire.

It is expected that use of credible food traceability measures for access to export markets will reduce administrative burden and costs. This could potentially simplify the often onerous trade administrative

[33] https://www.dfat.gov.au/about-us/publications/trade-investment/trade-at-a-glance/trade-at-a-glance-2015/agriculture-and-food-trade

processes. Digital traceability for the provenance of farm exports will enhance the integrity and authenticity of products, lower food fraud and may generate a premium price for products[34].

Scenario 2: Prospective market access and food exports from the use of food traceability systems

In this scenario, it is assumed that widespread use of food traceability systems in Australia will help to lower administrative costs associated with exporting and enhance the integrity and authenticity of export products, lower the extent of food fraud, and generate premium prices for some products. Combined, these factors are expected to potentially increase the quantity and gross unit and total value of farm exports, relative to what would otherwise be.

To estimate this potential increase in illustrative and prospective market access and exports of food, the impact of an assumed increase in Australian farm exports by 1 per cent over the medium term (10 years) is simulated. This impact is assumed to result from the widespread adoption of traceability technology along the food supply chains. The assumed export growth rate is illustrative only.

It is noteworthy that the compound (nominal) annual growth rate (CAGR) of Australian agricultural exports was 5.7 per cent over the past decade (Rural Bank, 2020). Over 1998 to 2012, the nominal gross value of Australian agricultural exports has been increasing at a rate of between 5 and 6 per cent per year. The nominal annual value of global agricultural trade over the same period has been increasing at an average CAGR of approximately 8 per cent per year[35].

The premise in this scenario is that, given the historical trends in farm export growth trends, it is plausible to assume that greater adoption of food traceability systems in Australia will help mitigate administrative burden and the costs of exporting, enhance the authenticity of products, and generate a premium price for products, and hence will result in additional growth in the nominal gross value of farm exports as assumed in this illustrative scenario, relative to what would otherwise be.

Analytical framework

The method in undertaking analysis of the case study scenarios is based on a widely-used computable general equilibrium model, the Global Trade Analysis Project (GTAP) model (Hertel, 1997) and the GTAP global database (see Appendix 1). This model provides a robust representation of the structure of the global and regional economies and the transactions among economic agents.

An important feature of the GTAP model is that it includes economy-wide transaction and related transmission effects through the sectoral and regional (price and quantity) linkages. In so doing, this enables comprehensive assessment of the varying economic effects of the potential widespread adoption of food traceability in Australia.

The latest GTAP database (version 10) (Aguiar et al., 2019) is used to produce an aggregation of eight identifiable regions (aggregated from 121 countries) and eight sectors (aggregated from 65 industries). The eight regions are: Australia, Rest of Oceania, North America, Central and South America, Europe, East Asia, South Asia and Middle East, and Africa. The eight sectors are: Grains, Other crops, Livestock and meat products, Processed food, Mining and extraction, Light manufacturing, Heavy manufacturing and Services.

[34] https://agriculture.vic.gov.au/export/traceability/what-is-traceability
[35] https://www.farminstitute.org.au/australias-agricultural-trade-performance-pedestrian-at-best/

Discussion of case study scenario results

It is noteworthy that the economy-wide analysis presented here is not aimed at providing precise estimates of the benefits of adoption of food traceability. Instead, it provides information on the market mechanisms through which benefits of the adoption of food traceability could potentially affect the Australian economy. These mechanisms help indicate the direction and magnitude of the economic flows resulting from enhanced food safety (hence reductions in foodborne illness), and expansion in the volume and gross value of exports of food because of widespread adoption of food traceability.

The simulation results are presented in Table 1. For the first scenario, they indicate the effects of the assumed illustrative growth of 0.1 per cent in the productivity of labour in the Australian economy in the medium term because of avoided adverse labour market (health) effects by improved food safety. The benefit of this avoided loss of productivity of labour could potentially lead to an estimated rise in GDP of 0.06 per cent relative to what would otherwise be the case. These effects are expected to result from widespread adoption of food traceability along the food supply chains reducing the incidence and cases of foodborne illness. These effects represent the relationship of households to the economy through impacts on labour markets.

