National Science Challenges

Driving Better Programme Investment and Accelerating Challenge Impact through a Prioritisation Matrix of International and National Perspectives: The Matrix

Short Title: Drivers Project (2018)

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Foreword

Optimising our land and freshwater resources on the basis of economic, environmental, social and cultural sustainability is a key outcome of the 'Our land and Water' National Science Challenge. Therefore identifying areas of the highest potential impact, as related to the hierarchy of international and national issues, is needed to provide an evidence base to guide investment and inform the Challenge Research Strategy. To this end, a project was conducted to deliver an overview of the international and domestic drivers, as well as their relevance to the New Zealand primary sector and its land use (Saunders et al, 2016a). The project combines and rates these international and domestic drivers on changes in water and land use. By using this approach, a summary representation of the level of interest/concern of international 'consumers' and customers was produced alongside an overview of domestic issues and stakeholder interests relevant to the primary sector. Where possible, the drivers were based upon quantifiable evidence.

This report provides an updated understanding of the national and international drivers and issues and their importance to the primary sector. This builds on an earlier report that assessed how these drivers change where we invest in primary sector research as related to economic growth, social, cultural and environmental interactions. Repeating this research overtime will allow us to understand how drivers and issues change and how this affects the impact the Challenge has and its future research directions. This work will provide a contribution to the Challenge Strategy and focus future programmes such as the primary performance indicators and 'greater value in global markets' Challenge theme**.** Working across the entire primary sector and involving stakeholders collectively will contribute to a more cohesive view of the primary sector's response to Challenge issues. This will also contribute to meeting a main aim of the Challenge, which is "to enhance primary sector production and productivity whilst maintaining and improving our land and water quality for future generations (OLW, 2017)."

This report is structured as follows: Chapter 1 presents an introduction to the current update of the Drivers Project; Chapter 2 outlines the methodology and results of a New Zealand-wide survey of primary industry experts regarding international and domestic drivers with the potential to affect land use change and/or practice; Chapter 3 presents a review of foresight literature for trends which are likely to affect land use change and/or practice internationally into the future; Chapter 4 presents a conclusion of the current report, including suggestions for future research.

1. Introduction

Project background

This report an updated overview of international and domestic drivers which have the potential to affect land use change and/or practice. This work has been undertaken in order to inform the strategic direction of the Our Land and Water component of the National Science Challenge. The OLW challenge mission is to "enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations." This has been organised under three main streams: 'greater value in global markets', 'innovative resilient land and water use' and 'collaborative capacity' (OLW, 2017). As different international and domestic drivers are likely to impact on New Zealand land use change and/or practice in a variety of ways, it is important to quantify to what extent this is likely to occur in order to prioritise key areas of focus for the Challenge.

To meet this requirement, this report presents an academic literature review of the latest research relevant to the international and domestic drivers of land use change and/or practice. The initial literature review undertaken in the first Drivers Project identified a preliminary list of 30 drivers (Saunders et al., 2016a). This Drivers Project updated the original drivers and identified additional drivers likely to affect land use practice and/or change including digital communication systems, emissions trading, innovative products, social responsibility and fair trade, and precision agriculture. The current list of international and domestic drivers is presented in Table 1.1 below. This report has also expanded previous literature reviews, with an examination of the latest reports produced by key organisations including the FAO, IPCC and Royal Society of New Zealand and the academic literature. A summary of each driver and its likely impact on land use change and/or practice (where possible) has been compiled, and can be accessed digitally by clicking on the links in Table 1.1 below. The updated evidence base used to inform these summaries is also available here.

Table 1.1. Current list of international and domestic drivers likely to impact on land use practice and/or change (as of December 2017)

Agricultural and Trade Policy	Air Quality	Animal Health and Welfare	Authenticity and Traceability
Biodiversity	Biosecurity	Brand	Carbon Emissions Trading Schemes
Chemical Residues	Climate Change	Country-of-Origin	Cultural Values
Demographics	Digital Communication Systems	Environmental Condition	Extreme Weather Events
Family and Community	Food Safety	Functional Food	GHG Emissions

GM and Nanotechnology	Innovative Products	Local Food/Food Miles	Organic Production
Pasture-Based Production	Precision Agriculture	Product Quality	Religion
Social Responsibility and Fair Trade	Soil Quality	Sustainable Supply	Waste and Recycling
	Water Footprinting and Use	Water Quality	

The literature review identified the key domestic and international drivers that have the potential to affect land use change and/or practice in New Zealand. The review also identified literature that demonstrated how these drivers may change over time drawing on trade modelling, consumer attitudes and behaviour research (see Guenther et al. 2014, 2015; Barrios and Costell, 2004; Hemmerling et al., 2015; Wilcock et al., 2004).

The domestic drivers were informed by key strategic documents of government agencies such as the Business Growth Agenda (MBIE, 2017) and Biosecurity 2025 (MPI, 2016). Recent additions include the 2016 Environmental Protection Authority's ETS Report (EPA, 2016) and Trade Agenda 2030 (MFAT, 2017a), and the annual reports of government departments (MFAT, 2017a). The strategic documents of regional and local agencies were also reviewed, such as the Canterbury Water Management Strategy (eCan, 2009). Recent additions include Environment Canterbury's 2016/17 Annual Report (eCan, 2017) and studies produced by Crown Research Institutions such as AgResearch (AgResearch, 2017). Where publicly available, key information from sector groups and farmer associations such as Federated Farmers, DairyNZ and Fonterra were also reviewed. The strategic documents and annual reports of main industries were also included. Finally, relevant academic literature was assessed, with recent updates including Larned et al., 2017; Miller et al., 2017; Snelder et al., 2016; Daigneault et al., 2016; and Doole and Romera., 2015. Important legislative and regulatory documents such as the New Zealand Emissions Trading Scheme (MfE, 2017), Resource Management Act (1991) and Animal Products Act (1999) were also reviewed. This review included voluntary standards such as AsureQuality Organic standards and Sustainable Winegrowing New Zealand standards.

International trading agreements, government legislation and reports, retailer requirements, strategic documents, and academic literature helped inform the international drivers. Recent developments such as Brexit have been included in updated literature review. Brexit in particular was included under Agricultural and Trade Policy for the Drivers with key publications such as Chang, 2017; Hine, 2017; and Swinbank, 2017 included. The literature review also looked at future trends that are influencing drivers. Academic literature and reports from NIWA, IPCC, World Economic Forum and UNFAO were included.

The initial Drivers Project also included a broad literature review of studies involving the use of methods such as choice experiments (CE) – an economic valuation method used to assess willingness-to-pay (WTP) for different attributes of goods and/or services than can be traded in markets. Purchasing behaviour in markets is often influenced by product attributes such as

price, quality and appearance but also the credence attributes of a product. These are qualities that are not immediately seen or experienced during purchase or consumption, such as food safety, animal welfare, environmental protection, country-of-origin, and sustainability credentials. The CE method requires participants to make trade-offs between attributes by selecting one option from a series of products with multiple attributes, typically with an associated price attribute. This literature review has been updated to include recent CE and other WTP studies relevant to the drivers, covering academic literature published up to 2017. This can be found in Appendix A of this report.

2. New Zealand Primary Industry Stakeholder Survey

The overall aim of this project is to review and cross-reference national and international drivers in order to identify and prioritise areas of importance to the National Science Challenge. To assess the relative importance of the drivers across international regions, a survey addressing issues relating to the drivers was distributed to stakeholders involved in New Zealand's primary industries. In this report, the survey has been redesigned and updated, as presented below.

2.1 Survey methodology

Following previous survey work undertaken in the initial Drivers Project, a redesigned survey was distributed in November 2017. The overall aim of this survey was to assess the relative importance of the drivers across international regions, with a particular focus on the drivers' impact on domestic primary industries in relation to land use practice/change. The survey was distributed in September/October 2017, with primary data collected using Qualtrics™, a web-based survey system. Participants were selected in consultation with the directorate based on their experience and expertise in relation to New Zealand's primary industries, with participants invited to participate via an email link. Two additional reminder emails were distributed following the initial distribution. The survey was distributed to 174 participants in total, receiving 38 completed surveys.

The survey asked participants to identify the most critical international and domestic issues that could influence New Zealand land use practice/change. Participants were then asked to identify whether the issues/drivers would have a 'high', 'medium' or 'low' impact on New Zealand land use change/practice. Participants were also asked to identify their field of expertise and geographical region that they were most familiar with in relation to their work in New Zealand's primary industries. A copy of the survey instrument is presented in Appendix B of this report. Completed responses were then analysed and are presented in this report.

2.2 Survey results

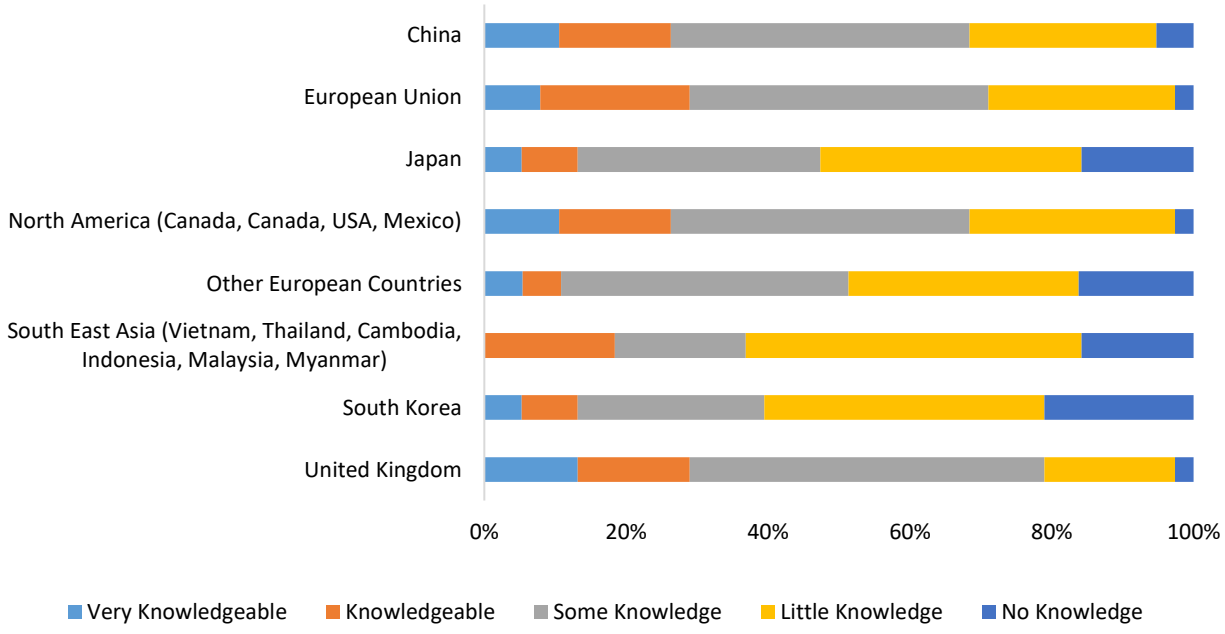
Survey participants were asked to identify the sector which they were most aligned with. As shown in Table 2.1, 32 per cent of participants identified with the meat sector, while 16 per cent identified most closely with the dairy sector. Table 2.1 also shows that 32 per cent of participants identified with 'other' sectors which included technological, pastoral, food manufacturing, cropping, resource management, NGO management, and regulatory and environmental management.

Figure 2.1: Survey participants' alignment with sectors

Sector	Total Participants (%)
Meat	32%
Dairy	16%
Wool	5%
Viticulture/wine	0%
Forestry	13%
Aquaculture	3%
Other	32%

Participants were also asked to indicate their levels of knowledge regarding particular markets and regions. As shown in Figure 2.1 below, 22 per cent of participants indicated they were 'very knowledgeable' or 'knowledgeable' regarding the European Union and United Kingdom. Only one participant indicated they had 'no knowledge' about the European Union, North America and the United Kingdom. In relation to North America and China, 11 per cent of participants indicated that they were 'very knowledgeable' 16 per cent indicated they were knowledgeable, while 42 per cent indicated that they had 'some knowledge'. Three per cent of participants indicated they had 'no knowledge' of the European Union, North American, and United Kingdom markets/regions. Participants also identified the Middle East, South America, Australia and the Pacific as markets/regions they were familiar with.

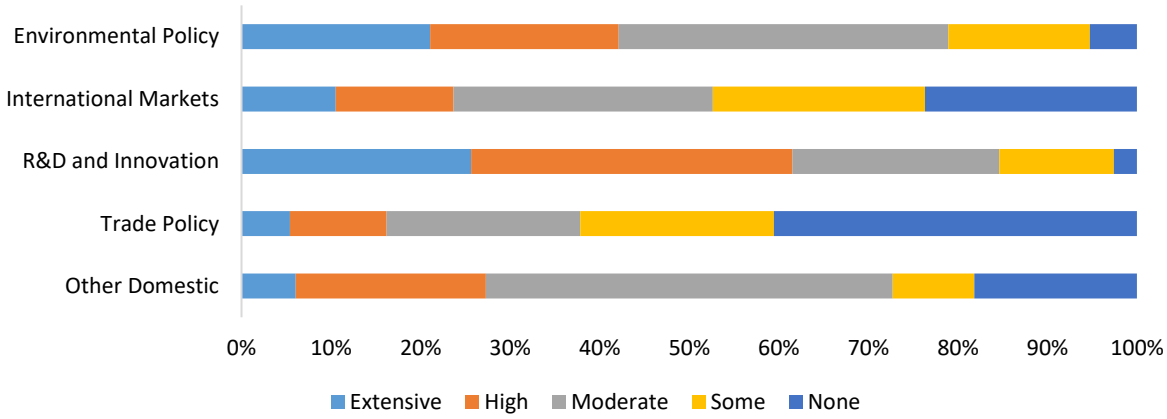
Figure 2.1: Participant's level of knowledge regarding markets/regions



As shown in Figure 2.2 below, participants were also asked to indicate their level of experience in Environmental Policy, International Markets, R&D and Innovation, Trade Policy and 'Other Domestic' fields. Eighty-five per cent of participants had at least moderate experience in R&D and Innovation. Twenty-six per cent of these had extensive experience, 36 per cent had a high

level of experience, and 23 per cent had a moderate level of experience. Only 3 per cent of participants indicated they had no experience in R&D and innovation. Seventy-nine per cent of participants had at least moderate experience in environmental policy. Twenty-one per cent of these indicated they had extensive or high experience, while 37 per cent had moderate experience. Only 5 per cent of participants indicated they had extensive knowledge about trade policy, while 41 per cent indicated they had no experience. Forty-five per cent of participants indicated that they had moderate experience in other domestic fields.

Figure 2.2: Participants' level of experience in industry fields



Critical domestic issues

Participants were then presented with an open-ended question that asked them to identify the three most critical domestic issues that would have the potential to influence land use change/practice in New Zealand. This was done to allow participants to identify important domestic issues without being prompted. Environmental degradation, water quality, land use practices, climate change, the New Zealand emissions trading scheme, rural/urban perceptions, innovative products and government policy were all identified frequently as critical issues.

Water was identified by 22 participants as one of the most critical domestic issues. It was raised in a variety of contexts and frequently linked with government policy, public perception and environmental degradation. The implementation of water taxes and changes to the National Policy Statement for Freshwater Management were identified by several respondents as critical issues that could affect land use change/practice in New Zealand. The degradation of waterways and decline in water quality were also seen as critical issues. They were linked closely to rural land use practice and its impacts, including nitrogen leeching, effluent runoff and erosion. Some participants also viewed the urban perception of rural water use/quality as an issue, while others identified water ownership and storage as issues that could influence New Zealand land use practice/change.

Climate change and New Zealand's Emissions Trading Scheme (ETS) was identified by 14 respondents as critical issues. In 2015 New Zealand signed the Paris Climate Agreement and then ratified it the following year. The agreement outlined the country's climate change commitments/Nationally Determined Contributions which would reduce Greenhouse gas emissions, and allow New Zealand to reach net-zero emissions by 2050 (NDCs). New Zealand's new commitments under the scheme meant a number of respondents saw the Paris Agreement as a key driver of future land use change/practice. As the ETS is New Zealand's

principal response to climate change, this was identified by participants as an important issue. Their responses focused on the inclusion of agriculture in the ETS, forestry plantations, and the impact of the newly appointed Climate Commission on the ETS.

Interactions between New Zealand's rural and urban communities was identified by 14 participants as having the potential to influence land use change/practice. Urban sprawl and encroachment on primary land use, negative urban perceptions of rural land use practice, and pressure from urban areas to address environmental concerns were identified as critical issues.

Six respondents identified innovative products and technology as critical issues. Responses focused on alternative protein products and genetic modification (see table 1.1 for more information). Participants identified these new products as critical issues that could influence New Zealand land use change/practice. Artificial intelligence, biotechnology, alternative crops and farming practices were also identified as potential issue/drivers.

Respondents also provided a variety of other domestic issues that could influence New Zealand land use change/practice. These included biosecurity, social license to operate, product value/returns, tourism, labour shortages, market forces and Mātauranga Māori values.

Critical international issues

The survey also asked participants to identify the three most critical international issues that could influence New Zealand land use change/practice. Like the previous question, this was done to allow participants to identify important international issues without being prompted. The international trading environment was suggested as a key issue by 23 respondents. Trade barriers, market access, free trade agreements, trade liberalisation, subsidies and protectionists policies were identified as the critical issues affecting the international trading environment. Particular emphasis was placed on the development of Brexit and subsequent changes to trading relationships with the United Kingdom and European Union. Interestingly, 2 respondents also noted the need for New Zealand to transition from volume-based to value-added and niche product exports.

Climate change was a critical international issue that was identified by 12 participants. Responses focused on the Paris Climate Agreement and the global impacts of climate change on land use practice and production. Innovative foods such as alternative plant proteins, synthetic dairy and meat products were identified by 12 participants as critical issues that could influence land use change/practice. Gene modification and genome engineering were also identified as crucial international issues.

Several participants also identified animal welfare, food safety and traceability as crucial issues. New Zealand's international brand and reputation as clean, green and environmentally friendly was also identified as a critical issue by 7 participants. Participants emphasised the importance of reputation in successfully engaging with international consumers and markets. Other critical international issues identified by participants were social media, interest rates, exports costs, commodity prices and the health benefits of food.

In summary, climate change and alternative food products were both identified frequently as domestic and international issues that could influence New Zealand land use practice/change. These questions revealed that participants identified the trading environment as the most

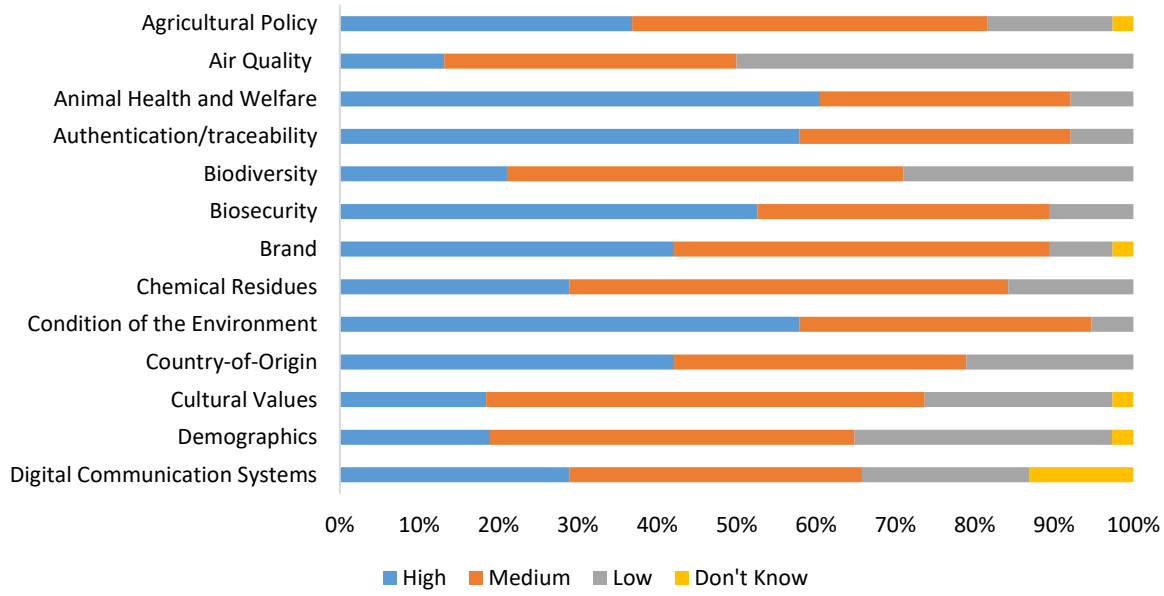
important international issue, and water quality and water use/rights as the most important domestic issue.

Impact of international drivers/issues on New Zealand land use change/practice

Participants were then presented with a list of 34 international drivers (as identified by previous studies) and asked to indicate whether these would have a low, medium, or high impact on New Zealand land use change/practise over the coming decade.

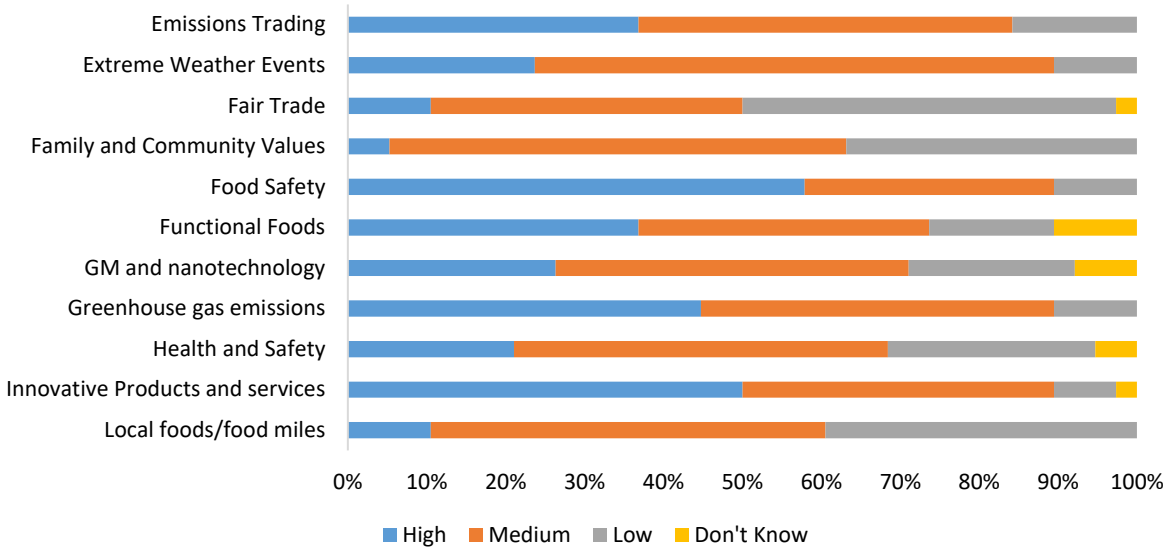
As shown by Figure 2.3 below, 61 per cent of respondents identified animal health as a high impact driver, and 58 per cent of respondents also indicated that authentication/traceability and the 'condition of the environment' could have a high impact. Air quality, biodiversity, cultural values and demographics were considered to have a high impact by 13 per cent, 21 per cent, 18 per cent and 19 per cent of respondents respectively. Eight per cent of participants indicated that animal health, authenticity/traceability and brand would be low impact, while only 5 per cent indicated that the condition of the environment would have a low impact. Thirteen per cent of respondents didn't know what the impact of digital communication systems would be on domestic land use practice/change.

