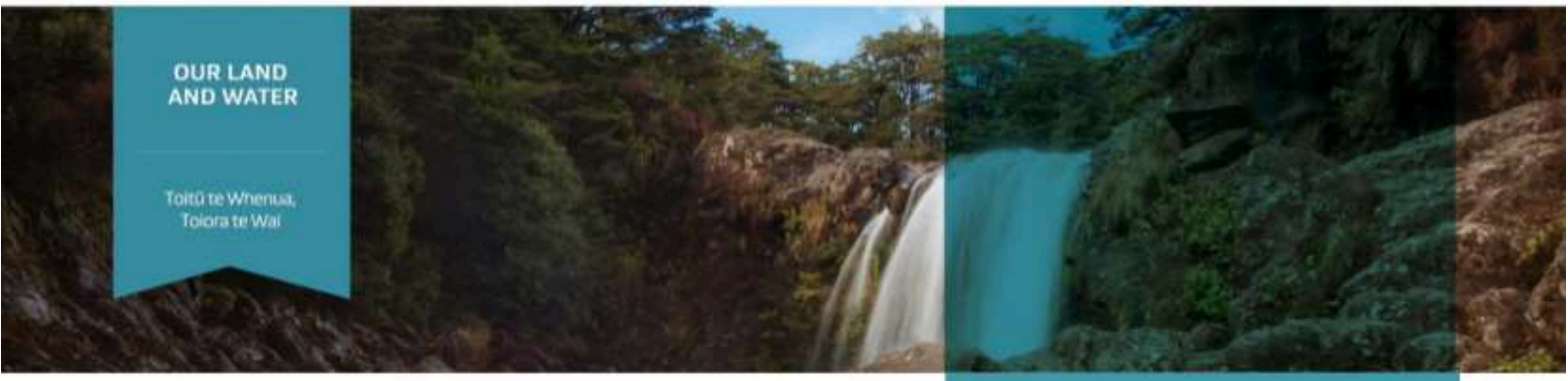
National Science Challenges



The Matrix of Drivers: 2019 Update

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Foreword

Enhancing primary sector production and productivity while maintaining and improving our land and water quality for future generations is a key outcome of the National Science Challenge for Our Land and Water. It is therefore important to identify the hierarchy of international and national issues in order to provide an evidence base to guide investment and inform the Challenge Research Strategy. To this end, it was proposed that a small project be conducted, and regularly updated.

This project aims to deliver an overview of international and domestic drivers, as well as issues that are of particular relevance to the New Zealand primary sector and land use. This overview is based on a literature search of the most important issues, followed by a survey of key stakeholders as to their opinion of the most important issues affecting New Zealand land use and land use practice from overseas and domestically. In addition, a review of the level of interest and concern of international consumers on various issues is produced relevant to the primary sector.

This is the third report in this series and provides an updated understanding of the international and national drivers and issues of land use change/practice, and their importance to the primary sector. These drivers will help prioritise where investments in primary sector research based on their relationship to economic growth, social, cultural and environmental interactions. Updates of this research will allow us to understand how drivers and issues change, which will help to assess the impact the Challenge has had as well as future research investment needs. This work also provides a contribution to the Challenge Strategy.

This report is structured as follows: Chapter 1 provides an introduction to this report and its wider context; Chapter 2 presents the results of a survey of primary sector stakeholders regarding their views of the importance of key international and domestic drivers of land use change/practice; Chapter 3 examines future trends and challenges related to land use change/practice (particularly within a New Zealand context); and Chapter 4 concludes the report and provides a summary of its findings.

1. Introduction

Project background

This report is the third in a series providing updated overviews of international and domestic drivers that 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 (OLW) 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." 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., 2016b). This was updated in late 2017 to include new arising issues or drivers relevant to land use change/practice (Saunders et al., 2018). The current list of international and domestic drivers is presented in Table 1.1 below. This report has expanded upon previous literature reviews, with an examination of the latest reports produced by key organisations such as the United Nations (including the FAO and IPCC), as well as key academic literature. A summary of each driver and its 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 2019)

Agricultural and Trade Policy	Air Quality	Animal Health and Welfare	Authenticity and Traceability
Biodiversity	Biosecurity	Brand	Chemical Residues
Climate Change	Country-of-Origin	Cultural Values	Demographics
Digital Communication Systems	Emissions Trading Schemes	Environmental Condition	Extreme Weather Events
Family and Community	Food Safety	Functional Food	Gene Technology
Greenhouse Gas (GHG) Emissions	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 Dalziel et al., 2019).

The domestic drivers were informed by key strategic documents from government agencies such as The Ministry for Primary Industries (MPI), The Ministry for the Environment (MfE) and The Ministry of Foreign Affairs and Trade (MFAT). The strategic documents of regional and local agencies were also reviewed. Where publicly available, key information from sector groups and farmer associations such as Beef+Lamb New Zealand and Fonterra were also considered. Relevant academic literature was assessed. Important legislative and regulatory documents were also considered. This review included voluntary standards such as AsureQuality Organic standards and Sustainable Winegrowing New Zealand standards. International trade agreements, government legislation and reports, retailer requirements, strategic documents, and academic literature helped identify the international drivers. The literature review also looked at future trends that could influence these drivers.

The initial Drivers Project 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. 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 2019. These 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

As stated above, the two earlier Drivers reports included a survey of stakeholders. This was repeated for this report with an updated survey, administered in October/November 2019. The overall aim of this survey was to assess the relative importance of the drivers from New Zealand and international regions, with a particular focus on drivers' impact on land use practice/change in New Zealand. The survey was distributed on October 27th 2019 using Qualtrics™, a web-based survey system. Two rounds of survey participation invitations were distributed – the first were specific invitations to a list of participants selected in consultation with the Science Challenge Directorate based on their experience and expertise in relation to New Zealand's primary industries (n=335). The second was to a list of participants from a database held by the Our Land and Water National Science Challenge (n=1,224). Additional reminder emails were sent following the initial distribution. The survey was distributed to 1,559 participants in total, receiving 226 completed surveys, thereby achieving a 14.5 per cent completion rate.

The survey first asked participants to indicate (unprompted) the three most critical international and domestic issues that they believed could influence New Zealand land use practice/change in a ranked order (e.g. 1 = most critical, in descending order of importance). These responses were then weighted (e.g. 1 (Most Critical) was given a weighting of 3; 3 (Least Critical) was given a weighting of 1) to provide scores of the overall importance of these international and domestic issues.

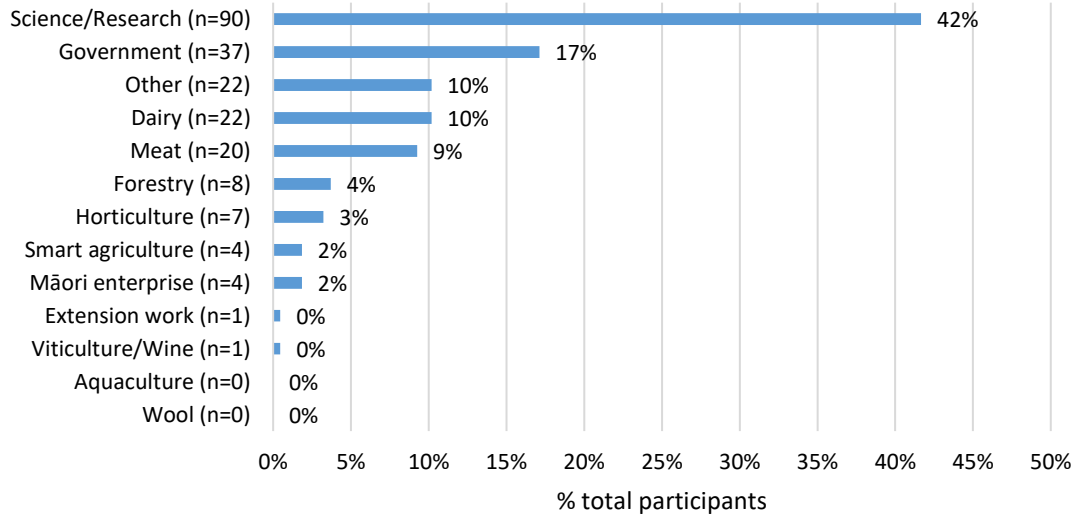
Participants were then asked to identify from a predetermined list of issues/drivers which of these were likely to have a 'high', 'medium' or 'low' impact on New Zealand land use change/practice. These predetermined drivers were chosen from previous Drivers reports, the literature, and in consultation with the Challenge Directorate.