For the second scenario, the results show that the assumed expansion in Australian farm exports by 1 per cent over the medium term from the widespread adoption of food traceability along the food supply chains could potentially lead to an estimated rise in GDP of 0.11 per cent relative to what would otherwise be the case. These illustrative effects are expected to result from the widespread adoption of food traceability along food supply chains in Australia.

The simulation results shown in Table 1 also highlight the economy-wide, potential welfare impacts of widespread use of food traceability (for example, an estimated US$ 0.9 billion rise in economic welfare, relative to what would otherwise be). This highlights the broader potential economy-wide ramifications of greater adoption of food traceability.

There are several caveats to the impacts of this medium-term prognosis for the adoption of food traceability. As highlighted earlier there are several challenges to the widespread adoption of digital food traceability systems. They range from the lack of digital literacy of some agricultural producers to certain technical issues. A lack of supply or quality of available expertise in the digital requirements would be an initial barrier to increasing adoption of traceability systems. This would be a short-term issue.

Table 1. Illustrative economic effects of widespread adoption of food traceability in the Australian agricultural sector (relative to the baseline case)

Scenario	Change in GDP (%)	Change in economic welfare (US$ million)
Avoidable labour market effects of improved food safety (due to the use of food traceability systems)	0.06	887
Prospective market access and food exports (due to the use of food traceability systems)	0.11	258

Source: Authors' simulations using the GTAP model

In this regard, if there is any 'market failure' or 'chain failure' of a public good nature, there may be a role for governments, or for participants in supply chains acting together, in providing information and training in digital and technical aspects of implementing food traceability systems. However, beyond that, mastering new technology is a major source of competitive advantage in all aspects of agriculture - something which the best operators do very well - and if learning to use digital traceability systems/tools are means to open opportunities etc., then this becomes a private and commercial matter.

Hansen et al. (2022) quoting the National Farmers Federation (NFF, 2020), point out that farmers generally prioritise learning from their peers and in-person events. This applies to the use of food traceability systems also. As highlighted by Hansen et al. (2022), given that many agricultural producers prefer to be provided with practical facts in a logical sequence rather than lots of information (see Nicholson et al., 2015), field days, demonstration and smart farms can play an important role in increasing producer awareness of food traceability and of the relevant knowledge and skills, and exposing the economic value propositions through well-evidenced use of traceability systems/tools (see Ayre et al., 2019).

At a public policy level, a technical constraint to wider adoption of food traceability systems and processes is the phenomenon, common in the Australian Federation, of different governance regions having different standards. State boundaries are legislative markers, not demarcations relevant to tradeable products. Lack of common national standards and processes bedevils progress, hampering or preventing interoperability of the use of traceability systems. Initiatives are underway in technical services to address this issue[36], but with some way still to go.

Concluding Remarks

There are numerous applications of traceability systems across a range of farm products in Australia, with many cases at a pilot stage. They cover products from horticultural goods such as citrus fruits, table grapes and apples, to livestock and dairy commodities.

In progressing food traceability adoption, there are some areas where Governments in collaboration with the industry can potentially play a role. First, as has been done in the recent past, Governments, in helping to correct failures in markets, can work with industry bodies to disseminate traceability mechanisms and information relating to the traceability tools and the benefits of their use.

Second, Governments may have a role in helping to disseminate relevant information for Small and Medium Enterprises (SMEs) to better understand the importance and the commercial value of food traceability, and to encourage them to use traceability tools. Agricultural field days, farm demonstrations and smart farms can play an important role in increasing farmer awareness of food traceability.

Third, given that there are numerous traceability systems available in Australia, having a common Australian traceability system may be helpful for the industry in general. This could be particularly so in the context of ensuring interoperability of the use of traceability systems. Lack of interoperability (or the presence of insufficient portability) of the use of different digital (traceability) systems/platforms could inhibit the interest of users and could lead to reduced participation and inefficiencies in the adoption of digital tools such as traceability systems along the supply chain and may pose a risk of some form of 'market failure' (see Tripathy et al., 2022; OECD, 2021).

