Backing food product claims with evidence

Words by Dr Nina Welti, Dr Geoff Fraser, Dr Christoph Gerber, Dr Stefanie Kethers and Lian Flick

The Australian food and beverage sector has experienced significant pressures from the global pandemic, inflationary pressures, geo-political conflicts, as well as changes in weather patterns. In addition, there have also been shifts in the way food and beverages are consumed and produced through new technologies. Taken together, these shifts present considerable opportunities for the Australian food and beverage sector to be optimistic about the future.

Australia's agriculture and food system is highly trusted and reputable, domestically and internationally. According to the Anholt-Ipsos Nation Brands Index, brand Australia is ranked ninth out of 60 nations.[1] The brand index compares nations across six categories, including how much country-of-origin increases the likelihood of a product being purchased.

Australia's enviable reputation in the food sector is underpinned by a world-class assurance system. Food safety and quality is highly regulated in Australia to ensure it meets export requirements and standards. This in turn results in high return value of Australian agricultural exports, a significant contributor to our national economy. The forecasted gross export value for 2023-24 is $84 billion, including fisheries and forestry production.[2]

Changing regulatory requirements over time can be a challenge for businesses to develop coherent strategies and meet multiple market access demands. Looking to the future, consumers increasingly care about where our food comes from and how it was produced. Rising consumer and importer interest in food provenance is growing the need for supply chain transparency and traceability.[3] Consumers want evidence that backs product claims, particularly on sustainability or safety credentials, if we are to pay a premium for products with these attributes.[4]

Regulatory compliance in food supply chains is clearly important, but the downside is the high cost of compliance. As in many other industries, it is onerous on businesses and regulators. Administration involves many systems, reporting and players across the supply chain. The National Agricultural Traceability Strategy[5] highlights that improving compliance efficiencies in agricultural trade could save $110 million to $170 million per year.

According to CSIRO's national protein roadmap, expanding and integrating systems across the supply chain to deliver end-to-end traceability and trusted credentialing could add $1.2 billion in export revenue for the red meat sector by 2030.[6] This would see new digital and integrity systems across the supply chain be used to trace food from farm to fork. This data would verify key attributes such as food safety, welfare and sustainability. The data used to provide this evidence must be trustworthy and balance the data interests of all actors, while maintaining a collective outlook.[7]

Providing this assurance requires objective, quantifiable evidence backed by data that links food products to their sources. One data type that can provide this link comes from comparing isotopic analyses from food products and from inputs to that food, such as the soil and water in the region of origin. These isotopic analyses can act as tamper-resistant 'fingerprints' of food provenance that are maintained faithfully through complex supply chains.

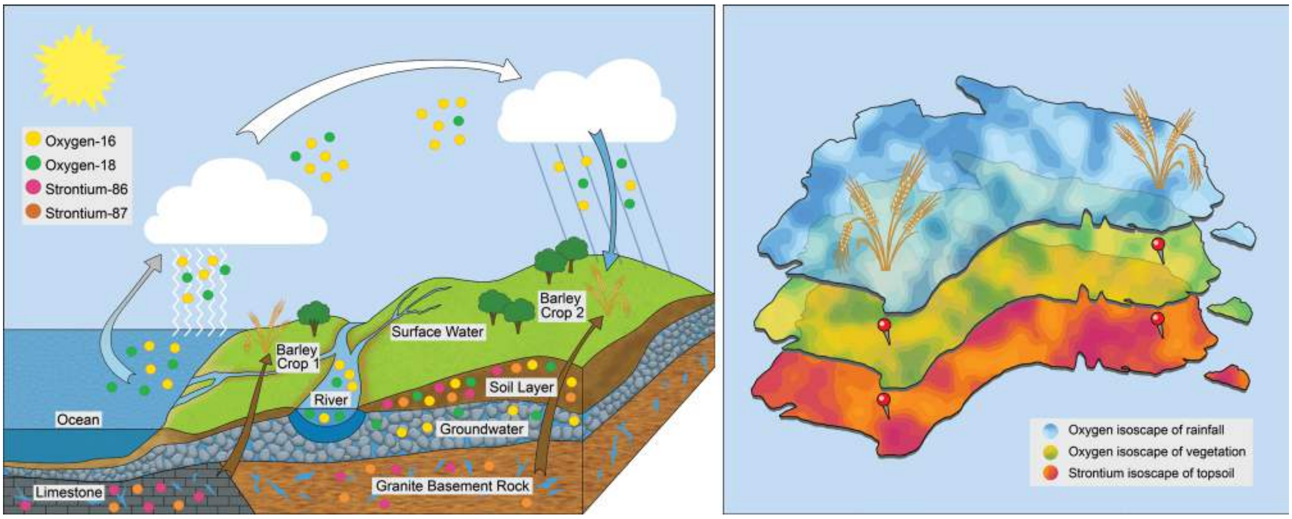

Figure 1. (a) Isotopes found in food relate to the soil and water conditions the food product grew in. (b) The isotopic signatures can be modelled across a larger area; these are called isoscapes.

The use of stable isotope ratios has been demonstrated as an effective method for authenticating geographic origin or production method for particular case studies,[8] but the approach is not used routinely and is currently not commercially viable as a general tool. The sample collection and analysis is relatively expensive and time consuming and measurement methodologies have not been standardised. In addition, to make isotopic 'fingerprinting' more effective and viable in the food industry requires a well-established 'library' of isotopic information from soils and waters across Australia, against which isotopic data from food products can be matched (see breakout text).