Figure 2.3: Impact of international drivers/issues on New Zealand land use change/practice



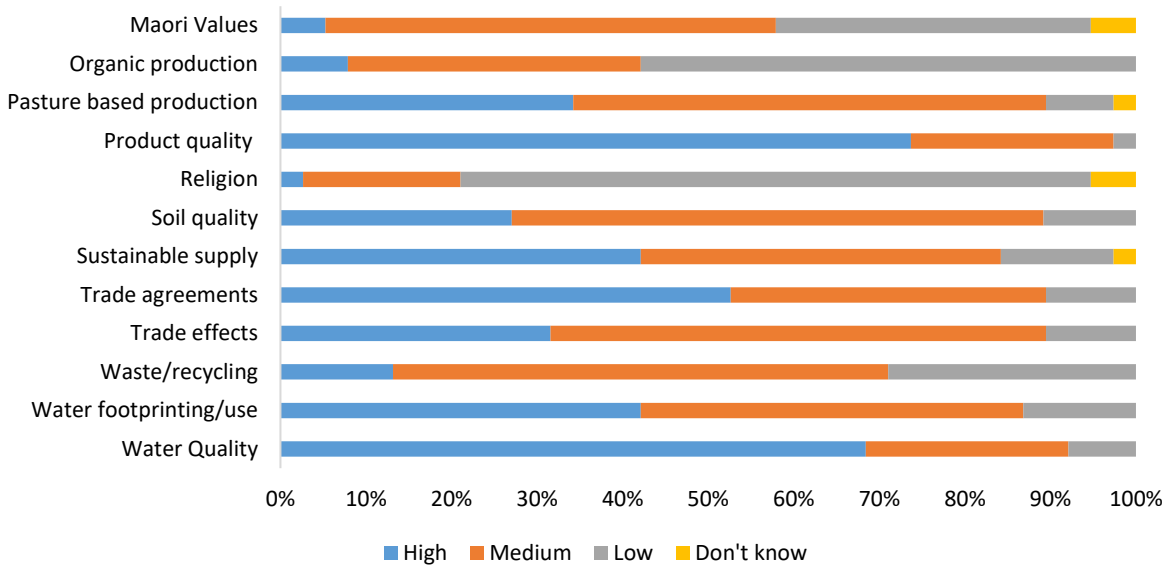
As shown in Figure 2.4 below, 58 per cent of participants identified food safety as a driver/issue that would have a high impact on domestic land use change/practice. Fifty per cent of participants identified innovative products and services as a high impact driver/issue, while 8 per cent indicated that this would have either a low impact or didn't know. Five per cent of respondents indicated that family and community values would have a high impact. Figure 2.4 also shows that 90 per cent of the survey participants indicated that extreme weather events, food safety, greenhouse gas emissions, innovative products and services would have either a high or medium impact on New Zealand land use change/practice.

Figure 2.4: Impact of international drivers/issues on New Zealand land use change/practice



As shown in Figure 2.5 below, 74 per cent of respondents indicated that religion would have a low impact, and only 3 per cent indicated it would have a high impact. Ninety-seven per cent of respondents indicated that product quality would have a medium or high impact on land use practice/change. Ninety-two per cent of respondents indicated that water quality would have a medium or high impact on land use change/practise. Ninety per cent of respondents indicated that pasture-based production, soil quality, trade effects and trade agreements would have a medium or high impact on land use change/practice. Māori values, organic production, religion, and waste/recycling were viewed by few participants as having a high impact on land use change/practice.

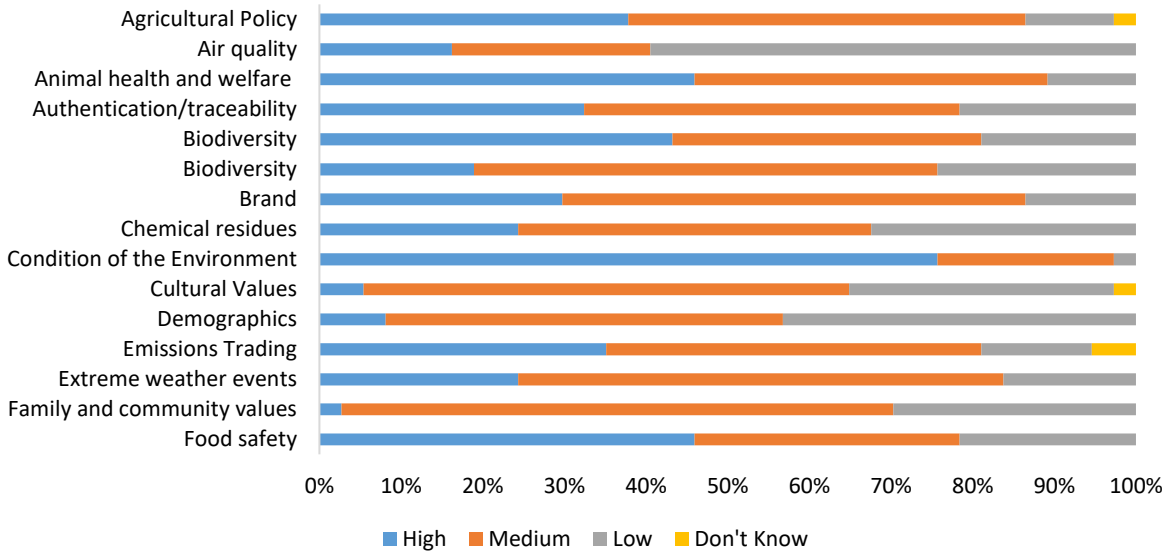
Figure 2.5: Impact of international drivers/issues on New Zealand land use change/practice



Impact of domestic drivers/issues on New Zealand land use change/practice

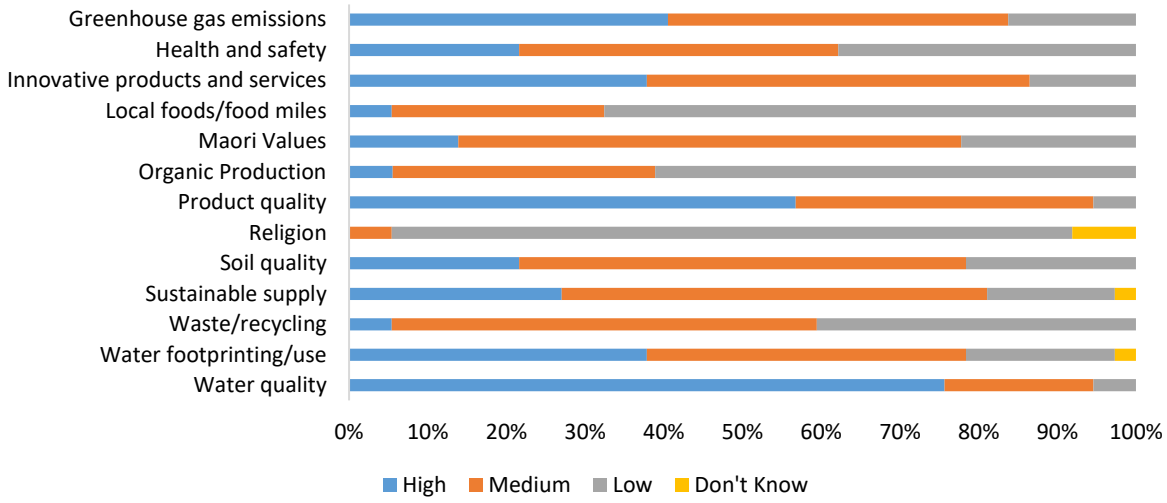
Participants were then presented with a list of 29 domestic drivers and asked to identify whether they would have a high, medium or low impact on New Zealand land use change/practice. As shown in Figure 2.6 below, 97 per cent of respondents indicated that the condition of the environment would have high or medium impact, and only 3 per cent respondent indicated the impact would be low. Five per cent of respondents indicated that cultural values would only have high impact, while 59 per cent indicated that this would have a medium impact. Eight per cent of respondents indicated demographics would have high impact, while 49 per cent indicated that it would have a medium impact. Three per cent of respondents indicated that family and community values would have a high impact, while 68 per cent indicated that it would have a medium impact. Fifty-nine per cent of respondents indicated air quality would have a low impact. Forty-six per cent of respondents indicated food safety, animal health and welfare would have a high impact on New Zealand land use practice/change.

Figure 2.6: Impact of domestic drivers/issues on New Zealand land use practice/change



As shown in Figure 2.7 below, 95 per cent of respondents identified water quality and product quality as issues/drivers that would have a high or medium impact on New Zealand land use practice/change. This was consistent with water quality and product quality in an international context. Religion was identified by 86 per cent of respondents as having a low impact, with these results also being consistent with religion in an international context. Local foods was seen as having a low impact by 68 per cent of respondents. Organic production was also seen as a low impact driver/issue by 61 per cent of respondents.

Figure 2.7: Impact of domestic drivers/issues on New Zealand land use practice/change



Additional analysis

Twenty participants indicated that they had experience in international markets, with eighteen participants indicating that they had little or no experience in international markets. The participants with moderate or higher experience levels in international markets were drawn out and examined more closely. This was done to see if there were any significant differences between those involved and not involved in international markets. Comparison of the results gave no indication of any major differences in the impact applied to each of the drivers by both groups.

3. Future trends and challenges and their impact on New Zealand land use change/practice

The primary sector represents a large proportion of domestic land use and contributes heavily to the New Zealand economy. Primary exports reached $38.1 billion in 2017, a 2.4% increase over the previous year. In 2018, it is expected that these exports will increase by 9.3% to $46.1 billion. The Ministry for Primary Industries has also set a goal of increasing the value of primary exports from $32 billion in 2012 to $64 billion by 2025 (MPI, 2017a). New Zealand's primary sector must achieve these export targets while simultaneously addressing global trends and challenges. Artificial intelligence, drone technology and autonomous vehicles represent a new generation of technology that are now being applied in the primary sector. Shifts in dietary patterns and new alternative foods are influencing millions of consumers globally. Climate change will continue to impact on regional production levels, biosecurity and ecosystem services crucial to the primary industry. The rise of bilateral free trade agreements and protectionist policy is also affecting the international trading environment. This report will

examine key future trends and challenges that could have the potential to impact primary land use change/practice in New Zealand.

3.1 Global trends and challenges

1. Growing global population, rising incomes and dietary changes

Global food systems are essential to the health, wellbeing and sustainability of the planet and its inhabitants. The global food systems are currently under pressure from 'the Triple Burden of Malnutrition,'- undernourishment, micronutrient deficiencies and over-nutrition (WEF;, 2016, p. 7). Eight hundred million people are hungry, 2 billion are micronutrient deficient, and 2 billion people are obese and overweight (WEF;, 2016). Developing "inclusive, sustainable, efficient, nutritious and healthy food systems" will be crucial to achieving the United Nations Sustainable Development Goals (SDGs) (WEF;, 2016, p. 4).

The global population is expected to reach 10 billion by 2050, up from 7.6 billion in 2017 (FAO, 2017a). Much of this growth will be focused around Asia and Africa (WEF, 2016). Global per-capita incomes are expected to rise by 2.2 percent each year between 2005 and 2050 (FAO, 2012). Sustained economic development, income growth and demographic changes will affect future consumption and dietary patterns around the world (FAO, 2017a). Diets will contain more salts, fats and sugars, and it is predicted that there will be a growing demand for meat, fruit and vegetables (FAO, 2017a). Intensive agriculture has already contributed heavily to greenhouse gas emissions, natural resource degradation, biodiversity loss, and water scarcity; it is likely that these future demands will place even greater stress on agricultural land use, production processes and natural resources (WEF;, 2016); (FAO, 2017a).

2. Food waste

Meeting future global demand will require more than increasing existing food systems production levels. Future demand could also be supported by a reduction in food wastage and loss. Food wastage costs industrialised countries $680 billion and developing countries $310 billion annually, which if reduced by as little as 25%, could help feed 870 million people (FAO, 2015). In developing countries waste is often generated by producers, while in developed countries waste is often generated by consumers. The FAO reported that approximately 1.3 billion tonnes of food is wasted each year (FAO, 2015). Research carried out by Rabobank New Zealand found that New Zealand consumers wasted an estimated $1.8 billion of food annually and that 94% of consumers wasted food (Shaw, 2017).

3. Commodity price fluctuations

It is likely that future supply and demand of agricultural products will follow historical trends, resulting in commodity price fluctuations. These fluctuations are a common market feature but have at times been volatile and impacted the food security for consumers, producers and countries (FAO, 2017b). Volatility in commodity prices can be attributed to factors such as changes in demand from developing markets (e.g. China and India) or extreme weather events (RBNZ, 2016). New Zealand's reliance on volume-based commodity exports will increase the potential impact of price fluctuations. Moving towards an economy that is focused on adding-value rather than volume-based exports will be crucial to minimising these vulnerabilities.

4. Phygital/personalised value chains

Phygital is a term used to describe the merging of the physical and digital worlds. Traditional brick-and-mortar stores are merging their processes with digital smart technology to generate a more tailored customer experience. The rapid proliferation of technology has meant

companies have access to large amounts of consumer data (Claes, 2017). Large multinational corporations such as Walmart and Tesco have large data storage units, which has allowed for more personalised advertising and promotions. The agri-food sector is now being increasingly influenced by artificial intelligence, augmented reality and smart technology. The Phygital era will change how food brands are marketed and sold in a significant way.

5. Social license to operate

Social License to Operate (SLO) has been defined as "the level of public trust granted to a corporate entity or industry sector by the community at large and its key consumer base" (Croplife, 2017, p. 1) There is now growing consumer demand for transparency and information provision in relation to primary production processes and practices. Commodity prices and public trust are now both key sector drivers. The New Zealand dairy sectors SLO has been affected by poor public opinion and trust. Perceptions around poor water quality management, pollution and the rural/urban divide, has forced the industry to address and adopt new land use practices to rebuild public opinion and trust.

SLO is changing globally as consumers demand supply chain information and transparency. The 2013 Business and Consumer survey found that over a 12 month period, 850,000 consumers in New Zealand switched brands due to unacceptable social, economic or environmental behaviour by firms (SBC, 2013). Significant environmental disasters such as the BP oil spill in the Gulf of Mexico and human rights issues such as clothing sweatshops in Bangladesh have led many to believe that industries production cannot be left unaccountable (SBC, 2013). SLO will continue to grow into the future and impact domestic and international land use change/practice, as consumers expect industries to operate in a socially and environmentally responsible manner.

3.2 Emerging technologies

Technological advancements are already dramatically impacting the global agricultural and food sector (WEF, 2016). Bio-innovation, gene editing, robotics, big data, artificial intelligence and machine learning will provide the agricultural sector with unparalleled access to data, which will help improve production processes, reduce waste and increase yields (WEF, 2016). These emerging technologies could significantly affect land use change/practice in New Zealand (Trice, 2017).

1. Artificial intelligence

Artificial intelligence (AI) is a radical new technology that sees computer systems performing tasks and making decisions like humans. AI is considered crucial to achieving the long-term sustainability of global food systems and agriculture (Trice, 2017). Technological systems that employ artificial intelligence and cognitive computing will have a significant impact on production efficiency (Irimia, 2016). Technology that condenses large data sources on research, historical weather data, nutrient levels, crop health, soil condition and moisture could provide recommendations that enhance yields and improve land use practices (Irimia, 2016). 'High speed variable rate planting equipment' has already allowed farmers to gather technical data about harvest production and yield trends, it is expected that this data will be the foundation of new predictive algorithms (Trice, 2017). AI will enable production processes to be automated and conducted remotely, which will aid the detection of risks and issues for quick and informed decision making (Irimia, 2016).

Automated irrigation systems which incorporate AI to predict and assess soil conditions will increase yields and improve water usage. It is hoped crop health monitoring will produce

individualized diagnostics for plots of land and single plants (WPGroup, 2017). Hyperspectral imaging and 3D laser scanning represent the cutting edge of automated detection and analysis (WPGroup, 2017). NatureSweet has begun incorporating AI into its tomato production process. The company's use of cameras and software to learn and recognize dying plants and disease/pest infestation has already boosted productivity by 2-4% (McFarland, 2017). AI is still in its infancy but is already has the potential to influence land change/practice domestically and internationally.

2. Unmanned aerial vehicle technology (UAVs)

Over the last 10 years there has been an exponential development and use of Unmanned Aerial Vehicles (UAVs) in agriculture. UAVs are now widely accessible and are being used to increase crop yields through field analysis, crop spraying and monitoring (WPGroup, 2017). The collection of nitrogen levels and irrigation data can help make production processes more efficient and sustainable, new start-up companies are now looking at using UAVs to shoot seeds and nutrients into the soil (Jennings, 2017). UAV technology could have a significant influence on New Zealand land use practice/change as its capabilities expand in the future.

3. Autonomous vehicles

Driverless tractors are new technological innovations that incorporate cutting edge sensors, radars and Global Positioning Systems (GPS) (WPGroup, 2017). It is envisaged that they will improve agricultural land use practices, reduce time-consuming processes and increase yields. Japan is currently developing these autonomous tractors and hopes to have the first generation available next year. Goldman Sachs has reported that advancements in AI and UAVs could increase yields by 70 per cent by 2050 (Daniels, 2016). As technology improves and prices drops, New Zealand could see an uptake in autonomous vehicles.

4. Plant genetics

Gene-editing is form of genetic engineering that has made significant progress in recent years. It is now far more precise and reversible compared to older techniques, and can now make single nucleotide changes which mimic natural base point mutations. Proteins such as zinc-finger nucleases, TALEN's and CRISPR are able to make site specific changes to DNA sequences (Royal Society, 2016). Importantly gene-editing can alter genes without the need of foreign DNA sequences, which could make it more appealing to consumers (Royal Society, 2016).

Gene-editing is already being trialled extensively around the world. In the US, maize, soybean, sorghum and rice have been altered to achieve desirable traits (Royal Society, 2016). Researchers in China have been using TALEN's and CRISPR modify crops and animals. New advancements have allowed the scientists to develop goats with longer coats and more muscle (Royal Society, 2016). Some researchers see a more radical future for plant genetics. Scientists from the United States Department of Agriculture (USDA) have proposed redesigning the process of photosynthesis. It is believed that changing chlorophyll molecules and CO_2 absorption rates could improve the growth rate and yield of crops (The Economist, 2017).

The Royal Society of New Zealand has convened a study that will examine the implications of gene-editing technologies for New Zealand. It is expected that gene-editing will have a significant impact on agricultural land use change/practice (Royal Society, 2016). New Zealand cows and the grasses consumed by them could be altered to reduce methane emissions (Royal Society, 2016). While studies are also examining allergenic milk protein production using cow embryos cultured in laboratories (Royal Society, 2016).

5. Vertical farming

Vertical farming is an innovative production model that uses controlled indoor environments to improve the efficiency of farming. The techniques used generate higher crop yields than traditional farming and greenhouse production, by controlling water, sunlight and nutrients more efficiently. Hydroponics, aeroponics and aquaponics are the three main concepts behind vertical farming. These systems do not require soil but instead use nutrient-rich water which is directly accessed by plant roots.

Supply chain disruptions, seasonality, production and price fluctuations severely impact the availability of fresh produce in urban areas, which means millions of people can only access produce erratically or at high cost (Pinstrup-Andersen, 2017). Vertical farming is not vulnerable to environmental disturbances or climate change, cuts water use by around 95 percent, and has lower emissions that traditional agriculture (Pinstrup-Andersen, 2017). Vertical farming still faces significant commercial and economic challenges, but could address urban production and consumption issues in the future (Pinstrup-Andersen, 2017).

3.3 Innovative Products - New Food Technology

1. Alternative Protein Sources

Global consumers are spending billions of dollars annually purchasing meat products, with demand expected to experience continued growth. The FAO estimates that the average person will consume 45.3kg of meat annually by 2030, up from 41.3kg in 2015 (Bruinsma et al., 2015). The projected increase in meat consumption will intensity the environmental impacts of agriculture. There has been significant investment in the development of alternative protein sources, with companies such as Memphis Meats, Beyond Meat investing heavily in their development and commercialisation. Campbell Soup, Nestle, Dannon, McDonald's, Land O'Lakes, and McCain have also shown significant interest in the industry (Wohl, 2017).

In 2016 Impossible Burgers began selling plant based vegan 'meat patties' at its restaurants (Wohl, 2017). The company has just established a new factory from which it expects to produce 1 million pounds of 'meat' annually (Wohl, 2017). New plant based protein products are also on supermarket shelves in retailers such as Whole Foods. Growing interest in vegetarian and vegan diets could drive demand for alternative protein products in the future. Studies have shown consumers often look for products that define their image and their core ethical and environmental beliefs (Manhire, 2009).

2. Synthetic Proteins

In 2013 the first cell cultured meat patty was produced at Maastricht University, and in 2017 Memphis Meats developed the first cell cultured meatball and chicken strips from animal cells (The Economist, 2017). It believes greenhouse gas emissions will be 90 per cent lower than traditional methods of meat production (Memphis Meats, 2017). Lab-grown meat is believed to still be 5 years away from commercialisation and at least ten years away from noticeably reducing the environmental footprint of meat production. Preliminary studies and surveys have indicated that consumers are willing to try, and if satisfied, incorporate lab-grown meat into their regular diets (Heffernan, 2017).

3.4 Consumer Trends

1. Vegetarianism, veganism and the Paleo diet

Vegetarianism and veganism have grown significantly over the last 20 years, overcoming scepticism and prejudice (Leitzmann, 2014). A 2006 research report examined 87 studies and found that the vegan/vegetarian diet was an effective method for weight loss (Williams, 2014). Vegetarian diets can include meat or fish, while vegan diets are stricter with generally no use or consumption of any animal-derived products. Vegetarian and vegan movements are influencing retailers which are increasingly stocking a wider range of alternative proteins and substitute products. US retailer Whole Foods has recently introduced an alternative to egg-based mayonnaise with a vegan product 'Just Mayo'. Restaurant outlets are also changing their menus to reflect the changes in consumer diets, with McDonalds in 2017 introducing a new vegan burger called the 'McVegan' in Finland (Hosie, 2017).