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 in Appendix B of this report. Completed responses were then analysed and are given below.

2.2 Survey results

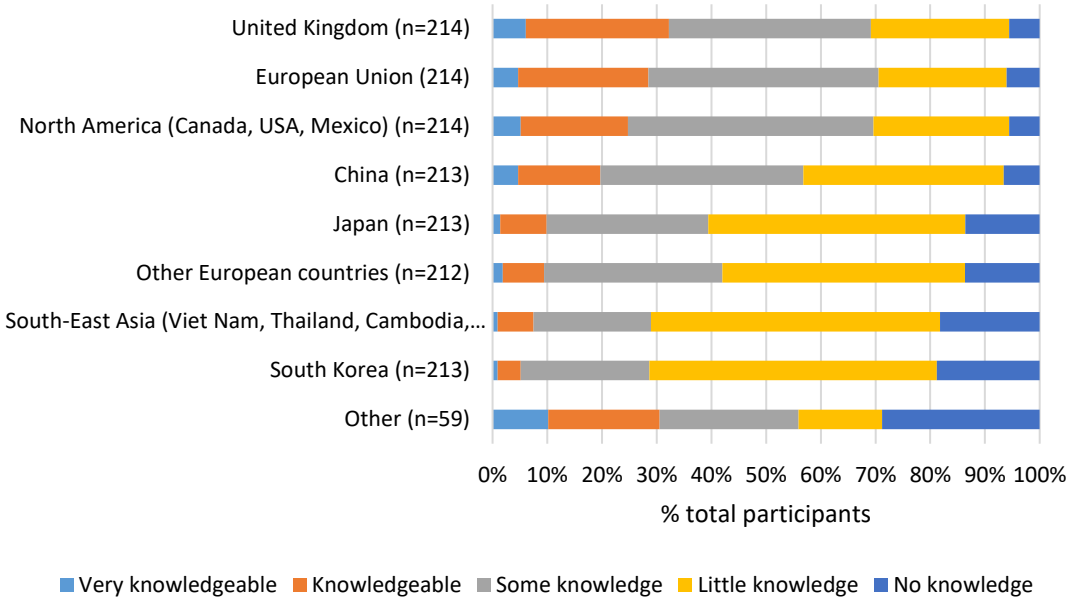
Survey participants were asked to identify the sector that they were most closely aligned with. As shown in Figure 2.1, 42 per cent of participants identified with the science/research sector, followed by government and other sectors (17 per cent and 10 per cent respectively). The most represented primary sector was dairy (10 per cent), followed by meat (9 per cent) and forestry (4 per cent). Sectors stated within the 'other' category included nutrient management, agribusiness and primary sector advocacy/consultancy, community, environmental management, irrigation, regenerative agriculture, water management, and food manufacturing, as well as work across multiple sectors.

Figure 2.1: Survey participants' alignment with sectors



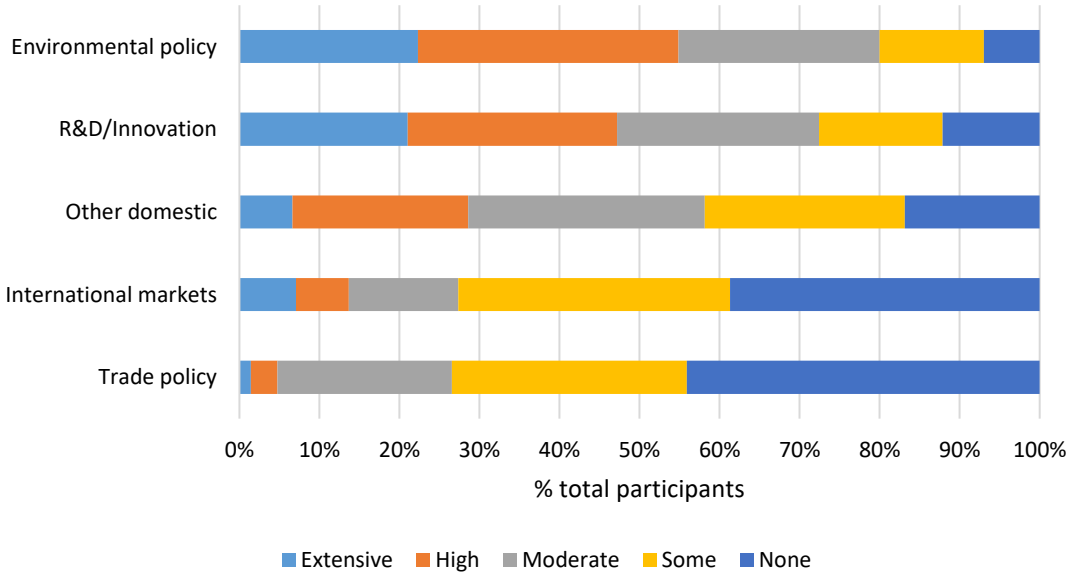
Participants were also asked to indicate their levels of knowledge regarding particular markets and regions. As shown in Figure 2.2 below, 32 per cent of participants indicated they were 'very knowledgeable' or 'knowledgeable' regarding the United Kingdom market, followed by other markets (30 per cent 'very knowledgeable' or 'knowledgeable) and European Union (28 per cent 'very knowledgeable' or 'knowledageable'). Other markets/regions that participants identified as being familiar with included Australia, India, Latin America, Middle East, New Zealand, Pacific, Russia, South America and Southern Africa.

Figure 2.2: Participant's level of knowledge regarding markets/regions



As shown in Figure 2.3 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'. Fifty-five per cent of participants had either 'extensive' or 'moderate' experience in *environmental policy*, followed by *R&D/Innovation* (47 per cent 'extensive' or 'moderate' experience) and *other domestic* (29 per cent 'extensive' or 'moderate' experience).

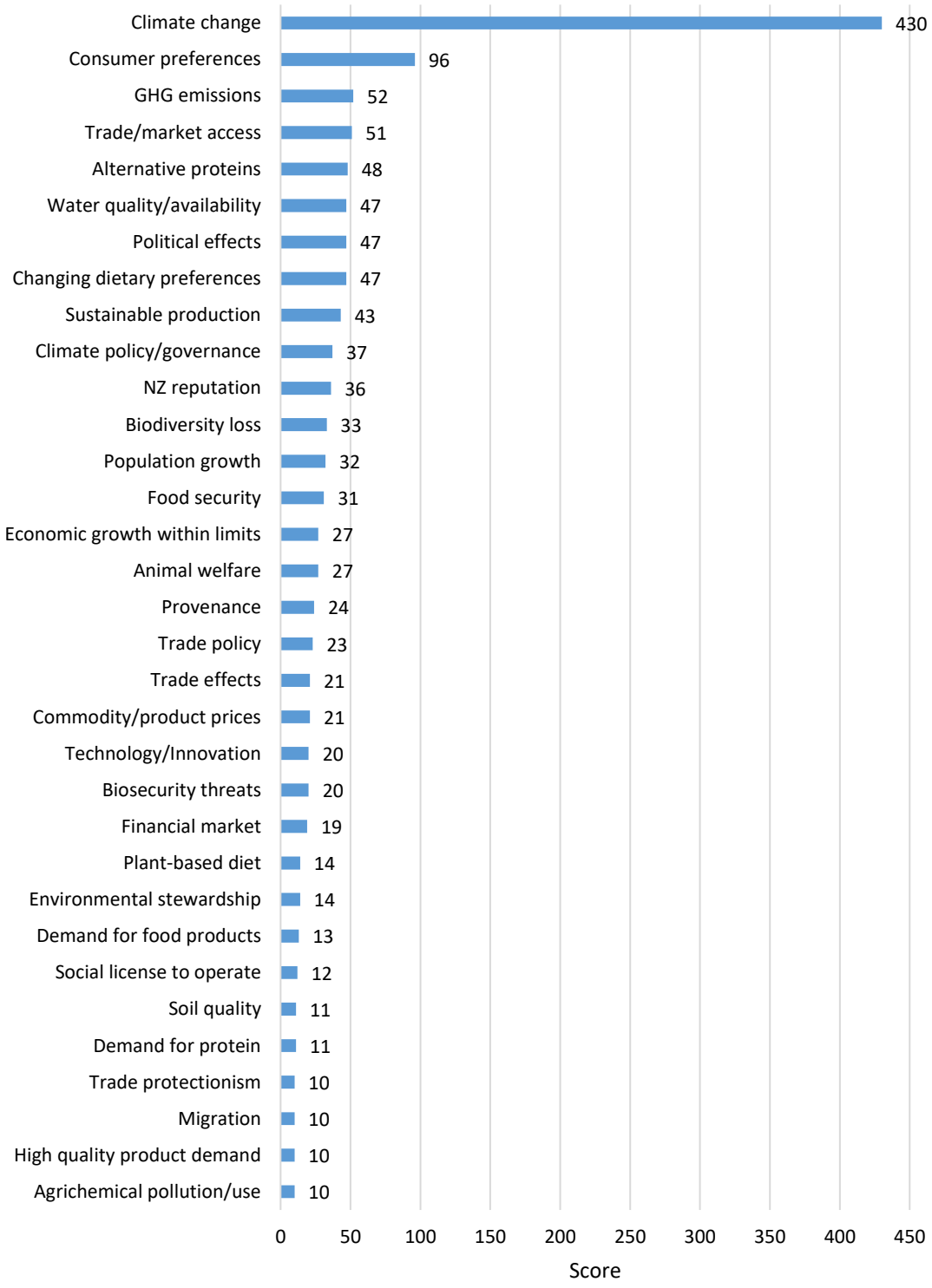
Figure 2.3: Participants' level of experience in industry fields