[36] https://www.thepacker.com/news/food-safety-markets/marketing-news/packer-tech/gs1-testing-interoperability-traceability

Fourth, there is a need for Governments and industry to work together to address concerns in relation to the cost of implementing traceability systems. To be successful, such a process will need to be balanced with a demonstration of the expected benefit to individual farmers and industry.

Finally, another factor relating to the cost of implementing more robust traceability systems relates to the situation where there are currently a range of food safety regulations administered under the FSANZ regulations/legislation. In this regard, any new or updated regulatory arrangements must be fit for specific purpose, and not impose any unrealistic regulatory burdens on the individual agricultural supply chains. In this context, a move towards a national consistency for traceability systems and standards could be a useful path for both Government and industry.

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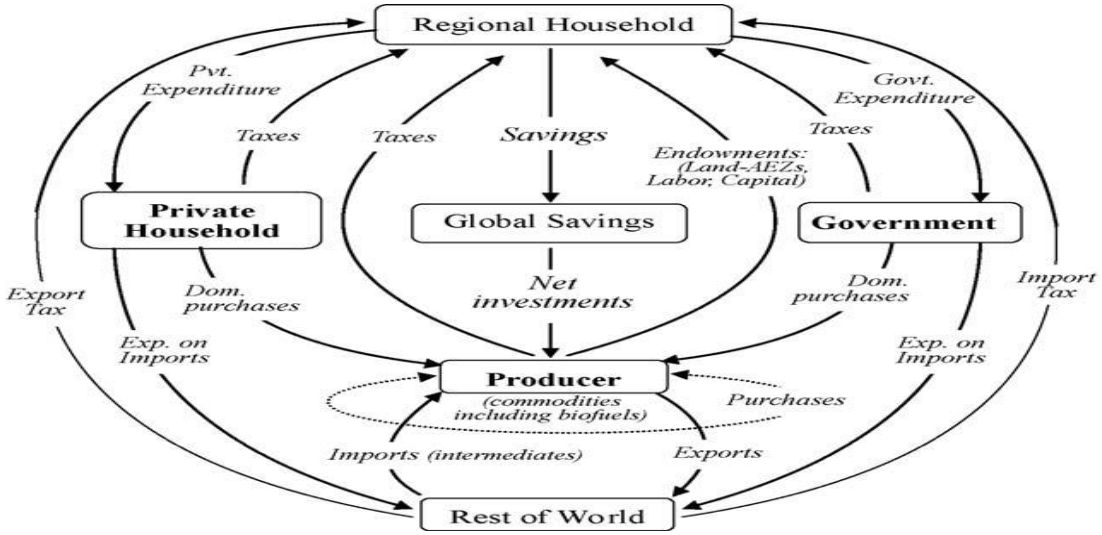
Appendix 1. Brief Description of the GTAP Modelling Approach

The standard Global Trade Analysis Project (GTAP) model used in this study is a multi-region, multi-sector, computable general equilibrium (CGE) model. For a full account of the key assumptions and equations, the reader is directed to Hertel (1997) and Valenzuela et al. (2008). The model assumes constant returns to scale and perfect competition in all the markets with Walrasian adjustment to ensure a general equilibrium. As illustrated in Appendix Figure 1, each region (for example, Australia) has a representative household that collects all the income in its region and spends it over three expenditure types: private household (consumer), government and savings, in accordance with a Cobb-Douglas utility function.

Each sector is modelled by a representative firm that maximizes profits subject to a nested Constant Elasticity of Substitution (CES) production function. The CES production function combines primary factors and intermediate inputs to produce the sector's final good. Firms pay wages/rental rates to the regional household in return for the employment of land, labour, capital, and natural resources. Firms sell their output to other firms (intermediate inputs), to private households, government, and investment. Firms also export tradable commodities and import intermediate inputs from other regions. These goods are assumed to be differentiated by region, following the Armington assumption, and hence the model can track bilateral trade flows.

The model was run with the standard comparative static model closure, allowing for the analysis of policy changes relative to what would otherwise be.

Appendix Figure 1. Schematic of the Standard GTAP Model



Source: Hertel et al. (2010) after Brockmeier (2001)