The Paleo diet is a new consumer trend that promotes that intake of only lean meats, vegetables, nuts, seeds and fruit (Gomillion, 2017). The CrossFit fitness programme, which has 13,000 gyms in 120 different countries, has heavily promoted the diet. (Wang, 2016). CrossFit athletes around the globe have often promoted and advocated the diet, inspiring millions to try it (Wang, 2016).

Veganism, vegetarianism, gluten-free and paleo diets are rapidly growing international consumer trends around the world. They represent a broader shift from 'mass-produced foods' to 'home-made or sustainably produced foods' (Williams, 2014). Growing awareness regarding the environmental, health and wellbeing implications of diets, could lead to a greater demand for vegetarian, vegan and paleo products. Social media services such as Facebook, Snapchat, Twitter and Instagram are also helping to accelerate the growth of these movements by advertising and distributing information around alternative diets (Puranen & Jansson, 2017). Changing consumer diets could affect the future demand for New Zealand primary products.

2. Products with credence attributes

The agriculture sector is facing significant change as demand for particular product attributes grows. In addition, agricultural policy in traditional New Zealand export markets is also shifting focus towards social and environmental protection and enhancement (Saunders et al., 2016b). Policy changes are helping the growth of market assurance schemes such as GLOBAL G.A.P. These schemes promote sustainability attributes, and set requirements and recommendations for production processes. Retailers and supplier are using the schemes across their entire value chain to address transparency concerns over sustainability and food origin.

The Agribusiness and Economics Research Unit (AERU) has found that consumers in important export markets are concerned about sustainability issues, and are willing to pay for food that is produced in a way that addresses these concerns (Guenther, 2015). Consumer concerns were particularly strong around environmental sustainability, animal welfare/health, and ethical issues such as Fairtrade (Guenther, 2015). The demand for products with these attributes is likely to grow in the future, and impact on New Zealand land use practice/change as domestic producers and suppliers seek to leverage and capitalise on these.

The Ministry for Primary Industries has set a goal of increasing the value of New Zealand's primary exports from $32 billion in 2012 to $64 billion by 2025 (MPI, 2017a). There is

significant potential to increase the value of our agricultural products by marketing non-physical credence values (Guenther, 2015). New Zealand producers have traditionally been successful at meeting international markets' requirements for physical attributes of products, but less successful at selling the credence attributes of our products (Guenther, 2015; Saunders et al., 2016b). New Zealand land use change/practice could be impacted as domestic producers and suppliers seek to leverage credence attributes in order to reach these future export targets.

3.5 Climate Change

1. Impacts on regional production

Climate change is expected to accelerate the environmental impacts of land use activities globally. Agricultural production is a major source of emissions that affect climate change (FAO, 2017a) Over the last 50 years, global primary production emissions have doubled, and are predicted to continue rising into the future (FAO, 2017a). In 2011, the Intergovernmental Panel on Climate Change (IPCC) developed a new set of climate scenarios (Kean et al., 2015). These formed the basis of the IPCC's fifth assessment report (released in 2015). Findings indicated that low-latitude countries crop production would be adversely affected by climate change, while countries' at higher latitudes could experience positive or negative impacts on production (FAO, 2017a). Similar studies have shown that warming could enhance primary production in colder climates and reduce it in warmer climates, while higher concentrations of CO_2 could potentially increase primary production around the world (Prentice, 2017). Climate change and population growth is likely to reduce the amount of arable land in Africa, South America, India and Europe, while Russia, China and United States may experience significant increases in arable land (Zhang, 2011). In the future crops that thrived in a particular area, may no longer be able to adapt to environmental disruptions induced by climate change. Changes to crops yields could also affect market demand, supply and prices (Lorencová et al., 2013). Climate change and global policies could improve returns for New Zealand's primary sector, with a decline in agricultural production overseas increasing demand for New Zealand products (Saunders et al., 2009).

2. Extreme weather events

The FAO predicts that agriculture and primary land use will be affected by increases in the frequency and intensity of natural disasters globally (FAO, 2017a). Over the last 30 years there has been more intense droughts, floods and storms which have impacted agricultural land use. The El Nino phenomenon in 2015/16 was one of the strongest measured around the globe (FAO, 2017a). In 2013, New Zealand experienced a drought which heavily impacted the primary sector and cost the economy around NZ1.3 billion dollars (Victoria University, 2017). The intensity and frequency of extreme weather events is likely to increase in New Zealand, which could impact the meat, wool, arable, dairy, viticulture, horticultural and forestry sectors (NZAGRC, 2012).

3. Higher biosecurity risks

Changes in temperature and rainfall could affect the dispersal and spread of damaging pests domestically and internationally (NZAGRC, 2012). New Zealand's ecosystems are particularly vulnerable to introduced species and diseases. The recent outbreak of the bacterium Mycoplasma bovis on several cattle farms around New Zealand highlighted this threat (MPI, 2017b). Although the disease was not a food safety or human health risk for milk or meat, it causes mastitis, pneumonia, arthritis, and abortions in cattle (MPI, 2017b).

Climate change could also increase the future risk of new "subtropical pests, vectored animal diseases, and self-introduced species with current transient establishment" (Kean et al., 2015, p. 48). Changes in temperature could allow vectors such as tics and mosquitos to spread high-risk diseases such as the West Nile virus or bovine ephemeral fever virus (Kean et al., 2015). Species which already inhabit New Zealand could thrive under the potential conditions induced by climate change, with 'sleeper' species having a significant impact on ecosystems and land use. In the future there may be an increase in use of bio-pesticides, to control and reduce the impact of transboundary flora/fauna pests and diseases. New Zealand will also become increasingly connected to the global trading environment, with the establishment of North-East Asia trade pathways potentially leading to an increased biosecurity threat from India, South America and other regions (Kean et al., 2015).

4. Ecosystem changes

Critical ecosystems services such as pollination and natural predator control could be disrupted by climate change (FAO, 2017a). These disruptions interacting with human land use stressors could have a dramatic impact on ecosystem health and stability (EPA, 2016). Primary production is reliant on these services, and their decline could affect crop yields, genetic variability, soil fertility, water quality, and feed/pasture production (Lorencová et al., 2013). Adopting sustainable land use practices will be critical to mitigating the effects of climate change on ecosystems.

5. Paris Climate Agreement

In 2015 the Paris Climate Agreement was adopted by 195 countries, the first ever legally binding international climate agreement (European Commission, 2017). It was signed with countries agreeing on net zero emission by 2050. A raft of measures were agreed upon, including attempting to limit global temperature increase to 1.5 degrees (European Commission, 2017). In 2017 President Donald Trump altered the United States position on climate change, and announced the country was leaving the Paris Agreement until terms were more favourable.

6. New Zealand domestic policy/emissions trading scheme

In 2015, New Zealand signed the Paris Agreement which reaffirmed the country's commitment to reducing emissions. New Zealand has committed to reducing its greenhouse gas emissions by 30% below 2005 levels by 2030 (MFE, 2017). New forestry plantations and the international carbon market will be used to meet these targets. In 2017, a new Labour government was elected and established a Climate Commission, which will determine whether agriculture will be included in the Emission Trading Scheme (MFE, 2017). Research using the Lincoln Trade Model suggested that the ETS alone would have a minimal impact on agricultural GHG emissions and production (Saunders, 2011). If deployed alongside mitigation technologies such as low GHG feeds and low methane emitting cattle there could be significant reductions in future emissions (Saunders, 2011). Economic modelling using the Lincoln Trade Model has also shown that net impacts of climate change could be positive or negative, depending on the actual climate change effects, domestic policies enforced, efforts to reduce emissions, and the use of an emissions trading market (Saunders et al., 2009).

New Zealand primary exports could also be promoted as zero or low-emission in the future, which could improve returns for producers (Saunders et al., 2009). Meat and Livestock Australia (MLA) are seeking to make the red meat sector carbon neutral by 2030 (Best, 2017). They see carbon neutrality as a source of competitive advantage, which would help

differentiate it from low cost competitors, and reduce the impact of demand for alternative meat products (Best, 2017).

3.6 International trading environment

1. Bilateral free trade agreements

Bilateral Free Trade Agreements (FTAs) are signed to open up market opportunities, streamline processes, reduce overhead costs, and generate more certainty and security for businesses conducting work overseas (MFAT, 2017). FTAs can also help local businesses be more competitive in overseas markets. New Zealand is currently negotiating FTA's with Russia, Kazakhstan, India, Belarus, Papua New Guinea and Vanuatu (MFAT, 2017). As new agreements come into force the primary sector may need to adapt production processes and land use practices to comply with new standards, quotas, or policies. FTAs will continue to play an important role in market connectivity and the international trading environment.

2. Global free trade agreements

The failure of the World Trade Organisation to complete the Doha Development negotiations in 2015 was a set back to the development of global/multilateral FTAs. New Zealand could be negatively impacted by the development of more bilateral trade deals which often favour the stronger signatory of the agreement. New Zealand is also at risk of being excluded from trade negotiations, which could affect market access and trade barriers.

3. Brexit

In 2016 the United Kingdom voted to leave the European Union. The EU is New Zealand's third largest trading partner, and the UK is New Zealand's fifth-largest export market (Kelly, 2017). These are significant markets, with these changes likely to affect New Zealand's primary industries. Preliminary negotiations are already underway to address future trading relationships. New Zealand and Australian governments are negotiating for an increased UK-EU quota for meat and dairy products post-Brexit. A recent proposal between the EU and UK would see existing quotas divided up according to where the agricultural goods were consumed (Beattie, 2017). The UK would take a larger quota as it traditionally had been the largest consumer of New Zealand products within the EU. However, the UK has always opposed large primary import quotas which compete with their own agricultural sector. Brexit could drive the UK to start negotiating more financially viable FTAs with other countries. The New Zealand primary sector may need to adapt new trade agreements with the EU and UK, which could affect quota limits, environmental regulations and restrictions, and demand for products.

4. Trans-Pacific Partnership

The United States has recently introduced more protectionist policies in order to shield US industries, which has affected trade deals such as the North America Free Trade Agreement (NAFTA) and the Trans-Pacific Partnership (TPP). The TPP was abandoned by President Donald Trump in 2017, and now Japan is advocating a restructured agreement. New Zealand's sectors are expected to save millions through reduced export costs and greater market access if a deal is reached (MFAT, 2015). The TPP agreement will affect trade policy, tariffs and export/import quotas, which will affect New Zealand's primary industries.

5. Agricultural subsidies/policy

The subsidisation of agriculture undermines market competitiveness for all countries exporting and importing food. The removal of subsidies encourages land use practices that

are more focused on sustainability, efficiency and yield (Strubenhoff, 2016). The EU is expected to introduce new reforms addressing its Common Agricultural Policy (CAP), which currently spends €60 billion subsidising farmers (EURACTIV, 2017). The World Trade Organisation abolished agricultural export subsidies in 2015 (Strubenhoff, 2016). However, the agricultural sectors in some countries such as China still remain heavily protected by government subsidies (Arsenault, 2014). Over the last 20 years China has become the world's largest producer, consumer and importer of agricultural products (Lopez et al., 2017). Its transformation from a rural to urban manufacturing and service economy has affected its agricultural policies (Lopez et al., 2017). To support these changes subsidies for farmers and the agricultural sector have been introduced and are expected to rise in the future (Lopez et al., 2017). As has been seen in developed regions such as the European Union, Japan and the United States, this may mean that China reduces imports which could affect New Zealand's export market.

6. Non-tariff barriers

Over the last twenty years, Governments internationally have introduced an increasing number of non-tariff trade measures (USC, 2016). Non-tariff trade barriers restrict imports and exports of goods and service, and range from import quotas, technical and licencing requirements, custom delays, and subsidies. Non-tariff barriers when applied correctly can increase competition and product quality, and improve social and environmental wellbeing. They can also become barriers to trade, distorting markets, raising costs, reducing competiveness, and impacting food security (USC, 2016). Non-tariff barriers could affect market access and quotas for New Zealand primary products in the future.

3.7 2024-2050: The future outlook for New Zealand land use practice/change

To address the likely impact of each trend/challenge affecting New Zealand land use change/practice by 2024 and 2050 a matrix table was produced (Table 3.1). A scale was developed (from low to high impact) which shows the likely impact of trends and challenges to New Zealand land use practice/change. Professors Caroline Saunders and Paul Dalziel of Lincoln University's AERU developed the matrix which was informed by the latest academic literature and foresighting, sector reports and other sources.

It is important to note that future shifts in demand and market connectivity are difficult to accurately control, predict or influence. Uncertainty around consumer trends, diets, and the intensity of demand for environmental sustainability, will affect whether future focus is placed on resource intensification or resource efficiency. It is also unknown how open and resilient commodity markets will be in the future, or whether countries will opt for more co-operative or protectionist trade policies. Innovative developments in artificial intelligence and alternative protein technology could either become highly guarded or dispersed on open platforms in the future (WEF, 2016). It is these uncertainties which makes it difficult to assess the true long-term impacts of these trends and challenges.

Table 3.1: Likely impact of trends/challenges on New Zealand land use practice/change by 2024 and 2050

		2024	2050
Global Trends	Global Population Increase	Medium-Low	Medium-Low
	Food Waste/Loss	Medium	Medium
	Rising Incomes	Medium-High	Medium-High
	Commodity Price Fluctuations	High	High
	Declining Land Area for Primary Production	Low	Low
	Phygital/Personalised Value Chains	Medium	High
	Changing Diets	Medium-High	Medium-High
	Social Licence to Operate	Medium	High
Emerging Technologies	Artificial Intelligence	Low	Medium
	Unmanned Ariel Vehicle Technology	Medium-Low	Medium-High
	Autonomous Vehicles	Low	Medium
	Vertical Farming	Low	Medium
	Plant Genetics (GE)	Medium-High	High
Consumer Trends	Alternative Plant Proteins (Impossible Burger)	Medium-High	High
	Synthetic Proteins	Low	Low-Medium
	Vegetarianism/Veganism	Low-Medium	Low-Medium
	Paleo Diet	Low-Medium	Low-Medium
	Products with Credence Attributes	High	High
Climate Change	Changes in Regional Production	Medium	High
	Extreme Weather Events	High	High
	Higher Biosecurity Risks	High	High
	Changes in Ecosystem Services	Medium	High
	Paris Agreement	Medium	High
	NZ Domestic Policy/Emissions Trading Scheme	High	High
International Trading Environment	Bilateral Free Trade Agreements	Medium	High
	Global Free Trade Agreements	Low	Medium
	Brexit	Medium	High
	Trans-Pacific Partnership	Low-Medium	Medium
	United States Protectionism	Medium	Low
	Agricultural Subsidies/Policy	Medium	Medium
	Non-Tariff Barriers	Medium	Medium

4. Conclusion

Optimising our land and freshwater resources on the basis of economic, environmental, social and cultural sustainability is a key outcome of the Our Land and Water National Science Challenge. Therefore identifying areas of highest potential impact, as related to the hierarchy of international and national issues, is needed to provide an evidence base to guide investment and inform the Challenge Research Strategy. This report presents an overview of the international and domestic drivers which have the potential to influence land use change/practice In New Zealand. This report also looks to inform the strategic direction of the OLW Challenge by identifying the likely impact of these drivers in the future.

The initial drivers report held a workshop and distributed a survey to identify what key stakeholders considered were the main drivers of land use change/practice in New Zealand. This report updated the original 30 drivers identified, and added digital communication systems, emissions trading, innovative products, social responsibility and fair trade, and precision agriculture. This report modified and extended the survey to a wider selection of stakeholders. Thirty-eight responses were received from individuals with experience and expertise in New Zealand's primary sector.

The survey found participants were most familiar with the European Union, Chinese, North American and United Kingdom regions and markets, and were most experienced in environmental policy, international markets and R&D and Innovation. The survey identified changes to the international trading environment, climate change, and alternative food products as the most critical international issues that could influence New Zealand land use change/practice. Water use and water rights, climate change, the emissions trading scheme, environmental degradation, the urban/rural divide and innovative products were identified as the most critical domestic issues that could influence New Zealand land use change/practice. The survey found that climate change and alternative food products was identified as both potential domestic and international drivers. Water quality and water rights were identified frequently as domestic drivers. While changes to the international trading environment was identified frequently as an international driver.

Participants identified animal health and welfare, condition of the environment, food safety, product quality and water quality as international drivers that would have a high impact on land use. While Māori values, family and community values and religion were identified as international drivers that would have a low impact on land use. In-depth analysis of the survey results found there was no significant difference in the impact of drivers between participants who were involved and not involved in international markets.

This report also examined future trends and challenges and their likely impact on New Zealand land use change/practice by 2024 and 2050. These were grouped under five broad heading: global trends, emerging technologies, consumer trends, climate change, and the international trading environment. Global commodity price fluctuations are likely to have a high impact on New Zealand land use, due to its reliance on volume-based commodity exports. Global dietary changes and growth in developing countries is likely to have a mixed impact as they increase demand for products but also increase their own production. Unmanned Ariel Vehicle technology (UAVs) and plant genetics are emerging technologies that likely to have a medium-high to high impact on New Zealand land use change/practice. Drone technology and gene-editing will be increasingly used in the primary sector as the technology progresses and capabilities expand.

This report has shown consumers are increasingly willing to pay for products that address environmental and ethical concerns such as sustainability and animal welfare/health. These consumer trends are likely to have a high impact on New Zealand land use practice/change as producers and suppliers seek to capitalise on these. Demand for transparency and information around production processes and practices will affect the primary industry's 'social license to operate' in the future. Consumers are also seeking out alternative plant proteins and products with credence attributes, as product costs decline and taste improves. The development of e-commerce and smart technology is revolutionising consumer and producer interactions. The Phygital era and personalised value chains are likely to have a high impact on land use change/practice by 2050, as the merging of the digital and physical worlds affect consumer behaviour and retailer marketing strategies.

Climate change will continue to pose a significant social and environmental threat in the future. Extreme weather events, biosecurity risks, ecosystems changes are all likely to have a high impact on land use by 2050. New Zealand's nationally determined contributions under the Paris Climate Agreement and Emissions Trading Scheme (ETS) are also likely to have a high impact on land use in New Zealand.

The failure of the World Trade Organisation to complete the Doha Development negotiations in 2015 has opened the door for bilateral free trade agreements. These agreements will be crucial for opening up new markets and reducing export cost and uncertainty. However, New Zealand risks being undermined by stronger signatories in these agreements. Brexit is also likely to have a high impact on New Zealand land use change/practice. New trade agreements with the European Union and the United Kingdom will affect traditional export markets for New Zealand. New Zealand risks losing quotas and market access as the EU and UK negotiate better trade agreements.

The mission statement of the Our Land and Water Challenge is to "enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations (OLW, 2017)." This report has examined the impact of domestic and international drivers on New Zealand land use change/practice, and has utilised the knowledge and expertise of those involved in the primary sector to help inform these. The likely impact of future trends and challenges on land use change/practice in New Zealand by 2024 and 2050 was also examined. The future of sustainable and productive primary land use will require addressing the issues, trends and drivers outlined in this report.

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Appendix A: Review of international consumer preferences studies – choice experience (CE) and willingness-to-pay (WTP) case studies

It is important to value the range of premiums that international consumers are willing to pay for the inclusion of attributes in products. One method to assess this is the use of choice experiments. A choice experiment (CE) is an economic valuation method used to assess willingness-to-pay (WTP) for different attributes of goods or services that can (but does not have to be) traded in markets. This belongs to the category of stated preference non-market valuation methods (Hanley et al., 2013; Hensher et al., 2015). CE can be used to explore consumer preferences for attributes that do not currently exist in-market (Teratanavat and Hooker, 2006) for application in product development or market access, and to simulate real markets and the product choices involving trade-offs (Carlsson et al., 2005; Mueller Loose and Remaud, 2013; Poelmans and Rousseau, 2016).

This chapter updates a literature review of consumer WTP for a series of basic and credence attributes relating to the international and domestic drivers included in this report. This review complements previous large-scale literature reviews produced as part of the Maximising Export Returns (MER) research programme by Agribusiness and Economics Research Unit (Miller et al., 2014), as well as Stage 1 of the Drivers Project for the Our Land and Water component of the National Science Challenge (Saunders et al., 2016), covering mainly academic CE literature published between 2003 and 2016. Previous reviews identified food safety as a key credence attribute across all markets, including positive WTP with high associated premiums in some cases (e.g. food safety credentials on food products in China). This is understandable due to widespread public concerns regarding previous food safety incidents around the world. Moreover, some developing countries are experiencing rapid change such as growing populations and increased urbanisation - it is possible that these can also impact on consumer preferences.

Previous reviews also identified product quality (and associated indicators) as another popular credence attribute. Examples of this include the freshness of milk products or tenderness of steak products. Product quality can also extent to aspects of a product's origin, whereby a common finding is that people prefer domestically-produced over imported food products. There is also a range of case studies considering production methods, typically comparing organic, genetically modified (GM) and conventional production practices. Regarding GM production, evidence is mixed, while WTP for organic production (for dairy, fruit and vegetable, wine, oil and flour products) was found to be consistently positive. It has also been shown that consumers can associate organic foods with a range of benefits, such as increased healthiness and limited use of pesticides.

Similarly, functional foods (i.e. food products that offer health benefits beyond basic nutrition) have also shown some positive WTP. In China and Singapore, for example, there is growing interest in these types of products, such as those intended to enhance the immune system, supplement basic nutrition or assist with aspects of beauty, among other effects. Miller et al. (2014) includes limited empirical examples examining oil, bread, eggs and wine products.

Finally, the previous review found some evidence that consumers are concerned with environmental or animal welfare issues, particularly in relation to the ethical dimensions of production. For example, studies indicate that consumers in the UK, China and India are willing to pay for reduced water pollution, reduced greenhouse gas (GHG) emissions and improved biodiversity in agricultural production (Saunders et al., 2013), and for certified paper towels

associated with several environmental attributes in the USA (O'Brien and Teisl, 2004). Likewise, research has indicated that many consumers are concerned about the health and welfare of animals, potentially influencing their purchase decisions. The CE studies have included general animal welfare or free range attributes alongside other types of attributes related to animal health and welfare.

A1.1. Meat and seafood products

The current review includes 28 CE and other WTP studies examining the attributes of meat and seafood products in Europe, North America, Asia and other regions. The most commonly examined markets across these studies include Germany, the United Kingdom (UK), the United States (US) and China. Attributes examined in these studies include animal health and/or welfare, organic, different production methods, traceability, local food, country-of-origin, nutritional content, functional foods, social responsibility, environmental condition, certification, carbon/GHG emissions associated with production, water use and genetic modification (GM), as well as generic attributes such product quality, appearance and taste.

General studies

Clark et al. (2017) conducted a review of international WTP literature regarding farm animal welfare for pigs, chickens, cattle and fish. The authors estimated a weighted mean WTP (in Euros) for the provision of higher standards of farm animal welfare across a range of studies, measures and differences in WTP by type of production animal. As shown in Table A1, the authors found higher mean WTP for beef cows and fish compared to pigs and broiler chickens. This indicates that consumers prefer the provision of farm animal welfare depending on the type of animal involved in production.