Critical international 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. As shown in Figure 2.4 below, *climate change* was indicated to be significantly more important to participants than any other international issue. Other critical issues identified included consumer preferences, greenhouse gas (GHG) emissions, trade/market access, alternative proteins, water quality/availability, geopolitical effects and changing dietary preferences. The results were consistent with previous survey results, with the main exception being an increase in the importance of climate change (Saunders et al., 2017).

Figure 2.4. Critical international issues (ranked scores) (unprompted)

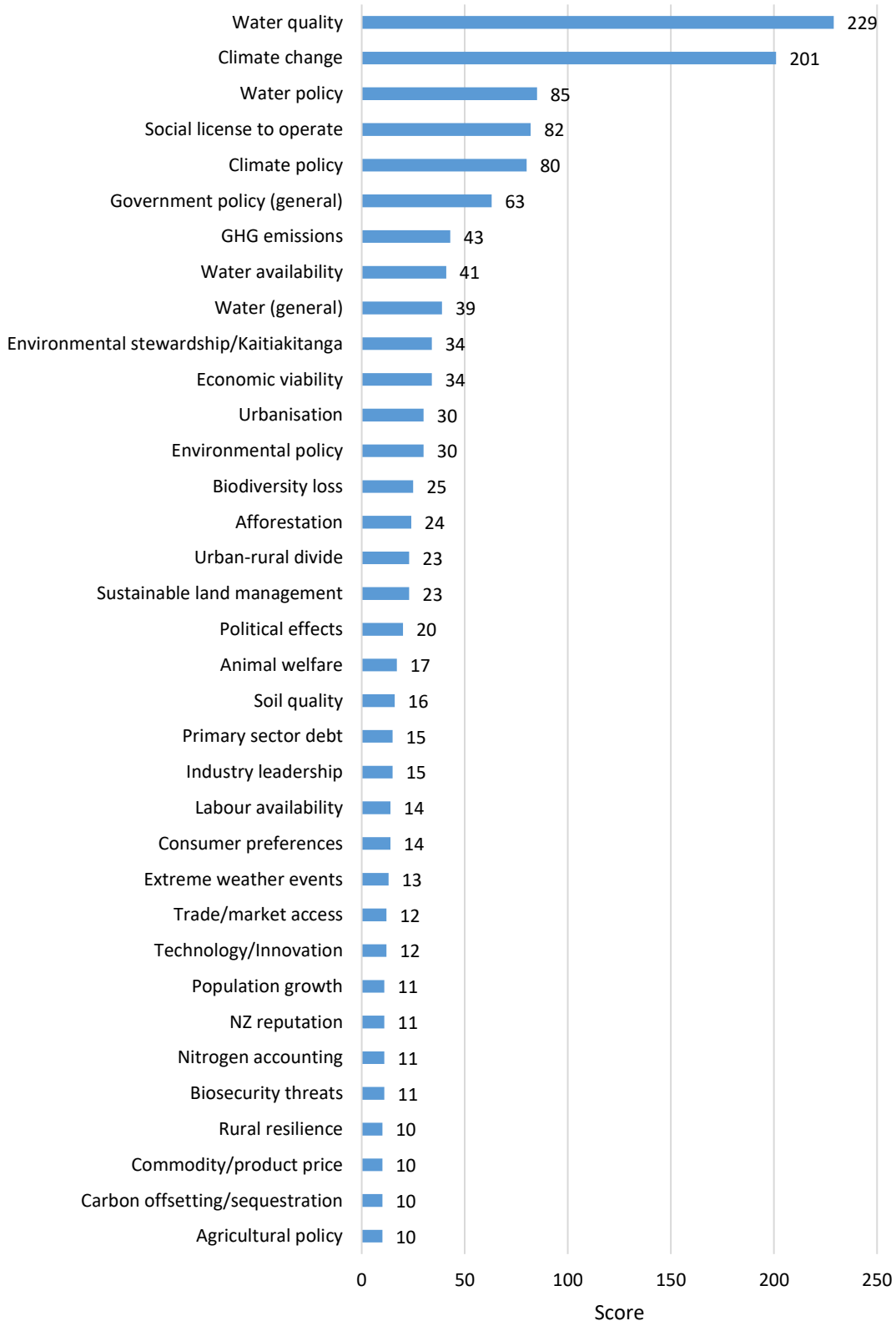


Note: Issues with scores of less than 10 are omitted from this figure.

Critical domestic 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. As shown in Figure 2.5 below, *water quality* was indicated to be important to more participants (followed by *climate change*) than any other domestic issues. Other critical issues identified included water policy, social license to operate, climate policy, government policy in general, GHG emissions and water availability. These results are consistent with the previous survey in which participants identified water-related issues as the most critical domestic issues (Saunders et al., 2018).

Figure 2.5. Critical domestic issues (ranked scores) (unprompted)