Although establishing such isotopic data libraries may appear a daunting task, much of the relevant data has already been collected. Australian government science agencies regularly include stable isotope measurements in their environmental monitoring and research activities. There is a wealth of existing data and models that describe the distribution and patterns of stable isotope ratios throughout the Australian environment. The challenge is that the data are often siloed within organisations, stored in different formats in different organisations, and with differing

Isotopes are atoms of the same chemical element that differ in how heavy they are. Since they are the same element, they behave the same way in chemical reactions, so for example when plants photosynthesise sugar, it doesn't matter whether the oxygen atom from the water molecule is a light oxygen-16 or a heavy oxygen-18, both will form the same chemical compound, and the ratio of heavy and light isotopes therefore remains approximately unchanged during chemical reactions. In contrast, the variation in mass means that different isotopes of the same chemical element behave slightly differently during physical processes, such as evaporation or condensation. This leads to useful differences in isotopic ratios within, for example, sea water, clouds, rain and river water.

Stable isotope ratios are naturally occurring chemical signatures or 'fingerprints' used to characterise and understand the environment. For example, soils across Australia (and elsewhere) have been shown to contain distinct isotopic signatures in different regions for a range of chemical elements, related to the composition of the underlying rocks from which these soils are derived. As the plants take up these elements, they assimilate the isotopic ratios of the soils in which they are growing.

Similarly, the water in rainfall, rivers and different groundwater aquifers typically exhibits distinct isotopic signatures. This characteristic isotopic signature of soils and waters is then transferred into plants as they grow and into animals through the plants they eat.

We can use the stable isotope ratios of oxygen and hydrogen in plants to understand movement of water through the soil-plant-atmosphere continuum or groundwater flows and storage, and the stable isotope ratios of carbon in soils to understand the nutrient cycles relating to soil health as well as climatic patterns. Isotopes found in food relate to the soil, water, production techniques and climatic conditions that it grew in.

In this way, measurements of isotopes in foods can be used to verify the origin of that food, via relationships with the soil, water, production techniques and climatic conditions during food production.

Isotopic patterns are determined by quantifiable mechanisms of climate, geology and food webs and so provide an evidence-based solution for verifying the geographical origin, sustainability, production and distribution of food products around the world. They can be used to authenticate Australian agricultural and food product claims and environmental credentials by verifying where our food comes from and how it was grown.

Dr Nina Welti is building a picture of where Australian food is grown and how.

levels of accessibility. These factors limit the utility of the existing data for food provenance applications, and make it difficult to address growing expectations from industry, researchers, consumers and governments for more availability of information and data from across supply chains.

To address this challenge, and to enable the effective and efficient use of these public-good data collections, a current project led by Australia's national science agency CSIRO, in partnership with Geoscience Australia, the Australian Nuclear Science and Technology Organisation (ANSTO) and the National Measurement Institute (NMI), with co-investment from the Australian Research Data Commons (ARDC), is breaking down data silos and creating a national isotope data resource. The goal is to develop a FAIR (Findable, Accessible, Interoperable, Reusable)[9] data ecosystem, balancing the data needs and interests across industry, researchers, consumers and governments across supply chains.

This project to connect and federate stable isotopic data resources is one of nine projects that the ARDC is investing in through the Food Security Data Challenges program. The projects are developing innovative digital infrastructure solutions with the aim of improving research into Australia's production, consumption and distribution of safe and high-quality food. The nine projects received a total of $3.6 million in investment from the ARDC's Food Security Data Challenges Program, with a total of more than $5.7 million co-investment from project partners. Learn more about Food Security Data Challenges[10] in *food australia* Vol.75(4) and by visiting https://ardc.edu.au/program/food-security-data-challenges/.

Connecting these rich databases in a way that is trusted, shareable and useful is a big challenge, beyond the realms of a single organisation. By coordinating this effort between these national government science organisations, we bring together expertise on isotopes, supply chains and data harmonisation. This ensures long-term utility of valuable data and balances the potential commercial and scientific outcomes that underpin trust in the data. This single national collection creates a data foundation that can be used, is maintained, and is public, and the data will serve as objective, quantifiable evidence that can be trusted by regulators and the public.

Using public-good data enables equitable access across industry to sophisticated verification technology. Future research and commercial development can make use of this national data collection. Investments can be made into solutions which support the continued data collection efforts of Australian government science organisations. Repurposing these data collections creates a return on investment for the research organisations and incentive for continued research. The national data collection also provides a foundation for developing and testing new approaches to isotopic fingerprinting of foods.

Ultimately, government, research and industry will be able to use these public data collections to create accessible and trusted verification tools that can tell consumers where our food comes from and how it was grown. The data could be used to visualise food production regions and trace the origin of a product through the spatial modelling of environmental stable isotope ratios (see breakout text). These verification tools can help Australia maintain key export markets, as well as enter new high-value markets.

This requires good data governance, which is a major challenge for the digital transformation of food value chains. The project partners are taking on the challenge of ensuring responsible use of data as well as responsible data curation (this is trusted data from trusted science organisations) in the operating model for the data resource.

The existing intergovernmental agreement on data sharing between commonwealth, state and territory governments[11] commits all jurisdictions to share public sector data where it can be done securely, safely, lawfully and ethically, allowing for innovative operating models to realise its full value. This project demonstrates how government agencies can make foundational, public-good data available to realise the full value of these national assets, and to support key industries.

Australia is leading the way in an unprecedented effort to bring together data for the benefit of future innovation across our agricultural system to underpin the reputation of the Australian food industry with trusted, objective evidence.

Realising the potential of digital technologies to transform the food system will require collaboration. The future is not just collecting data, but creating shared benefits for public-good research and commercial outcomes. Use cases from industry, peak bodies, universities and other research organisations will help to inform how the data resource will be developed and operated in a way that is relevant, accessible and serves the needs of different sectors. Register your interest to participate and develop the future at: https://ardc.edu.au/project/connecting-federating-stable-isotopic-data-resources/.

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