Table A1: Willingness-to-pay for farm animal welfare, international literature review

Animal Type	No. of Measures	No. of Studies	Weighted Mean WTP (€)
Pig	90	13	0.54
Layer Hen	47	10	0.09
Broiler Chicken	26	8	1.24
Dairy Cow	27	7	0.50
Beef Cow	24	7	5.00
More than one type	6	2	11.20
Fish	6	3	3.53

Source: Clark et al., 2017.

European studies

The current review includes 13 CE and other WTP studies examining the attributes of meat and seafood products in Europe, including studies conducted in Germany, Denmark, Portugal, Spain, France, UK, Sweden, Italy, Netherlands and Belgium. Attributes examined in these studies include animal health and/or welfare, organic, different production methods, traceability, local food, country-of-origin, nutritional content, functional foods, social responsibility, environmental condition, certification, carbon/GHG emissions associated with production, water use and genetic modification (GM), as well as generic attributes such product quality, appearance and taste.

Denver et al. (2017) conducted a WTP study to value Danish consumers' WTP for the provision of relative levels of animal welfare for pigs in pork production. The study was designed to assess consumers' WTP for trade-offs between standard, medium and high levels of animal welfare in production. Table A2 shows that there is a small difference between WTP for

medium and high levels, with many consumers not willing to pay additional premiums to move beyond the medium level of animal welfare.

Table A2: Willingness-to-pay for animal welfare in relation to pork, Denmark (N=396)

Attribute Level	Market price premiums	Stated WTP for welfare pork	
		Respondents usually buying standard or medium level welfare pork	*Respondents usually buying high level welfare pork*
Standard	0%	Base (WTP not estimated)	
Medium (relative to standard)	17-75% higher	80% higher	170% higher
High (relative to medium)	14% higher	0% higher	15% higher

Source: Denver et al., 2017.

Risius and Hamm (2017) examined the effects of exposure to communication materials on German consumers' WTP for organic and animal husbandry attributes in relation to beef products. The authors tested consumer preferences and WTP for beef products before and after being shown communication materials regarding different animal husbandry and production methods. Prior to being shown material, participants indicated a preference for enhanced husbandry practices and organic production. Participants were then shown either an image film, a documentary film or a leaflet giving further information regarding each type of production method or husbandry practice (including organic production, extensive suckler cow husbandry and pasture-based husbandry). As shown in Table A3, following the presentation of this information, consumer preferences and WTP for each system changed based on the type of information presented.

Table A3: Willingness-to-pay (€) for organic and animal husbandry attributes following presentation of communication materials (image film, documentary film and leaflet), Germany (N=676)

Communication material	Attributes		
	Organic	*Extensive suckler cow husbandry*	*Pasture-based husbandry*
Image film	2.98	3.79	0.98
Documentary film	2.67	5.93	0.27
Leaflet	4.22	4.68	-0.31

Source: Risius and Hamm, 2017.

Calvo Dopico et al. (2016) examined European fish consumers' (Portugal, Spain, France, UK and Germany) preferences and WTP for the provision of traceability information with fish products. Table A4 shows that while around half of participants stated that they would not be willing to pay a premium for this (particularly Portuguese and Spanish participants).

Table A4: Willingness-to-pay for traceability programme, European countries

Country	Sample	WTP: No	WTP: Yes	WTP for traceability programme	
				Premium	*% participants*
Spain	410	262 (63.9%)	148 (36.1%)	€0–0.25	10.2
				€0.26–0.50	8.8
				€0.51–0.75	6.3
				€0.76–1	5.9
				€ > 1	4.9
UK	302	147 (48.68%)	155 (51.32%)	€0–0.25	9.93
				€0.26–0.50	18.87
				€0.51–0.75	9.27
				€0.76–1	7.28
				€ > 1	5.96
Portugal	728	553 (75.96%)	175 (24.04%)	€0–0.25	7.69
				€0.26–0.50	7.42
				€0.51–0.75	4.67
				€0.76–1	3.02
				€ > 1	1.24
France	335	160 (47.8%)	175 (52.2%)	€0–0.25	14.93
				€0.26–0.50	17.31
				€0.51–0.75	9.25
				€0.76–1	7.46
				€ > 1	3.28
Germany	300	126 (42%)	174 (58%)	€0–0.25	6.00
				€0.26–0.50	21.33
				€0.51–0.75	16.00
				€0.76–1	11.00
				€ > 1	3.67

Source: Calvo Dopico et al., 2016.

Hempel and Hamm (2015) examined German consumers' preferences and WTP for organic and local attributes across a range of food products, including beef steak, butter, apples and flour products. Based on a series of questions regarding preferences for organic and local products, the authors segmented participants into two groups – organic-minded consumers (OMC) and non-organic-minded consumers (NOMC). Table A5 shows differences in WTP for local and organic attributes between OMC and NOMC, with both groups indicating the highest WTP for local beef steak products (as opposed to 'from a neighbouring country'.

Table A5: Willingness-to-pay (€) for organic and local attributes, Germany (N=638)

	Organic-minded consumers (N=221)			Non-organic-minded consumers (N=427)		
	Organic	*Local (as opposed to "from Germany")*	*Local (as opposed to "from a neighbouring country")*	*Organic*	*Local (as opposed to "from Germany")*	*Local (as opposed to "from a neighbouring country")*
Apples (/kg)	1.22	0.63	4.25	-0.13	0.17	2.07
Butter (/250g)	0.31	0.37	1.26	-0.01	0.12	0.56
Flour (/kg)	0.97	0.36	3.44	-0.03	0.23	1.28
Steak (/200g)	2.46	1.26	5.56	0.46	1.94	4.80

Source: Hempel and Hamm, 2015

Lagerkvist et al. (2017) examined Swedish consumers' WTP for a range of credence attributes in relation to beef products using a discrete choice experiment. Attributes included country-of-origin labelling, traceability to various parts of the supply chain, animal health and welfare, human health, social responsibility, and production methods. As shown by Table A6 below, participants indicated a range of positive WTP values for all attributes, particularly to move from basic to slightly improved levels (e.g. Price 1 to Price 2).

Table A6: Willingness-to-pay (SEK) for a range of attributes in beef products (discrete price level), Sweden (N=440) (base price=200 SEK/kg)

Attribute	Price 2: 225 SEK/kg	Price 3: 250 SEK/kg	Price 4: 275 SEK/kg	Price 5: 300 SEK/kg	Price 6: 325 SEK/kg
Reference code	2.09	0.79	0.42	0.28	0.23
Traceability to specific slaughterhouse	1.46	0.55	0.30	0.20	0.16
Traceability to group or specific animal	2.00	0.75	0.41	0.27	0.22
Traceability to specific breeder	1.49	0.56	0.30	0.20	0.17
Animal welfare	2.89	1.09	0.59	0.39	0.32
Animal medication used for preventative purposes	2.52	0.95	0.51	0.34	0.28
Organic production	2.03	0.76	0.41	0.28	0.22
Environmental impact	1.68	0.63	0.34	0.23	0.19
Health impact	1.71	0.64	0.35	0.23	0.19
Social responsibility	1.96	0.74	0.40	0.27	0.22
Type of animal feed used	1.44	0.54	0.29	0.20	0.16

Source: Lagerkvist et al., 2017.

Balcombe et al. (2016) examined UK consumers' WTP for country-of-origin, production methods, product quality and certification attributes in 12 types of poultry, beef, pork and sheep meat products. Table A7 presents mean estimates of WTP for the range of products and attributes mentioned above. Results show that participants were willing to pay a premium for each of the attributes across most products, with negative WTP uniformly shown for products of non-UK origin.

Table A7: Mean willingness-to-pay (£) for a range of attributes in meat products, UK (N=2,951 – approx. N=490 per choice experiment)

Product Type	Attributes							
	*Choice**	*Premium**	*Organic*	*UK Origin*	*EU Origin*	*Origin Outside EU*	*Freedom Food Label*	*Intl. Quality Label*
Pork sausages (/450g)	0.17	1.08	0.91	0.84	-0.27	-0.73	0.33	0.87
Pork joint (/1.5kg)	0.46	2.40	2.62	3.15	-1.09	-2.28	1.68	2.42
Beef lasagne (/600g)	0.87	2.55	1.92	1.68	-1.0	-0.71	0.96	1.68
Bacon (/300g)	0.35	0.88	0.93	0.67	-0.62	-1.04	0.6	0.85
Beef burger (/450g)	0.49	1.02	0.67	0.65	-0.77	-0.86	0.48	0.85
Chicken curry (/400g)	0.4	1.45	1.29	1.16	-0.41	-0.87	0.52	1.19
Leg lamb (/1.5kg)	0.5	1.69	2.03	2.85	-2.62	0.03	1.68	1.43
Chicken breasts (/500g)	0.63	1.4	2.06	2.23	-0.38	-1.99	1.41	1.7
Pepperoni pizza (/14" pizza)	0.51	1.59	1.48	0.91	-0.95	-0.5	1.35	1.31
Chicken pie (/550g)	0.43	1.37	1.02	0.72	-0.86	-0.76	0.55	1.18
Gammon steaks (/225g)	0.52	1.44	1.06	1.59	-0.64	-1.31	0.8	0.75
Turkey mince (/400g)	0.32	1.05	1.21	1.12	-0.14	-1.01	0.69	1.03

**Choice* refers to improved product quality from the base product; *premium* refers to the top level of product quality.
Source: Balcombe et al., 2016.

Kallas et al. (2015) designed a study using a simulated market setting to assess the impact of a possible ban on surgical castration of pigs in the EU. This study also included a sensory parameter by including a scent and taste test between two CEs. As Table A8 shows, participants were willing to pay a small amount for the welfare attribute while the sensory impact resulted in some differences in WTP estimates, such as the WTP for flavour attribute changing from a negative to a positive WTP of 0.66 euros/package (55% premium) after exposure to product tasting. The results also show that participants' WTP was lower for the manufacturer's own brand compared to the private brand.

Table A8: Willingness-to-pay for pork sausage attributes, Spain (N= 150*)

		Pre Sensory CE		Post sensory CE	
		WTP €/package	*Premium (%)**	*WTP €/package*	*Premium (%)**
Flavour (vs. Original/ non-flavoured)	With spices and naturally smoked	-0.558	(-47%)	0.660	(55%)
Castration (vs. none)	Meat from castrated pigs or boars	0.340	(29%)	-	-
Brand (vs. manufacturer)	Private	-0.252	(-21%)	-0.342	(-29%)

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
*Compared to the average of the applied price vector: €1.19/package
Source: Kallas et al. (2015)

Animal welfare was also included in the Zanoli et al. (2013) investigation of consumers' beef product preferences in Italy. In particular, the study contrasted animal welfare with production methods, origin and quality indicators (e.g. fat content and colour). Table A9 shows that organic and domestic attributes had the highest relative WTP of between 24 and 26 euros/kg (109% and 206% of base price) respectively.

Table A9: Willingness-to-pay for beef attributes, Italy (N = 145*)

		WTP €/kg	Premium (%)**
Production method (vs. not organic)	Organic	26.25	(109%)
Production method (vs. not conventional)	Conventional	12.76	(106%)
Animal welfare (vs. Box)	Free-range	17.29	(144%)
Place of production (vs. abroad)	Italy	24.69	(206%)
Breed origin (vs. not local)	Local	6.40	(53%)

* Data were gathered from three different locations (medium-sized towns) in northern, central and southern Italy, in 2008.
** Compared to the basic prices reported in study: €24/kg for the organic beef attribute, and €12/kg for other attributes
Source: Zanoli et al. (2013)

Van Loo et al. (2014) combined different environmental and ethical attributes in a CE of chicken products, segmenting participants into income brackets. The attributes were presented in different logos, labels and claims associated with production, with CE results showing a consumer preference for product labels or claims over not having them at all. As Table A10 shows, average WTP is higher for free-range claims (43-93%), with respondents also favouring the introduction of domestic or EU-organic logos, carbon footprint and animal welfare labels.

Table A10: Willingness-to-pay for chicken breast attributes, Belgium (N = 359*)

Attributes		WTP euros/kg	Premium (%)**	WTP euros/kg	Premium (%)**
		Low income		*High Income*	
Organic logo (vs. none)	Biogarantie logo (Belgium)	2.16	(23%)	3.18	(34%)
	EU Organic logo	1.16	(12%)	1.70	(18%)
Animal welfare label (vs. none)	European animal welfare label	2.50	(26%)	3.67	(39%)
Free range claims (vs. none)	Free range	4.12	(43%)	6.06	(64%)
	Traditional free range	4.77	(50%)	7.02	(74%)
	Free range-total freedom	5.99	(63%)	8.81	(93%)
Carbon footprint label (vs. none)	20% CO2-reduction: 5.6 kg CO2e compared to 7 kg CO2	1.73	(18%)	2.54	(27%)
	30% CO2-reduction: 4.9 kg CO2e compared to 7 kg CO2	2.31	(24%)	3.40	(36%)

* Online survey conducted in the northern Belgium, 2012.
** Compared to the average price for conventional chicken breast in Belgium in 2012 (€9.49/kg)
Source: Van Loo et al. (2014)

Viegas et al. (2014) estimated Portuguese consumers' WTP for animal welfare in the context of testing whether premiums paid for credence attributes can justify higher associated production costs. Specifically, the authors hypothesised that WTP for a particular attribute (e.g. animal welfare) is conditional on the presence of other attributes (e.g. environmental quality and/or food safety). The reference alternative included legal minimums and a status quo price. As shown in Table A11 below, the estimated WTP suggests that the highest value was placed on food safety, ranging from 7-16 euros/kg, followed by animal welfare and environmental protection. An important implication was that the WTP for different combinations of attributes should not be obtained from independent valuation and summation due to significant interaction effects. The authors then applied a conditional approach on estimating attribute WTP (Table A11, last column) whereby, for example, the WTP for food safety in the presence of both animal welfare and environmental certification decreases the average WTP (from up to 16 euros to negative or close to zero). This suggests that animal welfare and environmental attributes may be proxies for food safety.

Table A11: Willingness-to-pay for beef attributes, Portugal (N = 613)

Attribute	Levels	Average WTP €/kg (premium %*)		Conditional WTP** €/kg (premium %*)		
		main effects	*main + interaction effects*			
Beef safety (vs. legal standards)	Certified additional level: Reduction/control of the quantity of antibiotic residues in beef	7.31 (42%)	16.23 (93%)	AW =0 ENV = 0 AW = 1 ENV = 0 AW = 0 ENV = 1 AW = 1 ENV = 1	16.23 7.47 7.32 -1.43	(93%) (43%) (42%) (-8%)
Animal welfare (vs. legal standards)	Certified additional level	7.30 (42%)	12.07 (69%)	FS = 0 FS = 1	12.08 3.32	(69%) (19%)
Environmental Protection (vs. legal standards)	Certified additional level: Air, water, soil pollution and reduction/ prevention	4.81 (28%)	7.35 (42%)	FS = 0 FS = 1	7.35 -1.55	(42%) (-9%)

*Compared to average of the applied price vector (€17.98/kg)
** 1 indicates the condition, zero otherwise: AW = Animal Welfare; ENV = Environmental Protection; FS = Food Safety
Source: Viegas et al. (2014)

Gracia (2014) investigated Spanish consumers' WTP for local lamb products using a simulated market environment with an additional objective of reducing the risk of hypothetical bias in the results. The results shown in Table A12 indicate that consumers are willing to pay a premium of between 9 and 13 per cent for local and "Ternasco" lamb, respectively, over unlabelled or "suckling" lamb, respectively.

Table A12: Willingness-to-pay for fresh local lamb attributes, Spain (N = 133)

Attribute		*WTP €/package*	*(Premium %)*
Locally grown label (vs. unlabelled)	Labelled as "Ojinegra from Teruel"	0.29	(9%)
Type of commercial lamb (vs. *"Suckling" lamb*)	"Ternasco" lamb	0.43	(13%)

Source: Gracia, 2014.

Van Wezemael et al. (2014) conducted a European cross-country study exploring consumer preferences and WTP for nutrition and health claims in relation to beef steak. The study tested an information/framing effect in a split-sample approach wherein one sample was shown attributes with nutritional claims only (N sample) and other sample were shown both nutritional and health claims together (NH sample). The results from Table A13 suggest that the valuation of nutritional and health claims varies across countries. Across samples, the NH sample had consistently higher WTP, with the exception of a "rich in protein" claim in the UK. This indicated the existence of country-specific marketing opportunities when considering nutrition and health claims on beef products, such as information regarding product protein levels in the UK.

Table A13: Willingness-to-pay for beef steak attributes, Belgium, France, The Netherlands and UK (N = 600/country*)

N sample			WTP €/kg	Premium (%)**
Iron (vs. no claim)	Nutritional claim: "Source of iron"	Netherlands	5.44	(33%)
		Belgium	4.26	(26%)
		France	4.11	(25%)
		UK	5.04	(31%)
Protein (vs. no claim)	Nutritional Claim: "'Rich in protein''	Netherlands	2.71	(16%)
		Belgium	3.42	(21%)
		France	4.96	(30%)
		UK	5.81	(35%)
Saturated fat (vs. no claim)	Nutritional Claim: ''poor in saturated fat''	Netherlands	5.78	(35%)
		Belgium	5.60	(34%)
		France	6.73	(41%)
		UK	1.20	(7%)
NH sample				
Iron (vs. no claim)	Nutritional claim: "Source of iron" Health Claim: ''Iron contributes to the normal cognitive function''	Netherlands	5.62	(34%)
		Belgium	5.89	(36%)
		France	5.49	(33%)
		UK	4.27	(26%)
Protein (vs. no claim)	Nutritional Claim: "'Rich in protein'' Health Claim: ''Protein contributes to the growth or maintenance of muscle mass.''	Netherlands	4.22	(26%)
		Belgium	6.20	(38%)
		France	9.70	(59%)
		UK	4.39	(27%)
Saturated fat (vs. no claim)	Nutritional Claim: ''poor in saturated fat'' Health Claim: "Consumption of saturated fat increases blood cholesterol concentration. Consumption of foods with reduced amounts of saturated fat may help to maintain normal blood cholesterol concentrations.''	Netherlands	8.45	(51%)
		Belgium	11.66	(71%)
		France	11.71	(71%)
		UK	4.60	(28%)

***** Online survey in 2011 with people consuming beef at least once a month.
**Compared to average of the applied price vector (€16.5/kg)
Source: Van Wezemael et al. (2014)

In Sweden, Lagerkvist et al. (2014) focused on COO and ethical cues in the presence or absence of price attribute, the differences of which should not (in theory) impact on the preferences and structural validity of CE. A large of range attributes with quality and ethical cues were included in the study (see Table A14) where the absence of labelling information was used as a reference point. In addition, a non-parametric test was used to confirm attribute ranking by consumers. A sample of over 1,000 participants completed the survey. The WTP results in Table A14 are only reported for that part of the sample who saw the CE with the price vector (required for WTP calculation). These results show that consumers were willing to pay an average 10% premium for a verified SR labelling in beef products – approximately four times lower than COO information. COO was also found to be the top ranked attribute in both samples. In regards to the comparison between the inclusion and exclusion of price attributes, one of the results indicated that there was consistently less heterogeneity in the CE without the price attribute.

Table A14: Willingness to pay for beef attributes, Sweden (N = 1,070*; n = 630 "no-price sample" and n = 440 "price sample")

		"Price sample"		"Price sample"	"No-price sample"
		WTP SEK/kg	*Premium (%)***	*Attribute ranking*	
Origin Information (vs. zone of origin inside or outside EU)	COO (inside or outside EU)	113.7	43%	1	1
Animal specific Reference code (vs. not present)	Information on package	15.0	6%	12	12
Traceability to specific slaughterhouse (vs. not present)	Information on package	32.0	12%	6	6
Traceability to group or specific animal (vs. not present)	Information on package	29.5	11%	7	9
Traceability to specific breeder (vs. not present)	Information on package	32.6	12%	5	4
Verified animal welfare for livestock production (vs. not present)	Information on package	42.1	16%	1	1
Organic production (vs. not present)	Information on package	37.0	14%	4	5
Verified Environmental impact of livestock production (vs. not present)	Information on package	25.6	10%	9	8
Verified health impact from consumption of beef production (vs. not present)	Information on package	21.5	8%	10	10
Verified social responsibility for livestock production (vs. not present)	Information on package	27.4	10%	8	7
Information about medication use (vs. not present)	Information on package	41.2	16%	3	3
Type of animal feed (vs. not present)	Information on package	18.4	7%	11	11

* Online survey in 2012 amongst beef consumers.
**compared to the average of the applied price vector: 262.5 SEK per kg
Source: Lagerkvist et al. (2014)

North American studies

The current review includes 6 CE and other WTP studies examining the attributes of meat and seafood products in the US. Attributes examined in these studies include animal health and/or welfare, organic, different production methods, traceability, country-of-origin, food safety, environmental condition and certification, as well as generic attributes including product quality and appearance.

Li et al. (2016) examined US consumers' household WTP for a programme aimed at reducing Greenhouse Gas (GHG) emissions associated with beef production. The authors created four consumer segments based on their willingness to support a programme certifying "carbon-friendly" beef products – '*does not support*', '*supports but will not pay more*', '*supports and will pay more*', and '*willing to pay specific premium for certified beef*'. For the latter two segments combined, results indicated that participants in these segments would be willing to

pay an average US$306 per year to support this programme (equating to 51.6 per cent of their average annual total beef product spend). Across all segments, including those that would not support this programme, average annual WTP was valued at US$64 (just over 10 per cent of all participants' average annual total beef product spend). Average WTP was also shown to be higher for participants that donated to environmental organisations (Li et al., 2016).

Byrd et al. (2017) examined US consumers' WTP for a range of attributes associated with chicken and pork products, including local production, animal welfare and food safety. These attributes were also assessed against a range of certifying bodies, including the USDA, retailers and industry bodies. Table A15 shows a range of premiums that participants were willing to pay in relation to the above, with results indicating the highest positive WTP for pasture access for chicken, particularly when certified by the USDA.

Table A15: Willingness-to-pay for chicken and pork products with associated local, animal welfare and food safety attributes, US (N=825) (US$/lb)

Attribute	Verifier	Chicken breast		Pork chop	
		WTP	*% positive WTP*	*WTP*	*% positive WTP*
Pasture access	USDA	1.78	91.7		
	Retailer	1.47	92.7		
	Industry	1.43	82.3		
Individual crate	USDA			1.98	84.0
	Retailer			0.27	45.5
	Industry			2.34	72.6
Antibiotic use	USDA	1.87	75.0	4.55	85.7
	Retailer	1.33	74.3	1.32	61.7
	Industry	1.11	61.7	1.17	70.0
Local	USDA	2.06	89.6	1.44	9.4
	Retailer	0.49	68.9	1.31	9.9
	Industry	0.49	59.7	3.37	3.9

Source: Byrd et al., 2017.