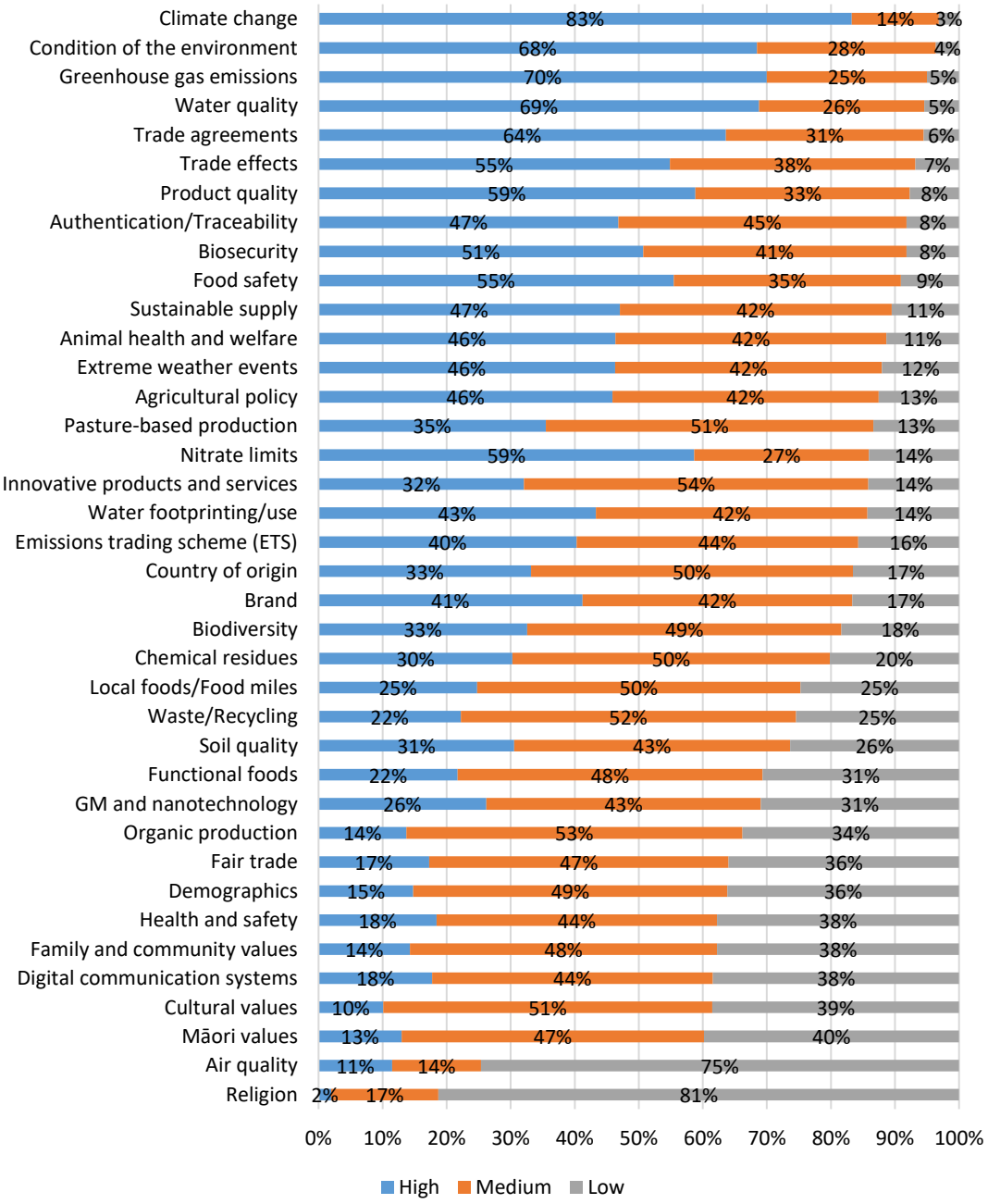
Note: Issues with scores of less than 10 are omitted from this figure.

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

Participants were then presented with a list of 38 international drivers (as identified by previous surveys and extensive literature review) 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.

Echoing prior unprompted statements, Figure 2.6 below shows that 83 per cent of respondents identified *climate change* as having a potentially high impact on New Zealand land use change/practice. This was followed by *condition of the environment* (68 per cent *high*, 28 per cent *medium*), *GHG emissions* (70 per cent *high*, 25 per cent *medium*) and water quality (69 per cent *high*, 26 per cent *medium*).

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

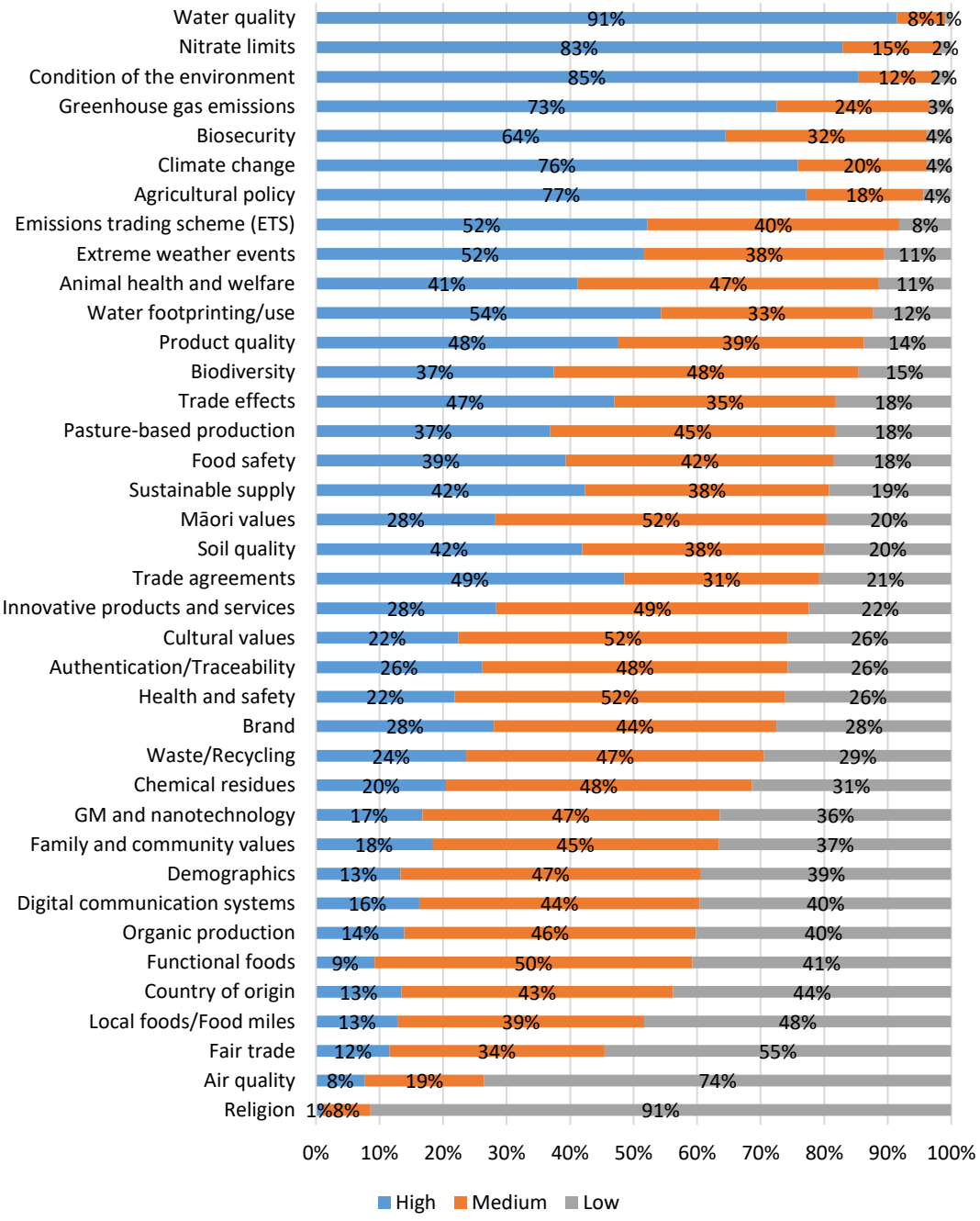


Impact of domestic drivers/issues on New Zealand land use change/practice

Participants were then presented with a list of 38 domestic drivers (as identified by previous surveys and extensive literature review) and asked to identify whether these would have a high, medium or low impact on New Zealand land use change/practice.

As shown in Figure 2.7 below, 99 per cent of respondents indicated that *water quality* was either of high or medium importance in relation to New Zealand land use change/practice, followed by *nitrate limits* (83 per cent 'high', 15 per cent 'medium') and *condition of the environment* (85 per cent 'high', 12 per cent 'medium').

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



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. The value of primary exports reached $42.7 billion in 2018, an 11.7 per cent increase over the previous year. By the end of 2019, it is expected that these exports will increase by 3.8% to $44.3 billion (MPI, 2018). This was primarily driven by higher exports of dairy, meat and forestry products, especially into China (StatsNZ, 2019b). New Zealand's primary sector aims to continue to achieve high export returns while simultaneously addressing local and global trends and challenges. This chapter will examine key future trends and challenges that could have the potential to impact primary land use change/practice in New Zealand.