In another pork CE, Ubilava et al. (2011) compared US consumers' WTP for the *certification* of credence attributes for branded and non-branded products. Selected credence attributes included antibiotic use, animal welfare and environmental friendliness in the production process where, in a split-sample, some CEs also included a product brand (*Hormel, Tyson, Store brand* or *no brand*). Table A16 reports the WTP results which range from 4 to 28 per cent (0.2 to 1 $/lb) for certified antibiotic-free, environmentally-friendly and animal welfare attributes. The study also reported a greater variation in WTP for the non-branded case, which could be related to an increased uncertainty when no brand information is provided; while it also appears that the attributes as *bundles* (i.e. attribute interactions) influenced consumer preferences.

Table A16: Willingness-to-pay for pork chop attributes, USA (N = 839*: brand CEs n = 642, non-brand CEs n = 197)

		Choices with brands		Choices without brands	
	By brand	*WTP $/lb*	*Premium (%)***	*WTP $/lb*	*Premium (%)***
3rd party certified antibiotic-free production (vs. no certification)	Hormel	0.78	22%	0.63	18%
	Tyson	0.35	10%		
	Store Brand	0.61	18%		
	No brand	0.98	28%		
3rd party certified environment-friendly production: water and air quality (vs. no certification)	Hormel	0.76	22%	0.24	7%
	Tyson	0.26	7%		
	Store Brand	0.15	4%		
	No brand	0.32	9%		
3rd party certified animal welfare in the production process (vs. no certification)	Hormel	0.58	17%	0.42	12%
	Tyson	0.41	12%		
	Store Brand	0.18	5%		
	No brand	0.67	19%		
ANTI*ENV	Tyson	0.45	13%	0.37	11%
	Store Brand	0.25	7%		
ANTI*WEL	Hormel	0.37	11%	0.31	9%
	Tyson	0.40	12%		
	Store Brand	0.29	8%		
ENV*WEL	Tyson	0.35	10%	0.48	14%
	Store brand	0.54	16%		
	No brand	0.37	11%		

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
ANTI = antibiotic-free production; ENV = environment-friendly production; WEL = animal welfare
* A mail survey in 2004 with a sample of 9,600 randomly selected households.
** Compared to the average of the applied price vector: US$ 3.475/lb
Source: Ubilava et al. (2011)

In the United States, Lim et al. (2014) focused on the valuation of COO information alongside trade-offs such as quality (e.g. tenderness), production practices (use of hormones and antibiotics), food safety (identified by testing and/or traceability), and price of beef. A nationwide survey was conducted with a sample size of 1000. WTP was only estimated for the COO attribute, either independently or taking into account the respondent specific attitudes toward food safety[1]. The results in Table A17 show that, on average, consumers preferred domestic beef, with negative WTP shown for imported products indicating a compensation of around $5-$7/lb to achieve these levels. A further analysis show that, ceteris paribus, COO preferences were related to the perceived food-safety level of the country. For example, consumers who had a high risk perception or distrust about the safety of Australian products were willing to pay less for imported beef from Australia, or that people who were risk-averse in regards to food safety had an overall lower WTP for imported products.

[1] General food safety attitudes and perceptions were explored in a Likert scale question.

Table A17: Willingness-to-pay for beef attributes, USA (N = 1,000*)

Attribute	Levels	WTP US$/lb	Premium (%)**
Country of Origin (vs. USA)	Canada	−5.75	(-53%)
	Australia	−7.33	(-68%)

* A nationwide online survey in 2010.
** Compared to average (USD 10.75) from a vector of low-to-high-end actual market prices
Source: Lim et al. (2014)

Van Loo et al. (2011) assessed US consumers' WTP for different organic label types on chicken products. Their analysis focused not just on average WTP but also WTP by different consumer segments based on the purchase-frequency of organic meat ('*non-buyers'*, '*occasional buyers'*, and '*habitual buyers'*) and on demographics (gender, age, education, household income and number of children). Table A18 shows positive premiums for both types of organic labelling, with higher premiums associated with the USDA organic label ($3.6/lb or 104% premium) over the generic label ($1.2/lb or 35%). Further analysis showed that WTP differs between demographic groups as well as between different organic buyers. Most respondents (59%) were occasional buyers; around one fourth of the respondents had never bought organic chicken; and only a small group of respondents (15%) bought organic chicken always or often. As expected, the premiums that consumers were willing to pay for organic chicken increased by the frequency of purchase. Consumer WTP estimated for each demographic group showed, for example, that females had a higher WTP than males, and that having more children reduced WTP, while higher income increased WTP for products with organic labels.

Table A18: Willingness-to-pay for chicken meat attributes, USA (N = 256 non-buyer, N = 571 occasional buyers, N = 149 habitual buyers)

		WTP full sample $/lb	Premium (%)**	By the type of buyer	WTP $/lb	Premium (%)**
Label (vs. no label)	USDA organic label	3.55	(104%)	Non-buyer Occasional Habitual	0.90 3.33 8.37	(26%) (97%) (244%)
	Generic organic label	1.19	(35%)	Non-buyer Occasional Habitual	-1.01 1.22 5.02	(-30%) (36%) (147%)

*Online survey amongst the members of a consumer database in Arkansas.
** Compared to the average price for boneless chicken breast ($3.424/lb)
Source: Van Loo et al. (2011)

Compared to meat products, consumer preferences towards the credence attributes of seafood products is relatively unexplored. In United States, Ortega et al. (2014) explored consumer WTP for imported seafood products for which past food contamination and adulteration incidents may have impacted on consumer preferences for Chinese tilapia. Two surveys were conducted (for shrimp and Chinese tilapia products) with 335 respondents each. The corresponding CEs included a variety of credence attributes: COO (US, China and Thailand) information was considered only for shrimps and the verification entity (US government, Chinese Government, US Third Party) was considered only for Chinese tilapia. The estimation process included attribute interactions between the credence attributes and COO for shrimps, and between credence attributes and verification entity for Chinese tilapia. The results in Table A19 show that consumers were willing to pay more for enhanced food safety: $10.65/lb for domestic shrimp, $3.71/lb shrimp from China, and $4.12/lb shrimp from Thailand. The respective premiums were 118 per cent, 41 per cent and 46 per cent. A similar relationship

was found for no-antibiotic use and environmentally friendly production, which were both associated with a higher WTP for the US product by US consumers.

WTP assessments for Chinese Tilapia, as presented in Table A20, show that consumers were, on average, willing to pay between $4 and $6 per pound (or 89-120 per cent of the base price) for enhanced food safety when verified by a US entity. Likewise for no-antibiotic use and environmental friendly production claims, the only statistically significant evidence was associated with US verification bodies. Overall, the government verification system was valued slightly higher relative to third-party verification. These results are consistent with the shrimp CE results wherein US consumers had a higher WTP for domestic over overseas seafood products and verification systems.

Table A19: Willingness-to-pay for seafood (shrimps) attributes, USA (N = 335*)

			WTP $/lb	*Premium (%)***
Food safety (vs. no claim)	Enhanced	US product	10.65	(118%)
		Chinese product	3.71	(41%)
		Thai product	4.12	(46%)
Antibiotic use (vs. permitted)	Not permitted	US product	9.83	(109%)
		Thai product	2.84	(32%)
Production practice (vs. conventional)	Eco-friendly	US product	5.40	(60%)

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
* An online survey in 2011.
** Compared to average of the applied price vector (US$9/lb)
Source: Ortega et al. (2014)

Table A20: Willingness-to-pay for seafood (imported tilapia) attributes, USA (N = 335*)

			WTP $/pound	*Premium (%)***
Food safety (vs. no claim)	Enhanced	US government verified	6.02	(120%)
		US third party verified	4.43	(89%)
Antibiotic use (vs. permitted)	Not permitted	US government verified	5.39	(108%)
		US third party verified	2.75	(55%)
Production practice (vs. conventional)	Eco-friendly	US government verified	2.67	(53%)

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
* An online survey administered by a market research company in 2011.
** Compared to the lowest given price option ($5.00/pound) in the price vector
Source: Ortega et al. (2014)

Asian studies

The current review includes 5 CE and other WTP studies examining the attributes of meat and seafood products in Asia, including the markets of China, Japan, Korea and India. Attributes examined in these studies include animal health and/or welfare, organic, different production methods, traceability, country-of-origin, food safety, environmental condition, certification, water use and GM production, as well as the generic attributes of product quality and appearance.

In Asia, Wu et al. (2015) explored consumer preferences and WTP for a traceability and certification information for pork meat. The sample consisted of consumers in seven Chinese cities that had been designated by the China Ministry of Commerce as pilot cities for a meat and vegetable traceability system. Each respondent was classified by their level of income and education, which was used in the WTP analysis. As shown in Table A21, estimated WTP across the full sample ranged from 2.31 Yuan/kg to 15.80 Yuan/kg (or 19% to 32% premiums) for the different product attributes. The provision of product traceability information had the highest WTP (ranging from 42% to 91% premiums of base price) for the full traceability over no information. Only those consumers with low income/education level were willing to pay for the minimum level of traceability information. Likewise, regarding quality certification, most consumers were willing to pay more (ranging from 104% to 149% premiums of base price) for government certification over no certification. The high profile consumers were the only group that valued third-party certification (over no certification), which is consistent with findings that higher education and income are related to the WTP for traceability certification (Zhang et al. 2012). It was also found that product freshness had a significant impact on respondents' meat choice preferences.

A separate consumer class-based analysis generated four distinct consumer classes based on the respondents' choices, thus further supporting the preference heterogeneity in the sample. These were labelled as '*certification-preferred'*, '*price-sensitive'*, '*appearance-preferred'* and '*scared'* consumers, whereby the first class included over half of the respondents. Overall, the findings presented in Table A22 complement those presented above, including that WTP for quality certification appears slightly higher than for others, apart from the 'a*ppearance preference'* class; and that there are obvious class-specific preferences. The '*scared'* class was different to the others in that they preferred the possibility to opt-out in the given alternatives. Furthermore, for this class, no WTP values are reported here (as the price attribute was not statistically significant).

Table A21: Willingness-to-pay for pork attributes, China (N = 1,489)

Attribute		WTP full sample yuan/500g (premium %**)	WTP by age and income/education level yuan/500g (premium %**)				
				High	*Medium*	*Low*	*High income Low education*
Traceability Information *** (vs. none)	Full	8.32 (69%)	Age = 35	10.95 (91%)	7.94 (66%)	6.70 (56%)	9.44 (79%)
			Age = 45	9.78 (82%)	6.76 (56%)	5.53 (46%)	8.26 (69%)
			Age = 60	8.01 (67%)	5.00 (42%)	- -	6.49 (54)%
	Partial	5.72 (48%)	Age = 35	8.13 (68%)	5.72 (48%)	5.00 (42%)	7.96 (66%)
			Age = 45	7.96 (66%)	5.55 (46%)	4.83 (40%)	7.78 (65%)
			Age = 60	7.71 (64%)	5.29 (44%)	4.57 (38%)	7.43 (62%)
	Minimum	2.31 (19%)	Age = 45	-	-	2.29 (19%)	- -
			Age = 60	-	-	2.84 (24%)	-
Quality Certification (vs. no certification)	Government	13.83 (115%)	Age = 35	11.35 (95%)	14.01 (117%)	15.16 (126%)	12.84 (107%)
			Age = 45	12.42 (104%)	15.09 (126%)	16.23 (135%)	13.92 (116%)
			Age = 60	14.04 (117%)	16.70 (139%)	17.85 (149%)	15.53 (129%)
	Domestic third-party	15.80 (132%)	Age = 35	11.22 (94%)	10.12 (84%)	10.33 (86%)	13.17 (110%)
			Age = 45	10.19 (85%)	9.09 (76%)	9.30 (78%)	12.15 (101%)
			Age = 60	8.64 (72%)	7.54 (63%)	7.75 (65%)	10.60 (88%)
	International third-party	-	Age = 35	12.03 (100%)	-	-	-
			Age = 45	10.86 (91%)	-	-	-
			Age = 60	9.11 (76%)	-	-	-
Appearance (vs. Bad-looking but edible)	Very fresh-looking	13.74 (115%)					
	Fresh-looking	11.34 (95%)					
	Passable-looking	-					

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.

* In-store intercept interviews, in 2013, in seven cities across different regions of China.

**Compared to the average price of pork hindquarters (12 yuan/500g) as reported in the study

*** Full traceability information covering farming, slaughter and processing, circulation and marketing; Partial traceability information covering farming, slaughter and processing; Minimum traceability information covering only farming.

Source: Wu et al. (2015)

Table A22: Willingness-to-pay for pork attributes, China (N = 1,489)

Attribute		Class 1* *certification-preferred*	Class 2* *price-sensitive*	Class 3* *appearance-preferred*	Class 4* *scared consumers*
	Class probability	52.7%	12.6%	20.8%	13.9%
		WTP Yuan/500g (premium %**)			
Traceability Information *** (vs. none)	Full	5.24 (44%)	-	3.40 (28%)	-
	Partial	2.68 (22%)	0.50 (4%)	2.37 (20%)	-
	Minimum	-1.30 (-11%)	-	-	-
Quality Certification (vs. no certification)	Government	8.82 (74%)	0.78 (7%)	3.05 (25%)	-
	Domestic third-party	6.28 (52%)	-	2.71 (23%)	-
	International third-party	4.06 (34%)	0.54 (5%)	3.64 (30%)	-
Appearance (vs. Bad-looking but edible)	Very fresh-looking	5.16 (42%)	0.69 (6%)	10.95 (91%)	-
	Fresh-looking	4.76 (40%)	-	9.49 (79%)	-
	Passable-looking	-4.18 (-35%)	-	-6.21 (-52%)	

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
* In-store intercept interviews, in 2013, in seven cities across different regions of China.
**Compared to the average price of pork hindquarters (12 yuan/500g) as reported in the study
*** Full traceability information covering farming, slaughter and processing, circulation and marketing; Partial traceability information covering farming, slaughter and processing; Minimum traceability information covering only farming.
Source: Wu et al. (2015)

Wu et al. (2016) examined Chinese consumers' WTP for the provision of traceability information in relation to pork products using real choice experiments (RCE) and experimental auctions (EA). In particular, the authors examined WTP for different types of traceability information, including farming, slaughter and processing, distribution and marketing, and government certification information against a base of a pork product without traceability information. Consistent with previous studies, Table A23 shows that mean WTP was positive but varied between the two methods used (RCE and EA) and the types of information provided, with consumers showing higher WTP across both experiments for government certification information and farming information (Wu et al., 2016).

Table A23: Willingness-to-pay for traceability information in relation to pork, China (N=108)

Information Type	Mean WTP (Yuan/500g) *(95% confidence interval)*	
	RCE	*EA*
Farming information	4.375	2.405
Slaughter and processing information	1.565	1.215
Distribution and marketing information	1.071	0.735
Government certification information	4.934	2.785

Source: Wu et al., 2016.

Ortega et al. (2015) explored consumer preferences and WTP for chicken, pork and egg product attributes across various retail channels in China. Retail channel types included wet markets, domestic supermarkets, and international supermarkets, wherein the products may vary in terms of food safety and other attributes such as animal welfare, organic, "green"

foods and price. Three hundred consumers were interviewed for each food product (pork, chicken and eggs) with an equal number of participants from each retail channel. Results presented in Table A24 show that while consumer WTP for food safety was mostly similar across the different retail channels, with premiums from 165 per cent to 267 per cent compared to the base price, these varied across product types. "Green food" certification was valued higher (up to 20 RMB/product or 195% premium) than organic certification across all products and retailers. Some differences across retail types can be observed for the WTP for the animal welfare attribute as this was significant only for pork and chicken products and not for wet markets.

Table A24: Willingness-to-pay for chicken, pork and eggs attributes, China (N= 300/product*)

		Pork		Chicken		Eggs	
		WTP RMB/product			*Premium (%)***		
Enhanced food safety claim (vs. no claim)	Wet market	27.73	(213%)	19.94	(199%)	9.93	(199%)
	Domestic supermarket	23.68	(182%)	26.69	(267%)	9.58	(192%)
	International supermarket	25.50	(196%)	21.45	(215%)	8.23	(165%)
Animal welfare claim (vs. no claim)	Wet market	-	-	-	-	-	-
	Domestic supermarket	7.36	(57%)	-	-	-	-
	International supermarket	-	-	-	-	2.28	(46%)
Organic certification (vs. no claim)	Wet market	-	-	-	-	3.28	(66%)
	Domestic supermarket	11.48	(88%)	15.44	(154%)	5.37	(107%)
	International supermarket	12.11	(93%)	-	-	3.89	(78%)
Green food claim (vs. no claim)	Wet market	-		-		5.07	(191%)
	Domestic supermarket	11.79	(91%)	19.69	(197%)	6.76	(135%)
	International supermarket	19.29	(148%)	16.27	(163%)	6.63	(133%)

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
***** In-store (at the point of purchase) interviews in Beijing, 2013.
**Compared to average of the applied price vector (pork: RMB 13/jin, chicken: 10 RMB 10/jin and eggs:, and RMB 5/jin
Source: Ortega et al. (2015)

Chung et al. (2012) focused on heterogeneity in WTP for beef attributes. Countries-of-origin of interest included Korea (i.e. domestic), USA and other exporting countries (e.g. New Zealand). They conducted 1,000 interviews amongst Korean consumers, with heterogeneity of preferences and WTP explored using a consumer segment-based approach. As Table A25 shows, the analysis resulted in three consumer segments based on the respondent's choices regarding concerns in relation to GM-beef and the use of antibiotics in production. These segments were labelled as '*very concerned*' (59% of the sample), '*moderately concerned*' (32%) and the smallest group of '*not too concerned*' (9%). Thus, over half of the sample were very concerned about the use of GM and antibiotics with WTP around $4.4/lb (20 per cent premium), and about product's origin with WTP around -$8/lb (37 per cent premium) for imported meat. This '*very concerned*' segment held generally higher WTP values than other segments, and generally these were higher than the weighted averages. Overall, these results suggest that there exists major heterogeneity in Korean (Seoul) consumer preferences towards meat choices, in particular, regarding the use of GM ingredients and antibiotics in production.

Table A25: Willingness-to-pay for beef attributes, Korea (N = 1,000*)

		Very Concerned	Moderately Concerned	Not too Concerned	
Class probability		59%	32%	9%	
		WTP $/lb Premium (%)**			Weighted Average WTP US$/lb Premium (%)**
Marbling Grade (vs. C)	Extra premium	3.01 (13%)	1.58 (7%)	0.88 (4%)	2.35 (7%)
	Premium	2.13 (9%)	1.05 (5%)	0.93 (4%)	1.67 (7%)
Marbling Grade (vs. not A)	A	2.04 (9%)	0.91 (4%)	0.62 (3%)	1.55 (7%)
Marbling Grade (vs. not B)	B	0.92 (4%)	0.39 (2%)	-	0.66 (3%)
Freshness (vs. low)	High	2.94 (13%)	1.69 (8%)	1.14 (5%)	2.37 (11%)
	Medium	1.09 (5%)	0.76 (3%)	0.56 (2%)	0.93 (4%)
Chilled versus frozen (vs. yes)	No - freshly chilled	0.63 (3%)	0.53 (2%)	0.24 (1%)	0.56 (2%)
Free of antibiotics (vs. no)	Yes	4.39 (20%)	1.06 (5%)	0.81 (4%)	3.00 (13%)
Free of GM-feed ingredients (vs. no)	Yes	4.35 (19%)	0.95 (4%)	0.59 (3%)	2.92 (13%)
Country-of-origin (vs. Korea)	United States	-8.38 (-37%)	-3.74 (-17%)	-2.85 (-13%)	-6.39 (-28%)
	Other exporting countries	-7.25 (-32%)	-3.47 (-15%)	-2.19 (-10%)	-5.57 (-25%)

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
* In-store intercept interviews in Seoul, 2007.
**Compared to the average of the applied price vector: US$ 22.50/lb
Source: Chung et al. (2012)

Uchida et al. (2014) examined Japanese consumer preferences for salmon, taking into account two-way interactions motivated by consumer valuations of different product attributes in relation to ecolabel characteristics. The study included a split-sample CE across three types of information effects regarding fisheries (specifically overfishing and the decline of fish-stock): (1) minimal information without the source of the claim; (2) Food and Agriculture Organization (FAO) based information with charts and graphics; and (3) scientific information accompanied by a diagram. Hence, instead of using a conventional approach of "no information" vs. "some information", the authors applied minimum information as the baseline. Likert-scales were used to understand general attitudes, information credibility, and the respondents' level of interest. A nationwide survey included in total 3,370 responses. As shown in Table A26, Japanese consumers were willing to pay a 27 per cent premium (90 yen/package) for the domestic fish compared to imported fish, with a similar premium found for the ecolabel. Considering these attributes together, the WTP was 149 yen/package which is slightly less than sum of the independent WTP values (90 + 89 = 179). Overall, the interaction effects revealed that the value of eco-labels increased value for the wild product, in particular for the

domestic product. The findings from the information effect testing revealed that compared to baseline, added information increased the value of the eco-label, although marginally, when the FAO or science based information were considered credible and interesting.

Table A26: Willingness-to-pay for salmon attributes, Japan (N = 3,370*: "minimal information" n = 1,122, "FAO information", n = 1,118, and "Science information" n = 1,130)

		*Premium (%)***
Product origin (vs. Chile)	Hokkaido (domestic)	(26%)
	Alaska	(8%)
	Norway	(7%)
Production (vs. farmed)	Wild	(10%)
Ecolabel (vs. no label)	Labeled	(26%)
Country of origin x Wild***	Ecolabel x Hokkaido	(44%)
	Ecolabel x Alaska	(27%)
	Ecolabel x Norway	(28%)
	Ecolabel x Wild	(37%)
	Hokkaido x Wild	(52%)
	Alaska x Wild	(36%)
	Norway x Wild	(37%)
Information treatments x Perceptions***	Ecolabel x FAO	22%
	Ecolabel x Science	20%
	Ecolabel x FAO x Credible	30%
	Ecolabel x Science x Credible	28%
	Ecolabel x FAO x Interesting	29%
	Ecolabel x science x Interesting	27%
	Ecolabel x FAO x Interesting	36%
	Ecolabel x Science x Interesting	34%

* A nationwide online survey in 2009.
**Reported in the study
***Base levels: Country of origin and wild: ''Chilean farmed salmon with no ecolabel"; and Treatments and perceptions: ''Minimal information perceived neither credible nor interesting''
Source: Uchida et al. (2014)

Other regions

The current review includes CE and other WTP studies examining the attributes of meat and seafood products in other regions, including Australia and Lebanon. Attributes examined in these studies include animal welfare, local foods, production quality and certification.

Mugera et al. (2017) examined Australian consumers' WTP for chicken and yogurt products based on their preferences for a range of attributes, including local production, free range, product quality and the size of the producer. This was based on whether a product carried a local food label, was certified free range, or contained other information relating to the attributes listed. The authors examined WTP for a combination of the above attributes, as shown in Table A27. This also shows a range of additional premiums for each of the product types and attributes based on a range of demographic variables, including gender and type of area.

Table A27: Willingness-to-pay for chicken and yoghurt products based on local production, free range, size of producer (relative to medium) and demographic variables, Australia (N=333)

Attribute 1	Attribute 2	Demographic variable 1	Demographic variable 2	WTP for product type ($AUD)	
				Skinless chicken breast	*Fruit yoghurt*
Local	Australian firm				5.15
	Overseas firm				3.67
		City		6.16	
		Country		8.32	
Not local	Australian firm				3.84
	Overseas firm				2.36
		City		3.74	
		Country		5.91	
Free range		City	Female	5.86	
			Male	3.77	
		Country	Female	4.27	
			Male	2.17	
Small producer				1.55	2.64
Large producer				-1.84	-2.8

Source: Mugera et al., 2017.

Chalak and Abiad (2012) studied Lebanese consumers' preferences and purchasing behaviour in context of shawarma sandwiches[2], a Lebanese fast food, which is considered to contain a high potential for food safety risk. The study attributes included food safety certification (International Organization for Standardization [ISO] and "ServSafe" food handling program), and contextual factors such as location, serving size and price. The sample included 284 respondents, wherein the information-effect was tested in a split-sampling approach by providing half of the sample with additional descriptions of each type of safety certification. WTP results, as summarised in Table A28, suggest that, overall, consumers appreciated the convenience in buying sandwich from "around the corner", and that they also preferred to pay extra 46 per cent for larger sandwich size (around US$1.12 (LBP 1,677)). The information effect was apparent in this study, as this increased the average WTP for food safety certification from a 282 to 314 per cent premium to a 320-431 per cent premium compared with the average price of a small sandwich. WTP for certification was highest for the ISO 22000 type.

2 "Shawarma is a Middle Eastern beef, lamb or chicken-based fast food" (Chalak and Abiad 2012 p. 82).

Table A28: Willingness-to-pay for sandwich attributes, Lebanon (N = 284*: informed n = 145, uninformed n = 139)

	Levels		WTP LBP/sandwich	Premium (%)**
Location/ Convenience (vs. Round the corner < 5 min walk)	Within walking distance (5+ min walk)		-445	(-12%)
	Need to go there by car		-4,181	(-115%)
	Delivery order		-1,009	(-28%)
Certification (vs. none)	ISO 9001	Uninformed	10,278	(282%)
		Informed	11,667	(320%)
	ISO 22000	Uninformed	11,466	(314%)
		Informed	15,719	(431%)
	ServSafe	Uninformed	1 0,372	(284%)
		Informed	14,366	(394%)
Portion size (vs. Typical small-sized sandwich)	Medium-sized sandwich		1,677	(46%)

LBP = Lebanese pounds; US$1 = LBP1,515

* The survey was conducted in Beirut, 2011, excluding participants who had never purchased shawarma sandwiches.

** Compared to an average of LBP3,650 (USD2.41) for a small-sized shawarma sandwich

Source: Chalak and Abiad (2012)

Cross-regional studies

Tait et al. (2016) conducted a cross-country analysis between developed and developing economies (UK vs. China and India). The authors explored preferences across certified environmental attributes (GHG, biodiversity, and water quality), animal welfare, food safety, country-of-origin (COO) label and price in relation to lamb products. A generic framing on the product, including a percentage price increase, was used to make the cross-country comparison more straightforward. Results reported in Table A29 show that food safety, followed by animal welfare, appeared to be the most valued attributes with WTP values of between 9% and 49% more for a certified product. Another similarity across the countries was that of different environmental attributes, the GHG certification was valued most, although not by much. Key differences included that while UK consumers preferred domestic products, consumers in developing markets were not likely to choose the domestic product or pay for it. Another difference was that the Indian respondents had higher WTP for environmental attributes compared with UK and Chinese consumers. Overall, this study shows there can be cross-country differences when looking into food attribute preferences but also that similarities might exist, for example, in terms of which attributes are valued the highest.

Table A29: Willingness-to-pay for lamb attributes, China, India, UK (N = 2,067*: China *n* = 686, India *n* = 695 and UK *n* = 686)

		WTP (in %)**		
		China	*India*	*UK*
Food safety (vs. not certified)	Certified	34%	49%	15%
Farm animal welfare (vs. not certified)	Certified	9%	29%	18%
Water management (vs. not certified)	Certified	7%	21%	6%
Greenhouse Gas (GHG) minimisation (vs. not certified)	Certified	8%	28%	6%
Biodiversity enhancement (vs. not certified)	Certified	5%	26%	4%
Country of origin (vs. no label)	Domestic	-27%	-	5%
	Foreign	-	13%	-5%

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
* Online survey in in 2012 with regular grocery shoppers who had purchased lamb at least once recently (last month).
** Reported in the study
Source: Tait et al. (2016)

A1.2 Dairy products

The current review includes 5 CE and other WTP studies examining the attributes of dairy products in Europe, North America and Asia. Attributes examined in these studies include country-of-origin, environmental condition, carbon/GHG emissions associated with production, local foods, organic, functional foods, product health claims, brand and food safety.

European studies

The current review includes 3 CE and other WTP studies examining the attributes of dairy products in Europe, including studies conducted in Germany, France, Italy, Norway, Spain and the UK. Attributes examined in these studies include country-of-origin, environmental condition, carbon/GHG emissions associated with production, local foods, organic, functional foods and product health claims.

Aichner et al. (2017) examined German consumers' WTP for ice cream and tea products based on their associated country-of-origin. The researchers selected an ice cream product from the USA with a Scandinavian name (Häagen-Dasz) as well as a German tea product with an English name (Milford) in order to gauge German consumers' WTP for the product(s) before and after their country-of-origin was revealed. Table A30 shows reductions in WTP for both product types following the reveal of the products' respective country-of-origin, including minimum, maximum and mean WTP ranges (Aichner et al., 2017).

Table A30: Willingness-to-pay for ice cream and tea products before and after COO information provided, Germany (N=100)

	Häagen-Dasz (ice cream)			Milner (tea)		
	Minimum (€)	*Maximum (€)*	*Mean (€)*	*Minimum (€)*	*Maximum (€)*	*Mean (€)*
Actual product price	4.99	5.99	5.05	1.85	2.39	1.89
WTP before COO was revealed	4.99	10.00	5.35	1.85	3.00	1.98
WTP after COO was revealed	2.00	6.50	4.48	0.90	2.50	1.74

Source: Aichner et al., 2017.

Feucht and Zander (2017) examined European consumers' (France, Germany, Italy, Norway, Spain and the UK) WTP for "climate-friendly" milk products (i.e. products with a lower carbon footprint), including products that displayed two types of CO_2 label, as well as product claims relating to "climate-friendliness", local production and organic production (EU organic label). Table A31 shows participants WTP for the inclusion of each of the above in relation to milk products, showing the highest indicated WTP for local production and organic production.

Table A31: Willingness-to-pay for milk products, environmental attributes, European countries (Euro per 1-litre UHT milk product)

	France (N=1,000)	Germany (N=1,001)	Italy (N=1,003)	Norway (N=1,001)	Spain (N=1,002)	UK (N=1,000)
CO_2 Label 1	0.11	0.13	0.24	0.14	0.14	0.10
CO_2 Label 2	0.03	0.03	0.09	0.00	0.11	0.06
"Climate friendly"	0.06	0.05	0.14	0.09	0.15	0.04
Local	0.19	0.20	0.27	0.27	0.15	0.15
Organic	0.12	0.10	0.23	0.14	0.16	0.09

Source: Feucht and Zander, 2017.

In Germany, Bechtold and Abdulai (2014) estimated consumer WTP for functional dairy products (yoghurt and cream cheese) by linking the choice data with demographics and general attitudes information. The choice alternatives were described as bundles of functional ingredients, health claims and product prices. The data included 1,309 responses where each respondent answering a CE for both yoghurt and cheese products. The data was analysed using the consumer segment based approach with the class determinants including the socioeconomic and attitudinal variables, the latter generated from principal component analysis (PCA). The results in Tables A32 and A33 show evidence for the class-specific preference heterogeneity when taking into account respondent attitudes, where the Class 2 was found with the most amount of statistically significant attitude and respondent-type associated determinants in relation to the reference group. For example, it was confirmed that "f*unctional food skeptics*" preferred non-functional dairy products, and vice versa by the "f*unctional food advocates*". Furthermore, the majority of consumers valued dairy products with functional ingredients, such as omega-3, highly. These WTP varied from €0.13 to

€0.31/serving of yoghurt and €0.35/serving of cream cheese, or premiums of between 10 and 23 per cent.

Table A32: Willingness-to-pay for yoghurt attributes, Germany (N = 1,309*)

		Class 1* Functional food sceptics**	**Class 2*** Functional food advocates**	**Class 3*** Functional food neutrals (reference group)**
Class probability		(21.5%)	(40.5%)	(38%)
		WTP €/200g Premium (%)**		
Functional Food ingredient	Omega-3 fatty acids	0.31 (24%)	0.24 (19%)	0.13 (10%)
	Oligosaccharides	-	0.10 (8%)	0.11 (9%)
	Bioactive	-	-0.10 (-8%)	-0.11 (-9%)
	Polyphenols			
Non-functional alternative		0.47 (36%)	-1.77 (-137%)	-
Health claim	Healthy blood vessels.	-	-0.41 (-32%)	-0.13 (-10%)
	Healthy blood vessels and metabolism	-	0.23 (18%)	-0.08 (-6%)
	One property depending on the ingredient	-	-0.18 (-14%)	0.11 (9%)
	Two properties depending on the ingredient	-	-	-

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
***** Nationwide mail survey, 2010-2011.
**Compared to the base price for conventional non-functional food as provided in the study: €1.29/500g
***Class determinants: **Class 1** Reward from using Functional Foods (FF), Safety of FF, General health interest, Natural product interest, Hysteria; **Class 2** Age, Education, Reward from using FF, General health interest, Natural product interest, Hysteria, Necessity for FF, Specific health interest
Source: Bechtold and Abdulai (2014)

Table A33: Willingness-to-pay for cream cheese attributes, Germany (N = 1,309*)

		Class 1*** Functional food sceptics	Class 2*** Functional food advocates	Class 3*** Functional food neutrals (reference group)
Class probability		(24.8%)	(33.9%)	(41.3%)
		WTP €/200g Premium (%)**		
Functional Food ingredient	Omega-3 fatty acids	0.35 (23%)	0.35 (23%)	-
	Oligosaccharides	-	0.05 (3%)	-
	Bioactive	-	-0.18 (-12%)	-
	Polyphenols			
Non-functional alternative		0.97 (65%)	-1.86 (-125%)	-0.02 (-1%)
Health claim	Healthy blood vessels.	-	-0.38 (-26%)	-
	Healthy blood vessels and metabolism	-	0.24 (16%)	-
	One property depending on the ingredient	-	-0.24 (-16%)	-
	Two properties depending on the ingredient			

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
***** Nationwide mail survey, 2010-2011.
**Compared to the base price for conventional non-functional food as provided in the study: €1.49/200g
***Class determinants: **Class 1** Children aged < 12, General health interest, Natural product interest, Hysteria, Necessity for Functional Food (FF), Confidence in FF, Safety of FF; **Class 2** Gender, Children < 12years, Reward from using FF, General health interest, Natural product interest, Hysteria, Necessity for FF, Specific health interest, Confidence in FF
Source: Bechtold and Abdulai (2014)

North American studies

Zou and Hobbs (2010) explored consumers' functional food choices and a labelling effect in a context of Omega-3 enriched milk in Canada. The different health claims included heart health, generic health claims and more specific risk reduction claims (RRC) and disease prevention claims (DPC). The authors separated these claims from the visual cues (a red heart symbol included in a choice set) and labelled them as full and partial functional food attributes, respectively. The CE also considered certification and product price. The data analysis used two approaches, the standard model (Table A34) and the segmented-based approach (Table A35). These initial results suggest that consumers respond positively to health claim labels, as well as the verification entities for these claims. Consumers were willing to pay, on average, between $0.12 and $0.51 for different health claims (or 6% to 26% more of the conventional milk price), being highest for the RRC. They were also willing to pay, on average, around 12 per cent more for verification (vs. none) with little difference on WTP across the type of verification entity. The study also found some sociodemographic influences, such as income, increased WTP for the Omega-3 attribute.

The second analysis confirmed these preferences were consumer group-specific (Table A35). Overall, the full health claims seemed to have a higher absolute WTP (over no claim) when

compared to the WTP value of the visual claim (over none), apart from the "*health claim challengers*" group, who were minority of the sample (7%). Looking specifically at the functional ingredient attribute, people were willing to pay, on average, $0.20/litre premium for Omega-3 enriched milk over regular milk, and this WTP was even higher for people with higher income and those with positive attitudes toward functional food in general.

Table A34: Willingness-to-pay for milk attributes, Canada (N = 740*)

		WTP $/2 Litres	*Premium (%)***
Omega-3 (vs. regular milk)	Contains Omega-3	0.20	(10%)
Health Claims (full labelling) (vs. none)	Function Claim: "Good for your heart health"	0.19	(10%)
	RRC: "Reduces the risk of heart disease and cancer"	0.51	(26%)
	DPC: "Helps to prevent Coronary Heart Disease and Cancer"	0.33	(17%)
Symbol (partial labelling) (vs. none)	Heart Symbol	0.12	(6%)
Verification Organization (vs. none)	Government	0.24	12%
	Third party	0.23	12%

* Online survey conducted in 2009.

** Compared to the lowest price in the given price vector: $1.99/2 litres of conventional milk.

Source: Zou and Hobbs (2010)

Table A35: Willingness-to-pay for milk attributes: The latent class approach, Germany (N = 740*)

		WTP $/2 Litres Premium (%)**			
		Conventional milk consumers	*Functional food believers*	*Functional milk lovers*	*Health claim challengers*
Class probabilities		48.9%	21.7%	22.1%	7.3%
Omega-3 (vs. regular milk)	Contains Omega-3	-	0.25 (13%)	1.64 (82%)	0.29 (15%)
	Omega3 x Factor1	0.11 (6%)	4.84 (243%)	0.48 (24%)	0.74 (37%)
	Omega3 x Factor2	-	-0.25 (-13%)	-	-0.23 (-12%)
	Omega3 x Income	1.39 (70%)	3.85 (193%)	8.94 (449%)	-4.37 (-220%)
	Omega3 x Gender	0.12 (6%)	3.09 (155%)	0.96 (48%)	0.96 (48%)
Health Claims (full labelling) (vs. none)	Function Claim	-	0.16 (8%)	0.49 (25%)	-
	RRC	-	0.37 (19%)	1.83 (92%)	-
	RRC x Factor1	-	-0.14 (-7%)	0.36 (18%)	0.26 (13%)
	RRC x Factor3	-	-	0.36 (18%)	-
	RRC x Heart disease	-	-	-0.58 (-29%)	-
	RRC x Education	-	-	-0.29 (-15%)	-
	DPC	-	0.46 (23%)	1.74 (87%)	-
Symbol (partial labelling) (vs. none)	Heart Symbol	-	-	0.31	0.27
Verification Organization (vs. none)	Government	-	0.17 (9%)	0.98 (49%)	0.37 (19%)
	Government x Factor3	-	0.09 (5%)	0.25 (13%)	0.33 (17%)
	Third party	-	0.33 (17%)	0.70 (35%)	-

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
* Online survey in 2009.
** Compared to the lowest price in the given price vector: $1.99/2 litres of conventional milk.
*** Heart disease: "respondent self-reports having heart disease"; Factor 1 "positive attitudes toward and experience consuming functional food"; Factor 2 "more awareness of health and healthy diet behaviours"; Factor 3 "higher levels of trust in health claims and nutrition labels" (Zou and Hobbs 2010 p. 10 Table 2).
Source: Zou and Hobbs (2010)

Asian studies

In China, Wu et al. (2014) assessed consumers' WTP for organic infant formula, as well as respondents' food safety risk perceptions and level of knowledge. The CE attributes included organic label, COO brand (including two Chinese ("unknown" *Dele*, and well-known *Yili*) and

two foreign brands (European *Topfer*, and North American *Enfamil*)) and product price. The design also included two-way interaction effects between the attributes in order to explain variance in preferences. The study was conducted in Shandong province (China's third most populous province), resulting in 1,254 completed responses. The result show, firstly, that the respondents' knowledge and understanding of organic food were relatively low while the perception regarding the food safety risk were relatively high. The CE results in Table A36 show that consumers had a higher average WTP of $5-$10 (or 36-69 per cent of the base price) for the EU and US-based organic labels than for the Chinese label (vs no label). These WTP estimates increased if the level of knowledge and the level of perceived food safety risk were higher, up to 112 per cent and 86 per cent, respectively. Furthermore, Chinese consumers preferred imported products and brands over domestic ones which is consistent with previous studies (Saunders et al. 2013). Lastly, the study highlighted two of the significant and positive findings from the attribute interactions (between the US organic label and China-COO, and between *Enfamil* and China-COO), which imply a potential complementary relationship whereby adding these labels/brands to formula produced in China could improve their value.

Table A36: Willingness-to-pay for infant formula attributes, China (N = 1,254*)

		Full sample		**By level of knowledge**			**By level of risk perception**	
		WTP US$/400g	*Premium (%)***		*WTP US$/400g*		*Premium (%)***	
Organic label (vs. no label)	Chinese	3.23	(22%)	Low Medium High	3.49 3.84 1.95	(23%) (26%) (13%)	3.84 4.28 4.20	(26%) (29%) (28%)
	EU	5.36	(36%)	Low Medium High	3.81 6.93 6.04	(25%) (46%) (40%)	3.75 6.02 6.25	(25%) (40%) (42%)
	US	10.40	(69%)	Low Medium High	10.66 16.87 16.55	(71%) (112%) (110%)	9.93 12.58 12.89	(66%) (84%) (86%)
Brand (vs. Dele)	Yili Topfer Enfamil	4.40 6.17 7.08	(29%) (41%) (47%)					
Country of origin (vs. Germany)	China the US	-2.42 3.53	(-16%) (24%)					

* In-store interviews, in 2012.
** Compared to the average of the applied price vector: US$ 15/400g
Source: Wu et al. (2014)

A1.3 Fruit & vegetable products

The current review includes 5 CE and other WTP studies examining the attributes of fruit and vegetable products in Europe, Asia and other regions. Attributes examined in these studies include organic, local foods, country-of-origin, social responsibility, carbon/GHG emissions associated with production, food safety, production methods and product quality.

European studies

The current review includes 2 CE and other WTP studies examining the attributes of fruit and vegetable products in Europe, including the markets of Denmark, France, UK and the

Netherlands. Attributes examined in these studies include organic, local foods, country-of-origin, social responsibility and carbon/GHG emissions associated with production.

Denver and Jensen (2014) focused on the organic and local food (apples) preferences in Denmark. The study combined CE and PCA, where the latter was used to aggregate attitudinal Likert-scale responses. The CE included attributes of food origin ranging from domestic (local or domestic) to imported apples (within or outside of the EU); production method (organic vs. conventional); alongside colour and taste/texture. The survey included in total 637 respondents. The PCA show two components - one related to organic products and the other to locally produced products. While no WTP was calculated, the authors provided an indication of WTP for these two attributes (Table A37). The participants were willing to pay 5.40 DKK/kg premium for organic apples and 19 DKK/kg for local food. These numbers increased by 97 percentage points if the respondents hold "maximum perception" of the organic attributes based on the PCA. This suggests that, in the case of apples, consumers with positive perceptions of organic food can also have relatively strong preferences for local food but not necessarily vice versa. The authors suggest that this asymmetry needs to be explored further.

Table A37: Willingness-to-pay for the local apple attribute, Denmark (N = 637*)

		Full sample		**Those with maximum perception of the organic attributes**	
		WTP DKK/kg	*Premium (%)***	*WTP DKK/kg*	*Premium (%)***
Production method (vs. conventional)	Organic	5.40	77%	12.20	174%
Origin (vs. outside EU)	Local	19.00	(271%)	22.60	(323%)

* Online survey in 2010.
**Compared to current price (status quo option) of a conventional apple 7 DKK/kg
Source: Denver and Jensen (2014)

In another European study, Akaichi et al. (2015) assessed consumers WTP for fair-trade (FT), organic and carbon footprint attributes (collectively known as ethical attributes) in bananas. A particular objective was to identify if these attributes compete in different markets. For the study, in total 247 consumers were interviewed in three countries. The CE results (Table A38) show that consumers were willing to pay between €0.08 and €0.14 for fair trade and organic bananas with French participants indicating a slightly higher, and statistically significant, WTP compared to Scottish and Dutch participants. All respondents were also willing to pay, on average, €0.10 (77% premium of the lowest price) to reduce carbon footprint (1kg on the transport). These WTP values were statistically significantly higher by Dutch over Scottish participants. In order to explore these trade-offs, a within-sample test of WTP differences was applied. These results show that, in Scotland, consumers were willing to pay significantly more for fair trade bananas compared to other attributes, but also that they would choose organic bananas if the FT price too high. In the Netherlands sample, there was no evidence for different WTP for attributes; thus these attributes are competing and the price of attribute determines choices. Lastly, French participants were willing to pay significantly more for organic bananas than fair trade bananas, if the price is not too high. Overall, consumers in all countries show positive WTP for all claims/labels, and although generally these ethical claims may not be competing, this study identified that under some circumstances this may change.

Table A38: Willingness-to-pay for the banana attributes, Scotland, France and the Netherlands (N = 247*: 100 in Edinburgh, 95 in Clermont-Ferrand and 52 in Amsterdam)

	WTP by all respondents		WTP by Country		
	€/banana	*Premium (%)***		*€/banana*	*Premium (%)***
Fairtrade Label (vs. no label)	0.10	77%	Scotland	0.14	108%
			Netherland	0.13	100%
			France	0.09	69%
Organic Label (vs. no label)	0.09	69%	Scotland	0.08	62%
			Netherland	0.09	69%
			France	0.13	100%
Carbon footprint/ reduction per kg	0.10	77%	Scotland	0.09	69%
			Netherland	0.12	92%
			France	0.12	92%

* Intercept survey at public places and retail stores with occasional buyers, at minimum, of bananas
** Compared to the lowest amount of the price vector: €0.13/banana
Source: Akaichi et al. (2015)

Asian studies

In a developing economy context, Wongprawmas and Canavari (2017) examined Thai consumers' WTP for fresh produce with associated food safety credentials, including a product's freshness, brand and food safety information. For product freshness, a range between 0 and 2 days post-harvest was indicated. Food safety labels used in the CE included a generic "safe produce" claim, the well-recognised Q Mark label, as well as well-known and trusted produce brands "Royal Project" and "Doctor's Vegetables", both of which may also use the Q Mark label. Table A39 shows a range of WTP for different brand and food safety information credentials in relation to Chinese cabbages among Thai consumers, with trusted private brands Royal Project and Doctor's Vegetables receiving the highest WTP.