3.1 Climate change

1. Impacts on regional production

The impact of climate change is likely to vary between regions. A number of studies have shown that low-latitude countries' crop production is likely to be adversely affected by climate change, while countries at higher latitudes could experience either positive or negative impacts on production (FAO, 2017a; IPCC, 2019b). It is also shown that animal growth rates in primary production systems have declined in recent years, exacerbated by climatic conditions (IPCC, 2019a).

While the effects of climate change are most likely to be considerably negative, some studies have shown that climate change could marginally enhance primary production in colder climates, while higher concentrations of CO_2 could potentially boost aspects of primary production (Prentice, 2017; Wirehn, 2018). For example, satellite observations have observed increased rates of vegetation greening occurring in parts of Asia, Europe, South America, Central North America and Southeast Australia, caused in part by extended growing seasons and CO_2 fertilisation processes (IPCC, 2019a).

The effects of climate change, in combination with demographic shifts and population growth, are likely to shift arable production regions. This will include an expansion in land area for arid climate zones and contraction in land area for polar climate zones (IPCC, 2019a). In particular, the amount and availability of arable land in Africa, South America, India and Europe are likely to decrease, while arable land availability may increase in areas of Russia, China and the United States (Zhang and Cai, 2011; IPCC, 2019b). This may be brought about by shifts in the suitability of particular regions for growing particular crops, with crops that thrived in particular regions not able to adapt to climate change-induced environmental disruptions (IPCC, 2019a).

In a New Zealand context, primary producers are likely to need to develop climate change adaptation strategies to maintain the sustainability of their operations. In the New Zealand kiwifruit sector, for example, Cradock-Henry (2017) found multiple vulnerabilities to climate change adaptation, including the use of short-term reactive practices over long-term strategies. Similarly, Kalaugher et al. (2017) showed that New Zealand dairy productivity is likely to be negatively impacted by the effects of climate change without the implementation of adaptation strategies. New Zealand primary production is also likely to be affected by a

number of other impacts, including the likely increased demand for irrigation and fertiliser to maintain yields, as well as increased fire risk in the forestry sector (CCATWG, 2017).

Global shifts in agricultural yields could also affect market demand, supply and prices (Hsiang et al., 2017). In this sense, the onset of climate change could marginally improve returns for New Zealand's primary sector, with a decline in agricultural production overseas increasing demand for New Zealand products, as well as increasing commodity prices potentially benefitting New Zealand producers and exporters (NZAGRC, 2012; Saunders et al., 2009). In addition, for particular regions of New Zealand, climate change may produce higher productivity for particular crops through improvements in climatic conditions required for plant growth (Kenny, 2001). However, this may be offset by the increased incidence of extreme weather events, diseases and pests associated with climate change (expanded upon in the following sections).

2. Extreme weather events

Climate change is likely to significantly increase the frequency and severity of extreme weather events, potentially negatively affecting food security and significantly influencing land use change/practice. This includes increases in the frequency and intensity of events such as heatwaves, droughts, dust storms, precipitation, flooding and similar effects (IPCC, 2019a). As discussed above, extreme weather events are likely to cause reductions in total yield for many staple crops, thereby negatively affecting food security (IPCC, 2019b). Lesk et al. (2016) estimated that extreme weather events were responsible for approximately 9-10 per cent reductions in national cereal production losses internationally between 1964 and 2007, the frequency and intensity of which are likely to increase under climate change. Climate change-induced extreme weather events can also negatively affect food security and supply by disrupting food supply chains (IPCC, 2019a).

Climate change-induced extreme weather events are estimated to be already affecting New Zealand, at a conservative cost of approximately NZ$840 million in total between 2007 and 2017 (Frame et al., 2018; Harrington et al., 2014). Changing weather patterns and increasing extreme weather events have also been identified as critical challenges in climate change adaptation for a number of New Zealand's primary industries (Cradock-Henry, 2017; HNZ, 2017). For example, the 2013 New Zealand drought, which impacted the primary sector, bringing about an estimated NZ$1.3 billion in damages, has been suggested to be a direct result of anthropogenic climate change (Harrington et al., 2014; VUW, 2017). More frequent and intense extreme weather events are likely to increase in New Zealand as a result of climate change, which could impact on several primary industries, including meat, wool, arable, dairy, viticulture, horticulture and forestry (NZAGRC, 2012).

3. Higher biosecurity risks

Climate change-induced effects, such as changes in regional temperature and weather patterns, could affect the dispersal and spread of damaging pests and diseases, both internationally and domestically (IPCC, 2019a; NZAGRC, 2012). Historic losses to primary producers caused by pest or disease incidence have included direct losses of their products (e.g. crops and/or animals), or through the loss of income associated with declines in yield. On an international level, biosecurity risks affect subsistence farming and other activities that are relied upon for human survival. Climate change is likely to exacerbate biosecurity risks to primary production, thereby potentially greatly influencing land use change/practice internationally (FAO, 2008; IPCC, 2019a).

Climate change is likely to present challenges for maintaining biosecurity in New Zealand's primary sector. Specifically, changes in New Zealand's climate could provide ideal conditions for many pest species, including invasive and already-present "dormant" species, which could thrive and proliferate under these conditions (Aguilar et al., 2015; FAO, 2008; James, 2019; Kean et al., 2015; Roques, 2010). This also includes increasing prevalence of animal and plant diseases, which, in combination with the above pests, could significantly negatively affect ecosystems and primary production systems. New Zealand's ecosystems are particularly vulnerable to introduced pest or disease species, with outbreak discoveries such as Mycoplasma bovis in cattle-based industries and PSA-V in the kiwifruit industry exemplifying this (BNZ, 2019; Taunton, 2017). Biosecurity risks pose a clear threat to New Zealand's primary industry, and is highly likely to influence land use change/practice.

4. Ecosystems changes

Climate change is highly likely to negatively impact on the world's ecosystems. This is likely to be caused by changes in land, air and water temperature, shifting temperate zones, and other effects such as extreme weather events (IPCC, 2019a). As a result, critical ecosystems services such as pollination and natural predator control could be disrupted, having a dramatic effect on ecosystem health and stability (EPA, 2016; FAO, 2017a; IPCC, 2019a). In addition to services required for basic survival (e.g. oxygen generation), ecosystem services provide essential support for human primary production systems, such as pollination, nutrient cycling, water cycling, water purification, erosion regulation, pest and disease regulation, seed dispersal and climate regulation (CBD, 2008). Declines in ecosystem service provision could negatively affect crop yields, genetic variability, soil fertility, water quality and pasture production (Lorencová et al., 2013; Maes et al., 2016). Simultaneously, land use practices can impair ecosystem services, thereby undermining their sustainability (Bjorklund et al., 1999; Caride et al., 2012; Costanza et al., 1997; Lorencová et al., 2013).

In New Zealand, climate change is likely to have a significant impact on ecosystems and their services, altering temperate zones, annual/seasonal events and ecosystem functions (such as food webs). This includes New Zealand's unique native biodiversity as well as essential ecosystem services such as those listed above (CCATWG, 2017; Christie, 2014; DOC, 2011). The implementation of management systems that enhance native biodiversity, and therefore ecosystem services to primary production, are included in the strategic plans of New Zealand government entities, including the Department of Conservation and the Ministry for the Environment (Christie, 2014; Davis et al., 2016; MfE, 2017c, 2019b). Roberts et al. (2015) provide a review of estimates of the contribution of ecosystem services to New Zealand wellbeing, including specific services to agriculture such as pollination (approximately NZ$4.5 billion annually). Similarly, New Zealand's land-based ecosystems and their services were preliminarily estimated to contribute NZ$57 billion to human welfare in 2012 (Patterson and Cole, 2013). Adopting sustainable land use practices will be critical to mitigating the effects of climate change on ecosystems.

5. Social impacts

Climate change may also have impacts on population and social dynamics, migration and human health. It is likely that climate change will cause currently populous world regions to become unliveable, potentially leading to mass human migration. Estimates have shown that between 72 and 200 million people may be forced to migrate as a result of climate change-induced conditions rendering particular world regions uninhabitable for humans (IPCC, 2014; Rigaud et al., 2018). Population growth and increased migration leading to the requirement

for greater urbanisation can enhance temperature increases and extreme rainfall events in urban centres, contribute to GHG emissions from land use change, as well as act as carbon sinks by importing increasingly large intakes of carbon in the form of food, fibers and fuel (Churkina, 2016; IPCC, 2019a). Increased atmospheric CO_2 levels will also have a high likelihood of compromising the nutritional quality of crops, thereby influencing global human and animal nutrition (IPCC, 2019a). The social impacts of climate change may therefore impact on land use change/practice, as well as exacerbate existing climate change stressors. In New Zealand, the impacts are expected to lead to some movements of population, for example from vulnerable coastal zones, with possible increases in migration.