Table A39: Willingness-to-pay for Chinese cabbage with food safety credentials, Thailand (N=350)

Attribute	WTP (Thai Baht/kg)
Claim "safe produce"	39.23
Q mark	68.44
Royal Project and Q mark	74.56
Doctor's Vegetables and Q mark	79.06

Source: Wongprawmas and Canavari, 2017.

Other regions

The current review includes 2 CE and other WTP studies examining the attributes of fruit and vegetable products in other regions, including Peru and West African nations (Benin, Ghana and Burkina Faso). Attributes examined in these studies include organic, local foods, food safety and production methods.

Blare et al. (2017) conducted a CE to determine Peruvian consumers' WTP for locally grown tree fruits (avocadoes, apples and pears). Table A40 shows the percentage of participants willing to pay a range of premiums (0%, 10%, 20%, 30%, 40% and 50% more) for locally-produced apples, avocadoes and pears, with highest overall premiums shown for local apples, followed by pears and avocadoes.

Table A40: Percentage of participants willing-to-pay for locally-grown tree fruits, Peru (N=300)

	WTP range					
	0%	*10%*	*20%*	*30%*	*40%*	*50%*
Apples (%)	26	17	24	16	6	11
Avocadoes (%)	24	29	30	12	1	4
Pears (%)	25	21	26	16	8	4

Source: Blare et al., 2017

Probst et al. (2012) explored the potential for marketing certified organic vegetables in three West African cities (Cotonou in Benin, Accra in Ghana and Ouagadougou in Burkina Faso). In particular, certified organic production was examined as a potential strategy to improve food safety. Two separate CEs were developed - one for the food vendors' choices of tomatoes (a common ingredient in meals) and another for consumer meal choices of (continental or traditional) when eating out. The vendor CE included trade-offs across appearance (freshness, colour and neatness), production method and price attributes, while the consumer CE included trade-offs across taste, production method and price attributes. Both CEs targeted different types of retailers ranging from street food vendors to restaurants, where the interviews resulted in 180 vendor responses and 360 consumer responses. There were some differences in sample dem

ographics between vendors and consumers, such as consumer sample being predominantly female whereas the vendors were mostly male. In both CEs, the WTP was only reported for the organic production attribute. As shown in Table A41, the vendors were willing to pay, at median, US$0.85 for organic certification of the fresh tomatoes, which equals to a premium between 12 and 53 per cent of typical retail price. These WTP across the cities vary depending on the season. Next, Table A28 shows they consumers were willing to pay, at median, just over US$1 per meal if the food served contained only certified organic vegetables. This equates to around a 19 per cent premium on average meal price for restaurants, 75 per cent premium for small food businesses, and 177 per cent premium on average meal price for street food vendors.

Table A41: Willingness-to-pay for basket of tomatoes attributes (by vendors), Benin, Ghana and Burkina Faso (N = 180*, n = 60/city)

			By City	**Lean season**	**Peak season**
		WTP US$/3 kg basket		*(premium %)***	*(premium %)***
How vegetables were grown (vs. not organic)	Certified organic	$0.848	Benin	(16%)	(39.9%)
			Burkina Faso	(26.7%)	(53.4%)
			Ghana	(12.1%)	(23.9%)

Note: The WTP values were not estimated for all attributes.

* Intercept interviews, in 2009, with street food vendors, small food businesses and restaurants.

** Reported in the study.

Source: Probst et al. (2012)

Table A42: Willingness-to-pay for meal attributes (by consumers), Benin, Ghana and Burkina Faso (N = 360*)

		WTP US$/plate	*By retailer*	*(% premium)***
How vegetables added to the meal were grown (vs. not organic)	Certified organic vegetables	$1.044	Street food vendor	177%
			Small food business	75%
			Restaurant	19%

* Intercept interviews, in 2009, with customers of the street food vendors, small food businesses and restaurants.
** Reported in the study.
Source: Probst et al. (2012)

A1.4 Wine products

The current review includes 8 CE and other WTP studies examining the attributes of wine products in Europe, North America, Asia and other regions. Attributes examined in these studies include sustainability (generic), country- and region-of-origin, grape variety, vintage, brand, social responsibility, organic, carbon/GHG emissions associated with production, environmental condition, reduced packaging and taste.

General studies

Schaufele and Hamm (2017) conducted a review of international WTP literature regarding WTP for the inclusion of a range of sustainability credentials in wine products. The authors found that consumers across different countries showed a willingness to pay a premium for wine products with associated sustainable production methods, including environmental friendly, local and organic production methods (Schaufele and Hamm, 2017).

European studies

The current review includes 2 CE and other WTP studies examining the attributes of wine products in Europe, including the markets of Spain, France, Germany and the UK. Attributes examined in these studies include sustainability (generic), region-of-origin, grape variety, social responsibility, organic, carbon/GHG emissions associated with production and reduced packaging.

Sellers (2016) examined Spanish consumers' WTP for sustainable wine products based on their market segment and levels of knowledge of wine culture. As shown in Table A43, premiums that Spanish consumers are willing to pay may be based on their level of knowledge of wine culture, with less participants with higher levels of knowledge of wine culture willing to pay a premium as well as a generally lower average percentage of premium price paid. In addition, Table A44 shows that Spanish consumers in different segments may be willing to pay higher premiums than others. For example, a higher percentage of urban-based consumers may be willing to pay a higher premium than consumers in the 'traditional segment'. This study shows that relative levels of expertise as well as socio-demographic segmentation may affect WTP for sustainability wine products in Spain.

Table A43: Willingness-to-pay (€) for sustainable wine by level of knowledge of wine culture, Spain (N = 553)

	(1) Beginner	*(2)*	*(3)*	*(4)*	*(5) Expert*	*Global*
% of consumers willing to pay a premium price	87.2	76.5	81.2	75	61.6	77.9
Average % of premium price	18.72	15.02	10.97	8.1	5.08	12.87

Source: Sellers, 2016

Table A44: Willingness-to-pay (€) for sustainable wine by market segment, Spain (N = 553)

	Traditional	*Urban*	*Trendy*	*Routine*	*Occasional*	*Social*	*Global*
% of consumers willing to pay a premium price	76.9	84.6	80.2	70.2	74.3	84.1	77.9
Average % of premium price	9.75	13.11	14.41	13.25	11.92	12.97	12.87

Source: Sellers, 2016

In a wine context, Kallas et al. (2013) focused on elements involved in wine choices for a special occasion, such as origin, people's experience and knowledge of wine ("wine references"), grape type and price. In the survey, the respondents were asked to complete two separate wine CEs. The first being a so-called "forced choice task" (with no opt-out option), and the second being "non-forced choice task" (with an added opt-out alternative). Four hundred wine consumers participated in the study. The results, shown in Table A45, indicate that the most preferred origins were non-imported wines, particularly the regional Catalonian wine with WTP around 2.60-3.10 €/bottle (or around 30% of the base price). Also experience and type of wine influenced consumers' wine choices, as indicated by the relatively higher WTP estimates. The main differences between forced and non-forced choices involved the significantly higher premium for regional wine and Cabernet Sauvignon wine when allowing opting-out. However, the forced choices resulted in higher WTP for national wines as well as lower discount or compensation (negative WTP) for prestigious wines and imported wines. Overall, the results from the non-forced CE suggest an increasing tendency of statistically significantly higher WTP for most preferred type and origin levels.

Table A45: Willingness-to-pay for wine attributes, Spain (N = 400*)

		Average WTP €/bottle (Premium %)**	
		"Forced choices"	*"Non-forced choices"*
Origin	Catalonia (regional) ***	2.65 (27%)	3.07 (31%)
	Spain (national) ***	0.50 (5%)	0.39 (4%)
	Imported (international) ***	-3.15 (-32%)	-3.46 (-35%)
Wine references	previously known/experienced	0.81 (8%)	0.73 (7%)
	Recommended wine	-0.17 (-2%)	0.04 (0.4%)
	Prestigious wine***	-0.64 (-6%)	-0.78 (-8%)
Grape variety	Cabernet Sauvignon (French variety) ***	1.77 (18%)	2.29 (23%)
	Grenache (Spanish variety)	-1.18 (-12%)	-1.33 (-13%)
	Merlot (French variety) ***	-0.60 (-6%)	-0.96 (-10%)

* Face-to-face interviews in supermarkets and streets (central city) of Barcelona.
** Compared to average of the applied price vector: 10 €/bottle
*** Statistically significant different between the forced and non-forced choices ($p < 0.01$ or $p < 0.10$)
Source: Kallas et al. (2013)

Asian studies

The current review includes 2 CE and other WTP studies examining the attributes of wine products in Asia (namely China). Attributes examined in these studies include country- and region-of-origin, vintage and brand.

Xu et al. (2014) used a mixed Logit model to examine Chinese consumers' WTP for country-of-origin, vintage and brand attributes in relation to red wine for personal consumption and gifting purposes. Table A46 shows that Chinese consumer WTP for red wine attributes differ depending on context (e.g. for personal consumption or gifting), with negative WTP shown for Chinese wines for gifting, as well as unanimously for non-branded wine products.

Table A46: Willingness-to-pay (Yuan) for red wine attributes for own consumption and gifting, China (N=540)

	Personal consumption	*Gift purchase*
USA to China	36.07	-63.3
USA to France	83.53	101.53
2- to 5-year old	57.42	36.81
2- to 10-year old	64.51	38.82
Branded to no brand	-91.32	-118.61

Source: Xu et al., 2014

Using the same dataset from the previous study, Xu and Zeng (2014) compared results using conditional logit and mixed logit models to examine Chinese consumers' WTP for red wine

attributes. Table A47 shows differences in WTP estimates produced through the use of each method.

Table A47: Willingness-to-pay (Yuan) for red wine attributes for own consumption and gifting, China (N=540)

	Conditional logit	*Mixed logit*
California to China	-45.19	61.89
California to France	35.13	144.40
2- to 5-year old	35.77	39.36
2- to 10-year old	63.28	67.58
Branded to no brand	-115.36	-120.69

Source: Xu and Zeng, 2014

Other regions

The current review includes 2 CE and other WTP studies examining the attributes of wine products in other regions, including Australia and Russia. Attributes examined in these studies include country-of-origin and taste.

In another special occasion wine study by Mueller et al. (2010), the objective was to understand the importance of different wine label statements for regular wine consumers in Australia, not calculate WTP. The CE included a relatively large number of attributes, with ten different statements (history of the winery; local grape sources; production method; taste descriptor; elaborate taste descriptor; food pairing between wine and type of meal; consumption advice; environmental consciousness; website; and ingredients) either present or not on the label, plus price. Each alternative was represented with an undefined Australian wine with the same alcohol level to enhance the use of extrinsic cues in the choices. A sociodemographic comparison indicates that the sample for this study is mostly aligned with the general Australian wine consumer population based on a wine consumer survey from Roy Morgan in 2007 (as cited in Mueller et al. 2010). The data was analysed with a consumer class segmentation approach which resulted in five distinct classes that varied in terms of preferences for certain label information and price, but not in terms of respondents' characteristics. Overall, the most influential label attributes associated with the wine choices were price, history, taste descriptors and food pairing. In contrast, environmental information, ingredients and website information on the labels had a relatively smaller, or negative, impact on choices. An additional analysis revealed that just over half of the participants, generally, read the wine labels and found them interesting as well as helpful.

In a Russian case study, Cicia et al. (2013) explored consumer preferences and WTP for red wine. Their CE included seven wine types varying by their geographical origin and quality-dependent price. Based on the estimated WTP (Table A48), three distinct segments were found: (1) high-quality-high-price Italian and French wines with WTP varying between €4.8-5.7/bottle, or 96-113 per cent of the base price; (2) a medium-quality wines (WTP of €2.96/bottle, or 54%); and (3) lower quality wines with WTP less than one Euro per bottle. Moreover, the non-CE results showed that wine consumption was generally described as occasional and that certification of origin was considered as a proxy for quality, which was also reflected in respondents' WTP.

Table A48: Willingness-to-pay for wine attributes, Russia (N = 388*)

		WTP €/bottle	*Premium (%)***
Geographical origin (vs. Chile Cabernet)	Italy-Tuscany (Chianti)	5.66	(113%)
	France (Bordeaux)	4.81	(96%)
	Spain (Rioja)	2.69	(54%)
	Italy-Sicily (Cabernet)	0.97	(19%)
	Russia (Krasnodar Grenache dry)	0.92	(18%)
	Georgia (Saperavi dry)	0.06	(1%)

* Sample included Russian households located in Moscow, Saint Petersburg and Novosibirsk.
**Compared to the lowest value of the applied price vector including Chilean wine, approximately €5/bottle.
Source: Cicia et al. (2013)

Cross-regional studies

Lastly, Mueller Loose and Remaud (2013) explored North American and European consumer preferences for wine choices which involve corporate social responsibility claims (an umbrella term for ethical and social attributes) alongside product price. Prior to the CE, participants were also asked about their awareness and trust of different claims in food and wine products. The survey targeting wine consumers resulted in between 982 and 2,027 respondents in different countries. The results show, firstly, that overall awareness, purchase penetration and trust with regards to social and environment claims were similar across for each claim but different across the markets. For example, compared to European markets, North American consumers seemed to have a higher level of trust and claim awareness. As shown in Table A49, WTP results support differences across markets, but also across the different label claims. Over all markets, the average WTP was highest for organic claims at around €1.20/bottle (or 14% premium) - twice as much than the WTP for the environmental claims. Across the markets, not all attributes were statistically significant in all countries, such as for social and environmental responsibility. In most of these markets, the organic attribute had the highest WTP, particularly in France and Germany. Negative WTP can interpreted as a consumer demand for a discount, or consumer dislike, if such labels exist for wine products, such as socially responsibility in French markets or the reduced glass weight of wine bottles. Overall, this cross-country study illustrates that differences might exist between different developed markets.

Table A49: Willingness-to-pay for wine attributes, USA, Canada, France, Germany and UK (N=11,322*: US n = 1,617 and n = 1,614, Canada n = 1,036 and n = 982, France n = 2,027, Germany n = 2,025, UK n = 2,021)

	Average all countries	By country	
	*Premium (%)***		*Premium (%)***
Social responsibility logo (vs. no logo)	2.3%	France	-3.4%
Environmental responsibility logo (vs. no logo)	6.6%	US East coast	10.4%
		US Midwest	7.3%
		CAN Anglo	8.8%
Organic logo (vs. no logo)	14.4%	UK	3.8%
		France	26.1%
		Germany	27%
		US East coast	17.6%
		US Midwest	10.7%
		CAN Anglo	12.8%
		CAN Franco	2.9%
Carbon zero logo (vs. no logo)	3.2%	UK	3.4%
		France	-3.1%
		Germany	-0.3%
		US East coast	9.6%
		US Midwest	5.2%
		CAN Anglo	4.0%
		CAN Franco	3.3%
10 per cent less glass logo (vs. no logo)	-2.9%	UK	-1.4%
		France	-4.3%
		Germany	-8.1%
		US East coast	1.2%
		US Midwest	1.7%
		CAN Anglo	-4.6%
		CAN Franco	-4.3%

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
* Online survey, in 2009Samples in US included New York metropolitan area (Northeast) and Chicago metropolitan area (Midwest); samples in Canada included Anglophone and Francophone Canada
** reported in the study.
Source: Mueller Loose and Remaud, (2013)

A1.5 Other product categories

There has also been a number of CE and other WTP studies conducted for products that do not strictly fit in the previous categories (meat and seafood, dairy, fruit and vegetables, and wine) or include multiple types of food products. The current review includes 8 CE and other WTP studies examining the attributes of other types of food products in Europe and North America. Attributes examined in these studies include organic, local foods, GM production, country-of-origin, product quality, landscape of the place of origin, social responsibility, functional foods, environmental condition and carbon/GHG emissions associated with production.

European studies

The current review includes 6 CE and other WTP studies examining the attributes of other types of food products (almonds, lamb, strawberries, olive oil, honey and chocolate) in Europe, including the markets of Belgium, Italy, Spain and the UK. Attributes examined in these studies include organic, local foods, GM production, country-of-origin, product quality, landscape of the place of origin and social responsibility.

de-Magritis and Gracia (2016) examined Spanish consumers' WTP for almonds with organic and local attributes, including the inclusion of an EU organic label, as well as product labels indicating a series of distances between the production and consumption areas (i.e. food miles) (100km, 800km and 2,000km). Based on a series of preference questions, the authors placed participants in one of three segments: Segment 1 consisted of mostly male and younger participants who positively valued the organic and 100km labels and negatively valued the 2,000km label; Segment 2 consisted of mostly female and older participants who positively valued the organic and 100km labels and negatively valued both the 800km and 2,000km label; Segment 3 consisted of mostly female and older participants who positively valued both the organic and 100km label but negatively valued only the 2,000km label. Average WTP (€/package) for each of these attributes across the three segments are presented in Table A50 below. Results show participants in Segment 2 have the highest negative WTP for higher food miles, while participants in Segment 3 have the highest positive WTP for organic and local foods (de-Magritis and Gracia, 2016).

Table A50: Willingness-to-pay for almonds with associated organic and local attributes, Spain (N=171), €/package

	Segment 1	**Segment 2**	**Segment 3**
Organic	0.27	0.85	1.22
100km label	0.21	1.18	1.40
800km label	-0.04	-1.01	0.23
2,000km label	-0.32	-1.68	-1.33

Source: de-Magritis and Gracia, 2016.

Arnoult et al. (2010) conducted a cross-product CE, focussing on UK consumers' WTP for COO and related attributes, including origin, season, type (GM or organic) alongside price. The sample size were just under 200 for both products. The WTP results reported in Table A51 indicate strong preferences for local products and an aversion to EU imports for both product types. WTP values were just under £1.94/kilo (or 37%-60% premium of the base price) and approximately -£1.10/kg (-22% and -34%). However, some seasonality differences were observed between product types as the WTP for lamb increased in spring whereas WTP for strawberries increased in summer. Another difference was observed was that while organic strawberries had higher WTP than GM-free berries, WTP was higher for GM-free lamb than organic lamb. Finally, a number of socio-demographic influences were tested, finding that the locality of product was valued higher by higher income people, higher weekly spending influenced WTP for lamb, whereas gender influenced WTP for strawberries over different seasons.

Table A51: Willingness-to-pay for lamb and strawberry attributes, UK (N = 185 lamb CE and N = 187 strawberry CE*)

		Lamb		Strawberries	
		WTP £/kg	*Premium (%)***	*WTP £/kg*	*Premium (%)***
Location (vs. Rest of the world)	Local	1.75	37%	1.94	60%
	National	-	-	-	-
	European Union	-1.06	-22%	-1.11	-34%
Seasonality (vs. winter season)	Summer			0.58	18%
	Autumn	-0.52	-11%	-0.49	-15%
	Spring	0.31	7%		
Type 1 (vs. nothing stated)	GM-free	0.59	12%	0.40	12%
Type 2 (vs. nothing stated)	Organic	0.29	6%	0.64	20%

* Face-to-face interviews in 2005.
** Compared to average of the applied price vectors (lamb: £4.74/kg and strawberries: £3.24/kg)
Source: Arnoult et al. (2010)

In a Spanish study, de-Magistris and Gracia (2014) used the "food miles" concept as part of the CE where alternatives vary across almonds produced between 100km and 2000km distances, versus no such labelling at all. The survey participants completed two sets of choice sets, where the second one was used for validity checking. In addition, at the end of this process each participant were offered €10 with a *hold-out set* including a purchase option. The estimated WTP values are described in Table A52, which shows positive preferences with WTP of €0.62-€0.68/100g, or a 30-33 per cent premium, towards an organic label and a 100km label. WTP values towards longer distances were negative and increased according to total distance travelled, hence indicating preferences towards more local products.

Table A52: Willingness-to-pay for almond attributes, Spain (N = 171*)

		Average WTP €/100 g package (Premium %)**	
Production method (vs. No label: conventional)	EU organic label	0.62	(30%)
Origin of production (vs. no information of distance)	100-km label: almonds were produced within 100km (i.e., within province)	0.68	(33%)
	800-km label: almonds were produced around 800km (i.e., within Spanish or neighbour regions)	-0.25	(-12%)
	2000-km label: almonds were produced around 2000km (i.e., outside Spain but in Europe)	-1.03	(-49%)

* Random sample of respondents across the capital area of Spain.
** Compared to average of the applied price vector (€2.085/100g) based on the prices in supermarkets at the time.
Source: de-Magistris and Gracia (2014)

Aprile et al. (2012) assessed Italian consumer values for geographical and quality labels in olive oil products. These labels provide a tool to communicate sustainable production or products' value-added qualities. The labels included Protected Designation of Origin (PDO), Protected Geographical Indications (PGI) and organic farming (OF). The results suggested that all of these attributes affected consumer preferences with regards to olive oil product choices. Consumer

WTP, as summarised in Table A53, ranged from €1.52 up to €5.60 per litre, being highest for the PDO label with an 86 per cent premium compared with the base price. The second highest WTP was found for the PF label. The authors commented higher WTP for the PDO label than the PGI label may be due to the fact that olive oil produced in the study location is typically PDO-certified.

Table A53: Willingness-to-pay for olive oil attributes, Italy (N = 200*)

		WTP €/litre	*(Premium %)***
Type of olive oil/quality (vs. Virgin)	Extra virgin	4.44	(68%)
European OF label (vs. label absent)	Present	4.78	(74%)
European geographical indication (vs. label absent)	PDO label	5.60	(86%)
	PGI label	1.52	(23%)

* In-store interviews in grocery stores, 2010 in Naples.
** Compared to average of the applied price vector (€6.5/litre).
Source: Aprile et al. (2012)

In another Italian study, Cosmina et al. (2015) assessed consumer preference for honey attributes including product origin, product type, landscape of the place of origin and price. Most respondents (over 90% of the sample) were honey consumers – however, they typically consumed honey products only occasionally. The place of purchase varies between "buying directly from producer" and supermarkets. The result presented in Table A37 are based on the use of a consumer segmentation approach resulting in four consumer classes with similar choice patterns. People in the first class considered only the origin attribute in their choices. The other three classes were labelled as *'environmentally friendly'* consumers (35% of the sample), *'pro-intensive production'* consumers and *'organic'* consumers. As Table A54 shows, *environmentally friendly* consumers had a WTP of between €4.76 and €3.99 (84 and 70 per cent) for organic and local honey respectively while indicating negative WTP for other attributes, whereas *pro-intensive production* and *organic* consumers were willing to pay between €2.54 and €8.30 (45 and 146 per cent respectively) for most attributes, with the type of honey valued the highest in both classes. Overall these WTP values indicate strong preferences towards local and organic attributes in honey with some differences in WTP between consumer segments. Only a small section of respondents (in Class 1) were not willing to pay any premium for any product other than the local product.