6. Paris Climate Agreement

In 2015, the Paris Climate Agreement was adopted by 195 countries, the first ever legally binding international climate agreement, entering into force on November 4th 2016. It was signed with countries agreeing on net zero emissions by 2050. A raft of measures were agreed upon, including attempting to limit global temperature increase to 1.5 degrees (European Commission, 2017). However, following a decision made by President Donald Trump upon taking office in 2017, the US recently notified the UN of their intention to withdraw from the Paris Climate Agreement, stating that the deal will place an "unfair economic burden" on the US (BBC, 2019a). At present, at least 55 countries responsible for approximately 55 per cent of global GHG emissions have implemented instruments to ratify the agreement (UN, 2019c).

New Zealand is a signatory to the Paris Agreement, and has committed to reducing its GHG emissions to 30 per cent below 2005 levels by 2030 (MfE, 2017a). As of December 2019, the Climate Action Tracker (2019), New Zealand's progress towards achieving GHG emissions in line with keeping global warming below the Paris Agreement's 1.5^{o}C target are rated as "insufficient", with current rates of emissions likely to track towards 3^{o}C of global warming (CAT, 2019). Legislative and policy instruments designed to limit New Zealand's total GHG emissions have been developed and implemented (discussed in the following Section 3.1.7).

7. New Zealand domestic policy/emissions trading scheme

New Zealand legislation addressing climate change includes the Climate Change Response Act (2002), which was developed in order to meet obligations under the United Nations Framework Convention on Climate Change and Kyoto Protocol. This has been recently amended by the Climate Change Response (Zero Carbon) Amendment Bill, which was passed into law in October 2019. This sets a target of reducing all greenhouse gas emissions (excluding biogenic methane emissions) to net zero by 2050, with biogenic methane emissions to be reduced to 10 per cent below 2017 levels by the year 2030 (MfE, 2019a). The legislation of emissions reduction targets will likely impact on land use in New Zealand (particularly primary production) by potentially requiring land-users to adapt practices to meet legal requirements.

Under the New Zealand Emissions Trading Scheme (ETS), all sectors *except agriculture* are obliged to surrender their New Zealand Units (NZUs) (equivalent to 1 tonne of CO_2 emissions) to the government, which can then be given by government to land users with carbon sequestration practices in place. As the New Zealand agriculture sector was responsible for approximately 48 per cent of New Zealand's GHG emissions in 2017, the New Zealand government is pursuing options for its inclusion within the ETS (MfE, 2017b, 2019c). In particular, the New Zealand Government introduced the Climate Change Response (Emissions Trading Reform) Amendment Bill to Parliament in October 2019, outlining legislation to include agriculture in New Zealand's ETS. Parliamentary consensus on the inclusion of

agriculture in the ETS was achieved in July 2019, with a select committee expected to begin in late 2019 (MfE, 2019d). The agricultural sector has until 2022 to show how it plans to achieve net zero emissions by 2050, otherwise it will go into the New Zealand ETS in 2025.

Similarly, in response to climate change and other growing environmental concerns, the New Zealand Government has implemented the One Billion Trees programme, which aims to plant one billion trees across New Zealand between 2018 and 2028. This is considered to be effective in carbon sequestration, as well as improving productivity from land-based production and water quality, enhancing biodiversity by providing natural habitats, mitigating erosion and providing alternative sources of income for landowners (CEDC, 2018; Forestry New Zealand, 2018). This is estimated to require between 230,000 and 430,000 hectares of trees to be planted to meet the one billion tree target, with foresters expected to plant 500 million trees based on current planting rates (CEDC, 2018). This programme will offer landowners direct grants, as well as partnership grants, for planting trees on their land, with higher per hectare rates paid for indigenous mixed plantings over exotic species (Forestry New Zealand, 2018). This has the potential to affect New Zealand land use practice/change by incentivising tree planting as an alternative land use.

The One Billion Trees programme intends to use afforestation as a means of sequestering carbon emissions, as well as enhance biodiversity and ecosystem services. However, afforestation using exotic tree species (i.e. non-native species) may also produce adverse effects for native biodiversity and ecosystem services by displacing native vegetation, altering water cycles and increasing fire risk (CEDC, 2018; Christie, 2014). The promotion of native afforestation is included in the One Billion Trees programme, with greater financial incentives paid to land owners/managers for mixed native planting over exotic species (CEDC, 2018; Forestry New Zealand, 2018).

Other policy instruments designed to address land use in relation to climate change include the proposed National Policy Statement for Highly Productive Land (NPSHPL) and the National Policy Statement on Freshwater Management (NPSFWM). The proposed NPSHPL was developed by Ministry for Primary Industries and Ministry for the Environment to address several pressing concerns regarding increasing urbanisation, particularly the encroachment of urban expansion into highly productive land areas. It is hoped that the implementation of the NPSHPL can allow for mechanisms under the RMA to protect highly productive land from inappropriate development and subdivision and ensure its availability and benefits are maintained. Public consultation and submissions closed on October 10th 2019, and its current status is unknown (MPI, 2019a).

Similarly, in 2014, the New Zealand government introduced the NPSFWM, which outlines requirements for effective freshwater use, including protections for water quality, public health, native biodiversity, sociocultural values and Tikanga Māori (MfE, 2019e). The NPSFWM was amended in 2017, with Government looking to make improvements to strengthen current requirements, particularly with regards to ecosystem and human health. An independent advisory panel is expected to produce a report providing consultation summaries, with additional impact analysis to be submitted to Government (MfE, 2019f).

8. Climate activism

Public concerns regarding the onset of climate change, particularly government response and the relationship between global societal institutions and increasing environmental degradation, have led to a growth in climate activism in recent years. This can be seen in the

rise of activist groups such as Fridays For Future (FFF) and Extinction Rebellion (XR). In particular, the FFF movement was initiated by Greta Thunberg, whose protest on government inaction on climate change became virally popular, inspiring a global movement of school students into climate activism (FFF, 2019). In addition, Extinction Rebellion was initiated in the United Kingdom in October 2018 in response to government and industry inaction on climate change (XR, 2019a). Both groups have New Zealand chapters on a local level that have participated in regular climate activism since their inception (FFF, 2019; Forrester, 2019; TVNZ, 2019; XR, 2019b). Increases in climate activism could lead to greater public awareness of the impact of land use practice on environmental and climatic conditions, thereby potentially affecting land users' social license to operate (see Section 3.2.4 below). These movements could also place pressure on governments to enforce stricter regulations on activities likely to exacerbate climate change. This could ultimately affect land use management practices, leading to land use change.

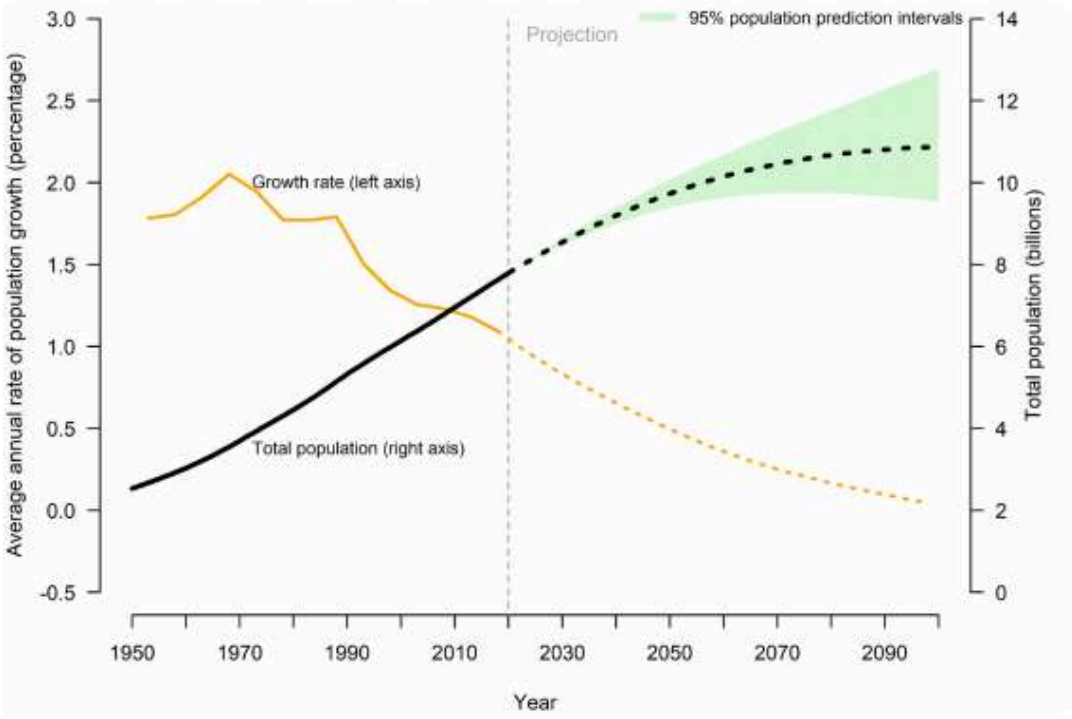
3.2 Global trends and challenges

1. Growing global population, rising incomes and dietary changes

The World Economic Forum (WEF) outlined that achieving inclusive, sustainable and efficient global food systems would require addressing the challenges and opportunities presented by major global trends such as demographic shifts, macroeconomic trends, the triple burden of malnutrition (undernourishment, micronutrient deficiencies and over nutrition), natural resource depletion and geopolitical dynamics (WEF, 2016).

The UNEDSA's 2019 report 'World Population Prospects' describes two demographic megatrends (*population growth* and *ageing*), as well key trends in human fertility, mortality, and net international migration. This shows that global population growth had continued to increase, albeit at a slowing rate. In the medium fertility projection, by 2100 the global population is projected to reach approximately 10.9 billion, with an annual growth rate of 0.1 per cent – a considerable decline from the current rate (see Figure 3.1 below). In addition, the global fertility rate is expected to be 1.9 births per woman by 2100, down from 2.5 today (UN, 2019a).

Figure 3.1. Global population size and annual growth rate: estimates, 1950-2020, and medium-variant projection with 95 per cent prediction intervals, 2020-2100.



Source: UN, 2019a.

It is anticipated that Africa will account for most of the growth of the world's population over the coming decades. Between 2020 and 2100, Africa's population is expected to increase from 1.3 to 4.3 billion. Projections have shown that the most increases will come predominately from sub-Saharan Africa, the population of which is expected to triple in size by 2100. European and Latin American populations are expected to decline by 2100. Populations within Asia are estimated to increase from 4.6 billion in 2020 to 5.3 billion in 2055, and then begin to decline. It is projected that India will surpass China as the most populous country by 2027 (UN, 2019a).

At the same time, economic growth has increased in major world regions. The United Nations (2019b) showed that economic growth had accelerated across 50 per cent of national economies in both 2017 and 2018. Developed economies expanded 2.2 per cent of GDP across both years, while unemployment rates in several developed countries e.g. United States increased. Both South and East Asia experienced growth, with GDP expanding by 5.6 and 5.8 per cent respectively in 2018. Global economic growth per annum was 3.1 per cent in 2018, and is expected to stay above 3 per cent through 2019. Similarly, PWC (2017) projected 130 per cent of cumulative global GDP growth between 2016 and 2050, with the size of the world economy expected to double by 2050 (PWC, 2017a). Global per capita incomes are expected to rise by 2.2 percent each year between 2005 and 2050, coupled with increasingly inequitable distribution (FAO, 2012). Similarly, emerging economies such as China and India are projected to continue to grow in terms of per-capita income. Economic growth coupled with rising consumer purchasing power means larger middle- and upper-class segments in these regions, with consumer preferences in these segments becoming more important.

Increasing incomes are associated with both increasing and decreasing food demand. International food demand is expected to increase up to 2050, likely driven by population growth over increasing incomes. The OECD-FAO's Agricultural Outlook 2019-2028 estimates that the demand for all agricultural commodities for feed, food, fuel and other uses will increase between 2019 and 2028. In particular, total global food use of pulses, roots and tubers is expected to grow at a rate of 1.9 per cent per annum, followed by sugar and vegetable oils (1.8 per cent per annum), animal products (1.7 per cent per annum) and cereals (1.2 per cent per annum). Increases in global food demand are expected to be driven by increases in population and income levels, as well as changing consumer preferences (OECD-FAO, 2019).

Global consumer demand for protein is currently experiencing high growth, which is likely to continue into the future. The OECD and FAO's Agricultural Outlook (2019) has estimated an increase in global meat consumption of 0.4 kg per capita over the next decade, driven by population and income growth, particularly in Asian and Latin American countries (OECD-FAO, 2019; Sogari et al., 2019). In addition, the FAO estimates that the average person will consume 45.3 kg of meat annually by 2030, up from 41.3 kg in 2015 (Bruinsma et al., 2015). The projected increase in meat consumption will likewise increase the environmental impacts of agriculture.

At the same time, intensive agriculture has contributed heavily to GHG emissions, natural resource degradation, biodiversity loss, and water scarcity. It is likely that increases in future demand will place even greater stress on agricultural land use, production processes and natural resources (FAO, 2017a; OECD-FAO, 2019).

2. Food waste

Meeting future global demand within environmental limits will likely require more than increasing existing food production levels. Future demand could also be supported by a reduction in food wastage and loss. The FAO has estimated that, on a global scale, approximately one-third of all food produced for human consumption is currently wasted, equating to approximately 1.3 billion tonnes of food annually (Corrado and Sala, 2018; FAO, 2015). Current per capita estimates of annual food waste range between 194 and 384 kg per person (Corrado and Sala, 2018). It was also estimated that a 25 per cent reduction in current rates of food waste could potentially provide food for approximately 870 million people (FAO, 2015). Internationally, food waste costs industrialised countries approximately US$680 billion and developing countries approximately US$310 billion annually (FAO, 2015). On a domestic level, it has been estimated that New Zealand consumers waste approximately NZ$1.8 billion of food annually, with 94 per cent of New Zealanders stating that they have wasted food at some stage (Shaw, 2017).

Research has also confirmed that food wastage occurs at all stages of global supply chains, with the scope and nature of food waste differing considerably between regions and states (Roodhuyzen et al., 2017; Xue and Liu, 2019). For example, food waste per capita is far higher in Europe and North America than in Sub-Saharan Africa and South/Southeast Asia, with food waste often generated at the consumption stage of the supply chain in developed countries, whereas in developing countries it is at the harvest and post-harvest storage stage. Food waste has also been linked with a number of adverse environmental (GHG emissions), economic (cost of waste, supply chain inefficiencies) and social impacts (reduced labour productivity, reduced wages) (Roodhuyzen et al., 2017). Food waste poses considerable

challenges to food security, natural resource use, the natural environment and human health (Xue and Liu, 2019).

Meeting future global demand will not only require increasing existing levels of food production, but will also need to be supported by a reduction in food waste. In response, the United Nations have set a target within the Sustainable Development Goals (SDG 2 – Zero Hunger) of reducing food waste by 50 per cent globally by 2030, with the European Union and United States also indicating an intention to meet this target (UN, 2019b; Xue and Liu, 2019).

3. Commodity price fluctuations

The FAO has stated that food prices have been reasonably volatile over the past decade, with a number of peaks and troughs characterising price trends for core commodities tracked (Bellman and Hepburn, 2017). This has been attributed to strong demand for food and feed, extreme weather events, market speculation, declining stock-to-use ratios and expanding biofuel production, all combining to give rise to market shocks and price fluctuations (FAO, 2017b). Agricultural commodity prices are also linked to the energy market, with farm inputs, production, storage and transportation all influenced by energy prices, but also the link between biofuels and energy prices (Bellman and Hepburn, 2017).