Table A54: Willingness-to-pay for honey attributes, Italy (N = 427*)

		Class 1 N/A	Class 2 Environmentally friendly	Class 3 Pro-intensive production	Class 4 Organic
Class probability		19%	35%	19%	27%
		WTP €/jar (premium %) **			
Geographic origin (vs. other Italian regions)	Friuli Venezia Giulia (local) Region	2.88 (51%)	3.99 (70%)	4.53 (80%)	5.41 (95%)
	Other countries	-	-6.45 (-114%)	-	-2.54 (-45%)
Honey crystallisation (vs. semi-solid state)	Liquid (runny) state	-	-4.84 (-85%)	8.30 (146%)	6.70 (118%)
Organic (vs. no)	Yes	-	4.76 (84%)	6.57 (116%)	6.33 (112%)
Landscape (vs. Skyscraper hives)	Evocative landscape	-	-	3.69 (65%)	2.54 (45%)
	Beehives near industrial buildings	-	-1.59 (-28%)	6.74 (119%)	5.23 (92%)

***** Face-to-face interviews, in 2014

** Compared to average of the applied price vector (€5.67/jar).

Source: Cosmina et al. (2015)

Social responsibility attributes have been included in some, but not many, food and beverage choice studies. Vlaeminck et al. (2016) assessed consumer WTP for a Fair Trade (FT) chocolate product in Belgium. This was done using a within-sample test with two separate CEs: a "*FT-label* experiment" including the label (FT and Bio-FT), quality & taste, origin of cocoa and price attributes; and a "*FT-characteristics* experiment" with sub-attributes of FT covering environmental standards, price paid to producers, community investment, working conditions and product price. Half of the sample saw the FT-label CE first, with the other half seeing a reversed order. In this sample, the general purchase habits of FT products in general, if available, was split across (almost) never (approximately 50% of sample), regularly (42%) and always (5%); and only quarter of respondents defined a FT-product correctly. These general results also show that while most people (70%) believed the FT-statement, not everyone care about these issues personally. A summary of the WTP results from the CE analysis is provided in Tables A55 and A56. As shown in Table A55, the results of the FT-label experiment show that consumers valued the FT-label with a positive WTP of €0.84/100g for the standard FT label and $1.22 for the Bio-FT label. This equates to 207 per cent and 301 per cent premiums, respectively, relative to the standard supermarket price. Average WTP for the FT-label was then compared with different combinations of the FT-characteristics (FT-high, FT-low, BioFT-high and BioFT-low). As shown in Table A56, WTP values for different FT-sub-attributes were between €2.25 and €3.76 (up to 928% premium); hence consumers valued the bundle of FT attributes more than the plain FT labels. The results of the plain FT-label valuation are comparable to the price premium operated in supermarkets indicating that consumer surplus is effectively captured.

Table A55: Willingness-to-pay for chocolate attributes, Belgium (N= 144*)

		CE with a Fair Trade label	
		WTP €/100g	Premium (%)**
Label presence (vs. no label)	Fair trade label	0.84	(207%)
	Bio-Fair trade label	1.22	(301%)

* Face-to-face intercept survey, in 2013.
** Compared to supermarket price of FT chocolate (€0.81/200g or €0.45/100g)
Source: Vlaeminck et al. (2016)

Table A56: Willingness-to-pay for chocolate attributes, Belgium (N= 144*)

Attribute bundles	CE with Fair Trade characteristics	
	WTP (€/200g)	Premium (%)**
FT highest outcomes: EU Environmental standard, price paid to producer, high community investment and frequent controls in working conditions	3.76	(928%)
FT lowest outcomes: EU Environmental standard, average price paid to producer, average community investment and infrequent controls in working conditions	2.54	(627%)
Bio-FT highest outcomes: Organic Environmental standard, fair price paid to producer, high community investment and frequent controls in working conditions	3.47	(857%)
Bio-FT lowest outcomes: Organic Environmental standard, average price paid to producer, average community investment and infrequent controls in working conditions	2.25	(556%)

* Face-to-face intercept survey, in 2013.
** Compared to supermarket price of FT chocolate (€0.81/200g or €0.45/100g)
Source: Vlaeminck et al. (2016)

North American studies

The current review includes 2 CE and other WTP studies examining the attributes of other types of food products (canola oil and coffee) in North America (US and Canada). Attributes examined in these studies include organic, GM production, country-of-origin, social responsibility, functional foods, environmental condition and carbon/GHG emissions associated with production.

A comparison of GM (or genetically engineered (GE)) products and associated health-enhancing (or functional food) benefits were explored by Ding et al. (2015) in Canada. In this study, consumer preferences for GM-food were linked with consumer trust (generalized trust and trust in the food system) and health-related beliefs. In the context of canola oil products, the selected attributes covered GM or GE information, omega-3 content, COO and price. Consumer trust and health beliefs (i.e. health locus of control (HLC)) were measured in Likert-scale statements. The results in Table A57 show that consumers were willing to pay a premium of between 12 and 29 per cent of the base price for domestic and/or regular/enhanced omega-3 levels over no label. However, this WTP was relatively lower compared to the perceived disutility, or required compensation, from the negative WTP associated with GM products. A further analysis with the interactions show (WTP not reported here) that stronger health concerns will increase WTP for enhanced omega-3, and that negative preferences of GM food can be offset or linked to trust. Some additional findings included that men valued

GM products more than women, older people and those with higher education were less likely to prefer GM products, and that people with higher income valued health benefits more.

Table A57: Willingness-to-pay for canola oil attributes, Canada (N = 1,009*)

		WTP CAN $/1 litre	Premium (%)**
Omega-3 content (vs. no label)	Contains omega-3	0.95	19%
	Enhanced omega-3	0.86	17%
Country of origin (vs. USA)	Canada	1.45	29%
GM (vs. no label information)	Non-GM	0.60	12%
	Contains GM/GE	-1.82	-36%

***** Nationwide online survey

** Compared to average of the applied price vector ($5 per 1 liter)

Source: Ding et al. (2015)

Van Loo et al. (2015) focused on consumer preferences for sustainability certification of coffee products. The sustainability labels considered were Fair Trade (FT), Rainforest Alliance, USDA Organic and carbon footprint, the latter of which is less common in the US coffee market. A novelty in the study was a focus on visual attention on the choice sets (coffee packages) by respondents. This was done by an eye-tracking exercise on areas of interest (AOI) using a tracking device connected to the computer used to complete the surveys. From this, two measures were calculated - time and count of total fixation. In addition, Likert-scales were used to explore participants' attitudes to and perceived importance of the sustainability concepts. Three consumer segments were discovered based on the cluster analysis[3]: '*indifferent', 'sustainability and price conscious'* and "*price-oriented"* consumers. Relative WTP values presented in Table A58 show that respondents, on average, were willing to pay the most ($1.16/12oz, or 16% premium) for USDA certified coffee, and up to a 19 per cent premium for *'sustainability and price conscious'* consumers, which included most of the sample. The results also showed that visual attention to attributes is related to preferences for attributes whereby taking more time and fixating more attention on a particular attribute related to higher WTP. Significant interactions with participants' attention included USDA organic, Fair Trade and price attributes. Hence this study illustrated that *sustainability-motivated* consumers are also likely to seek information about sustainability credentials.

[3] Using the variables from the Likert scale questions and eye-tracking attention scores.

Table A58: Willingness-to-pay for coffee attributes, USA (N = 81*)

	Full sample		By consumer segments***		
			Sustainability and price conscious (n = 47)		Price-oriented (n = 26)
	WTP $/12 oz	Premium (%)**	WTP $/12 oz	Premium (%)**	
Fair Trade – label (vs. label not present)	0.68	(9%)	0.71	(10%)	-
Rainforest Alliance – label (vs. label not present)	0.84	(12%)	0.99	(14%)	-
USDA Organic – label (vs. label not present)	1.16	(16%)	1.41	(19%)	-
Carbon Footprint – label (vs. label not present)	-		0.51	(7%)	-

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
* Participants were recruited from a University database, in 2013.
** Compared to average of the applied price vector ($7.30/12 oz)
*** Since the "Indifferent consumer" segment consisted of only 8 participants, no WTP was calculated.
Source: Van Loo et al. (2015)

A1.6 Products adopting new technology

Finally, some studies have considered the opportunities provided by technological advancements in relation to food choices. The current review includes 3 CE and other WTP studies examining the attributes of food products adopting new technology in Europe (UK) and North America (US and Canada). Attributes examined in these studies include nanotechnology, animal welfare, food safety, traceability, country-of-origin, GM production, functional foods, environmental condition and taste.

European studies

Erdem (2015) explored UK consumers' preferences for reduced food safety risk in chicken products. The authors tested the impact of incorporating nanotechnology into food product packaging by including this attribute (as a symbol) in one CE and not in the other. Other attributes of consideration were risk of food poisoning and animal welfare level (based on the Welfare Quality index). Each subsample was further split into "welfare-improved" chicken consumers and "conventional" chicken consumers according to their reported purchasing behaviour[4]. Other than the nanotech attribute, the levels used in the status quo option varied according to purchasing behaviour. As Table A59 shows, consumers on average preferred chicken with a lower food safety risk and improved animal welfare, regardless of the presence of nanotechnology. WTP values were found to be higher for the "welfare-improved" consumers compared with "conventional" consumers. It also appeared that the presence of nanotechnology could increase WTP for food safety and chicken welfare. A choice debriefing question revealed that around half of the respondents considered the inclusion of such

[4] Approximately 30% of the respondents in both samples were welfare-improved chicken consumers.

nanotechnology to be "a good idea", with the remaining responses varying from "not bothered" to "more than concerned".

Table A59: Willingness-to-pay for chicken attributes, UK (N = 449*)

	Consumer type	Nano treatment (n = 225)		Non-nano treatment (n = 224)	
		WTP (£/chicken)	Premium (%) **	WTP (£/chicken)	Premium (%) **
Food poisoning risk: Reduction from a baseline	Conventional	-0.30	(-10%)	-0.30	(-3%)
	Welfare-improved	-0.59	(-20%)	-0.52	(-5%)
Chicken welfare level (scale 0-100)	Conventional	0.09	(3%)	0.08	(1%)
	Welfare-improved	0.67	(22%)	0.51	(5%)

* Online survey, in 2010
** Compared to average price (around £3/chicken).
Source: Erdem (2015)

North American studies

Lilavanichakul and Boecker (2013) explored Canadian consumer acceptance of traceability technology in ginseng products. This was explored amongst trade-offs with the products origin and manufacturer attributes. As summarised in Table A60, estimated WTP values implied a 16 per cent premium of the base price ($2.78/bottle) for having an internal tag for traceability/quality assurance. However, this WTP was relatively lower than for the inclusion of a Guarantee label or Canadian Ginseng product. The negative interaction term with a WTP of -$1.67/bottle for the simultaneous use of the 'Canadian Guaranteed' and 'Product of Canada' labels suggest that these attributes could be seen as substitutes.

Table A60: Willingness-to-pay for ginseng product attributes, Canada (N = 1,647*)

		WTP ($/bottle with 60 capsules)	Premium (%)**
Internal tag (vs. no)	Yes	2.78	(16%)
Manufacturer (vs. *Ontario Association of Ginseng Producers)*	National Manufacturer Brand	-2.34	(-14%)
Canadian Ginseng Guaranteed (vs. no)	Yes	9.52	(56%)
Product of Canada (vs. no)	Yes	5.74	(34%)
Canadian Ginseng Guaranteed* Product of Canada		-1.67	(-10%)

* Nationwide online survey
** Compared to average of the applied price vector ($16.99/bottle)
Source: Lilavanichakul and Boecker (2013)

In the third new-technology orientated CE, Yue et al. (2015) explored US consumer preferences for nano- and GM-food in the context of a rice product. The CE considered the possible benefits (e.g. better food safety) that these technologies could provide. The data was analysed using a class based approach from which four distinct consumer groups, based on their choices and characteristics (gender, income, education, race/ethnicity, and political and religious associations), were identified (see Table A61). Most respondents were in the *'benefit orientated group'* with a likelihood of 40 per cent for participants to belong to this group. Across all groups, new technologies had a negative WTP, varying between -2 and -89 percent of the base price, thus the conventional production method was preferred. The most valued benefits varies across consumer groups. *'Price oriented'* consumers were willing to pay the most for the enhanced nutritional elements (an approximate 10 per cent premium) and no

extra for improved taste or environmental impacts when compared to the provision of no additional benefits. The remaining three groups were willing to pay most for improved food safety, (premiums of between 9 and 136 per cent), with the *'benefit oriented'* group indicating the highest WTP. These results imply that consumers express highly heterogeneous preferences when distinguished by their choices and consumer characteristics. While new technologies had negative WTP values, the attached benefits were valued differently across the groups. Thus consumer preferences towards nanotechnology can include a complex set of trade-offs.

Table A61: Willingness-to-pay for (a bag of) white rice attributes: The latent class approach, USA (N = 1,117*)

		Class 1*** Price oriented	Class 2*** Technology averse	Class 3*** Benefit oriented	Class 4*** New technology rejecters
Class probability		18%	17%	40%	25%
		WTP ($/lb)			
		premium (%)**			
Production technology (vs. conventional)	Nanotechnology	-0.09 (-2%)	-0.70 (-16%)	-0.94 (-21%)	-3.39 (-77%)
	GM	-0.1 (-2%)	-0.78 (-18%)	-1.06 (-24%)	-3.9 (-89%)
Benefit from using the given technology (vs. no additional benefit)	Enhanced nutrition	0.42 (10%)	0.21 (5%)	5.16 (118%)	0.56 (13%)
	Improved taste	-	0.33 (8%)	2.99 (68%)	0.56 (13%)
	Improved food safety	0.22 (5%)	0.39 (9%)	5.96 (136%)	1.10 (25%)
	Less harmful environmental impact during production	-	-	4.08 (93%)	0.37 (8%)

Note: In this adapted Table, WTP was included only if the attribute was statistically significant.
* Online survey, in 2013
** Compared to average of the applied price vector ($$4.375/lb)
***Statistically significant class determinants: Class 1 reference group; Class 2 Gender; Class 3 Education, Gender, Income, Religion, Politics; Class 4 Gender, Religion
Source: Yue et al. (2015)

A1.7 Summary

In conclusion, this review included 56 international CE and other WTP studies regarding food and beverage choices and associated credence attributes from 2010 to 2017. This complements and updates previous reviews (Miller et al., 2014; Saunders et al., 2016) with the inclusion of more recent studies. Most of the studies reviewed pertained to meat and seafood products (28), following by wine (7), dairy (5), and fruit and vegetable products (5). Another 11 studies were reviewed in other product contexts (e.g. coffee and chocolate) or food products adopting new technology to communicate food safety or traceability. Most studies examined consumer preferences, typically targeting regular purchasers of the type of product examined; although one study included a comparison between food retailers and food consumers about their preferences towards the use of organic ingredients (Probst et al., 2012).

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Appendix B: Survey Instrument

Our Land and Water Science Challenge - Survey

Our Land and Water Science Challenge

The Drivers Project

Q1

Welcome to Our Land and Water Science Challenge survey.

We would really welcome your opinion on the international and domestic issues that have the potential to influence land use change/practice in New Zealand. The results you provide will feed into the research planning for the second phase of the Science Challenge.

This survey takes about 5 minutes. You have the right to decline answering any question or stop the survey at any time. If you do stop the survey before the end, the information you have provided will not be used. This survey is being conducted by the Agribusiness and Economics Research Unit (AERU) at Lincoln University in New Zealand.

The lead researcher is Prof Caroline Saunders. If you have any questions or concerns about the research, you may contact her at:Caroline.Saunders@lincoln.ac.nz

To begin the survey, begin by clicking on the >> button below.

Regards,

Caroline

Page Break

Q2 **Key issues**: What do you see as the three most critical ***domestic*** issues which have the potential to influence **New Zealand land use change/practice**?

- 1 (1) _____
- 2 (2) _____
- 3 (3) _____

Q3: What do you see as the three most critical ***international*** issues which have the potential to influence **New Zealand land use change/practice**?

- 1 (1) _____
- 2 (2) _____
- 3 (3) _____

Page Break

Q4: **International** - Below are some key issues that stakeholders and the team have previously identified. Please indicate whether you think the following **international** issues/drivers will have a high, medium or low impact on **New Zealand land use change/practice** over the coming decade:

	High (1)	Medium (2)	Low (3)	Don't know (4)
Agricultural policy (1)	❍	❍	❍	❍
Air quality (2)	❍	❍	❍	❍
Animal health and welfare (3)	❍	❍	❍	❍
Authentication/traceability (4)	❍	❍	❍	❍
Biodiversity (5)	❍	❍	❍	❍
Biosecurity (6)	❍	❍	❍	❍
Brand (7)	❍	❍	❍	❍
Chemical residues (8)	❍	❍	❍	❍
Condition of the environment (9)	❍	❍	❍	❍
Country-of-Origin (10)	❍	❍	❍	❍
Cultural values (11)	❍	❍	❍	❍
Demographics (12)	❍	❍	❍	❍
Digital communications systems (13)	❍	❍	❍	❍

Q5 Please indicate whether you think the following **international** issues or drivers will have a high, medium or low impact on **New Zealand land use change/practice** over the coming decade:

	High (1)	Medium (2)	Low (3)	Don't know (4)
Emissions trading (1)	❍	❍	❍	❍
Extreme weather events (2)	❍	❍	❍	❍
Fair trade (3)	❍	❍	❍	❍
Family and community values (4)	❍	❍	❍	❍
Food safety (5)	❍	❍	❍	❍
Functional foods (6)	❍	❍	❍	❍
GM and nanotechnology (7)	❍	❍	❍	❍
Greenhouse gas emissions (8)	❍	❍	❍	❍
Health and safety (9)	❍	❍	❍	❍
Innovative products and services (10)	❍	❍	❍	❍
Local foods/food miles (11)	❍	❍	❍	❍

Page Break

Q6: Please indicate whether you think the following **international** issues or drivers will have a high, medium or low impact on **New Zealand land use change/practice** over the coming decade:

	High (1)	Medium (2)	Low (3)	Don't know (4)
Māori values (1)	❍	❍	❍	❍
Organic production (2)	❍	❍	❍	❍
Pasture based production (3)	❍	❍	❍	❍
Product quality (4)	❍	❍	❍	❍
Religion (5)	❍	❍	❍	❍
Soil quality (6)	❍	❍	❍	❍
Sustainable supply (7)	❍	❍	❍	❍
Trade agreements (8)	❍	❍	❍	❍
Trade effects (9)	❍	❍	❍	❍
Waste/recycling (10)	❍	❍	❍	❍
Water footprinting/use (11)	❍	❍	❍	❍
Water quality (12)	❍	❍	❍	❍

Page Break

Q7: **Domestic** - Please indicate whether you think the following **domestic** issues/drivers will have a high, medium or low impact on **New Zealand land use change/practice** over the coming decade:

	High (1)	Medium (2)	Low (3)	Don't know (4)
Agricultural policy (1)	❍	❍	❍	❍
Air quality (2)	❍	❍	❍	❍
Animal health and welfare (3)	❍	❍	❍	❍
Authentication/traceability (4)	❍	❍	❍	❍
Biodiversity (5)	❍	❍	❍	❍
Biosecurity (6)	❍	❍	❍	❍
Brand (7)	❍	❍	❍	❍
Chemical residues (8)	❍	❍	❍	❍
Condition of our environment (9)	❍	❍	❍	❍
Cultural values (10)	❍	❍	❍	❍
Demographics (11)	❍	❍	❍	❍
Emissions trading (12)	❍	❍	❍	❍
Extreme weather events (13)	❍	❍	❍	❍
Family and community values (14)	❍	❍	❍	❍
Food safety (15)	❍	❍	❍	❍

Q8: Please indicate whether you think the following **domestic** issues/drivers will have a high, medium or low impact on **New Zealand land use change/practice** over the coming decade:

	High (1)	Medium (2)	Low (3)	Don't know (4)
Greenhouse gas emissions (1)	❍	❍	❍	❍
Health and safety (2)	❍	❍	❍	❍
Innovative products and services (3)	❍	❍	❍	❍
Local foods/food miles (4)	❍	❍	❍	❍
Māori values (5)	❍	❍	❍	❍
Organic production (6)	❍	❍	❍	❍
Product quality (7)	❍	❍	❍	❍
Religion (8)	❍	❍	❍	❍
Soil quality (9)	❍	❍	❍	❍
Sustainable supply (10)	❍	❍	❍	❍
Waste/recycling (11)	❍	❍	❍	❍
Water footprinting/use (12)	❍	❍	❍	❍
Water quality (13)	❍	❍	❍	❍

Page Break

Q9: Which primary sector are you most aligned with:

- ❍ Meat (1)
- ❍ Dairy (2)
- ❍ Wool (3)
- ❍ Viticulture/wine (4)
- ❍ Horticulture (5)
- ❍ Forestry (6)
- ❍ Aquaculture (7)
- ❍ Other (please specify): (8)

  _____

Page Break

Q10: What level of knowledge do you have concerning the following markets/regions:

	Very knowledgeable (1)	knowledgeable (2)	Some knowledge (3)	Little knowledge (4)	No knowledge (5)
North America (Canada, USA, Mexico) (1)	❍	❍	❍	❍	❍
China (2)	❍	❍	❍	❍	❍
South East Asia (Vietnam, Thailand, Cambodia, Indonesia, Malaysia, Myanmar) (3)	❍	❍	❍	❍	❍
Japan (4)	❍	❍	❍	❍	❍
South Korea (5)	❍	❍	❍	❍	❍
European Union (6)	❍	❍	❍	❍	❍
Other European countries (7)	❍	❍	❍	❍	❍
United Kingdom (8)	❍	❍	❍	❍	❍
Other (Please specify): (9)	❍	❍	❍	❍	❍

Q11: Please indicate the extent of your experience in the following areas:

	Extensive (1)	High (2)	Moderate (3)	Some (4)	None (5)
International markets (1)	❍	❍	❍	❍	❍
Environmental policy (2)	❍	❍	❍	❍	❍
R&D/innovation (3)	❍	❍	❍	❍	❍
Trade policy (4)	❍	❍	❍	❍	❍
Other domestic (5)	❍	❍	❍	❍	❍

Q12:

Thank you!

Thank you for your contribution to our research!

We value the time and contribution you have made to setting the direction of this National Science Challenge. If you have any queries, please contact:

Professor Caroline Saunders
Caroline.Saunders@lincoln.ac.nz

End of Block: Default Question Block