The OECD and FAO's Agricultural Outlook (2019) anticipated that agricultural commodity prices are likely to remain relatively flat over the coming decade (OECD-FAO, 2019). However, these agencies have also predicted that there is a strong chance of at least one severe price fluctuation over the same period, as there is uncertainty regarding oil prices, yields, economic growth and the impacts of climate change (Bellman and Hepburn, 2017). Price spikes affect food security and negatively impact consumers, producers and countries (FAO, 2017b). Moreover, the IPCC (2019b) also argue that climate change-induced extreme weather events may also lead to increased food price spikes, which when coupled with reduced land availability may mean greater difficulty for market recovery from price shocks (IPCC, 2019b).

4. Social license to operate

Social license to operate (SLO) has been broadly defined as the ongoing acceptance or approval of an operation by local community stakeholders, consumers and the general population who are affected by it, and those who can affect its profitability. It could also be understood as a set of demands and expectations held by affected parties and broader civil society for how a business or sector should operate (Moffat et al., 2016).

There is now a growing consumer expectation and demand for transparency and information provisions in relation to primary production processes and practices. New Zealand's primary sector has been adversely affected by negative public opinion and trust, particularly with regards to public expectations around environmental and social issues. In this way, for example, the New Zealand dairy sector's SLO has been affected by poor public opinion and trust. In particular, perceptions of poor water quality, animal welfare and labour management have forced the industry to address and adopt new land use practices to rebuild public opinion and trust (DairyNZ, 2017). Another example is that the Ministry for Primary Industries (MPI) has recently outlined intentions to grow New Zealand's aquaculture sector into a NZ$1 billion industry. However, it has been suggested that SLO may be a critical issue facing the development of this industry.

As primary production moves into areas proximal to large numbers of people, tensions between industry and communities could become more prominent, increasing the need for

building an effective and sustainable SLO (Baines and Edwards, 2018). SLO is therefore expected to play an important role into the future, potentially impacting domestic and international land use change/practice, especially as international consumers push industries to operate in a more environmentally and socially responsible manner.

A related issue is the increasing mistrust of information and affiliation with personal beliefs over facts has led to the development of a "post-truth" society. This term is commonly used in reference to political campaigns, but has been increasingly used to denote a mistrust of scientific information and its sources (Iyengar and Massey, 2018; Rose, 2017). This has been further exacerbated by the proliferation of "fake news" (i.e. intentionally incorrect information being presented and promoted as reputable to enhance ulterior motives/interests) via online sources including social media (Lazer et al., 2018). The promotion of misinformation can influence firms' SLO by actively encouraging poor public opinion and eroding trust, thereby potentially influencing land use change/practice in New Zealand.

5. Urban-Rural divide

Similarly, it has been suggested that there is an increasing social and knowledge gap between urban and rurally centred people, both internationally and domestically, referred to as the *urban-rural divide*. This concept includes the ratio of people living in urban and rural centres, urban dwellers' opinions of rural life and vice versa, gaps in knowledge of food production practices, media portrayal of primary production, relative access to information communication technology (ICT) infrastructure, and defined differences in personal and community wellbeing between urban and rural regions (Apatov et al., 2018; DIRG, 2017; Infometrics, 2019; UMR Research, 2017, 2019).

In New Zealand, the percentage of the total population based in urban centres was estimated to be approximately 87 per cent in 2018 (StatsNZ, 2019a). This considered, several studies have shown little difference between urban and rural New Zealanders in their attitudes towards each other. Research carried out by UMR Research showed that a higher percentage of urban people held positive views regarding rural people and primary production practices than negative views (55 per cent *positive*), with a higher percentage of urban people considering moving to a rural centre than vice versa. However (UMR Research, 2017, 2019). However, several gaps that define the urban-rural divide have been highlighted by researchers, including generally lower self-stated wellbeing and less access to ICT infrastructure in rural centres (DIRG, 2017; Infometrics, 2019). Relatively higher pressures placed on people in rural centres, including primary producers, could affect current land use practices, potentially leading to land use change. In addition, a lack of understanding of primary production by urban dwellers could influence primary producers' SLO, thereby influencing land use change.

6. Farmer wellbeing

It has been recognised that rural workers in New Zealand are subject to similar rates of mental health issues (such as anxiety and depression) as occur within the general urban population, with additional stressors unique to the farming environment and lifestyle (such as a lack of control of the environment, increased workload and financial burdens) (O'Hara, 2010; Scarlatti, 2017). Growing concerns over rural wellbeing in recent years have led to the development of multiple programmes aimed at improving mental health conditions for New Zealand farmers. This includes the Mental Health Foundation and FMG's FarmStrong initiative, the GoodYarn programme and DairyNZ's Wellbeing programmes (DairyNZ, 2019;

FarmStrong, 2019; GoodYarn, 2019). The FarmStrong initiative in particular has reported success in improving mental health outcomes for New Zealand farmers (Wyllie, 2019). In addition, Mortlock and Hunt (2008) found that farmers' wellbeing was enhanced by engaging in practices that improved the environmental sustainability of their operations, thereby influencing land use change/practice. The mental health and wellbeing of New Zealand primary producers could also potentially impact on land use change/practice by influencing decision-making processes such as stress-induced career changes by primary producers.

Similarly, one of the unique challenges faced by primary producers is the accumulation of debt. This is due, in part, to externalities faced by agricultural producers such as yield loss from extreme weather events, coupled with vulnerability to land price changes and increasing environmental policy enforcement (RBNZ, 2019). The Reserve Bank of New Zealand has recently valued New Zealand farmer debt at approximately NZ$62.8 billion, with 35 per cent of farms in the dairy sector defined as "highly indebted farms" with debt equivalent to more than NZ$35 per kilogram of milk solids produced annually (MoA, 2019; RBNZ, 2019). In response to increasing farmer debt, a law change known as the Farm Debt Mediation Bill has been proposed. If approved, this would effectively create a mandatory debt mediation scheme for farmers wherein creditors would be required to offer mediation to those who default on payments prior to taking enforcement action. It is expected that this will be entered into the legislature before the end of 2019 pending Select Committee approval, with farmers able to access debt mediation from October 2020 (MPI, 2019d).

7. Sustainable Development Goals (SDGs)

In 2015, the United Nations signed the 2030 Agenda for Sustainable Development, in which all UN Member States adopted a set of 17 Sustainable Development Goals (SDGs) (UNDP, 2019). These provide goals against which progress towards sustainable development can be measured, such as Zero Hunger (SDG 2), which aims to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture". Progress towards achieving these goals is outlined in the UN's annual Sustainable Development Goals Report, the 2019 edition of which indicated that progress towards many SDGs is currently too slow (UN, 2019d). International governments are now increasingly integrating SDGs within policy instruments to achieve these goals. In the New Zealand context, policy focus for achieving SDGs has been placed on the provision of aid, particularly for small island developing nations in the Pacific (MFAT, N.D.).

8. Indigenous enterprise

On an international level, there has been some growth in the awareness of and participation in consumption that supports food sovereignty. This concept is linked with food decolonisation, or the process of recognising that indigenous peoples' cuisines have often been subordinated by external forces, thereby leading to a deficit of culturally appropriate food choices (Grey and Newman, 2018). This has led to the development of indigenous enterprises, particularly for food or other primary products, across a number of indigenous communities internationally (Brown, 2016; ILO, 2015; Qi, 2019).

In a New Zealand context, the growth and continued success of Māori enterprises has sometimes been referred to as *the Māori economy*, which is currently valued at approximately NZ$50 billion (MFAT, 2018; RED, 2017). There is currently an estimated 1,200 Māori enterprises in New Zealand (in 2019), an approximate 30 per cent increase from 2011 numbers (918 Māori enterprises) (Figure.nz, 2019). Increasing Māori entrepreneurship and

business is being driven, in part, by a strong sense of cultural identity and competency, and promotion of Kaupapa Māori (philosophical principles underpinning Māori cultural identity) (Mika, 2018; Warren et al., 2018; Wood and Mika, 2018). This is also underpinned by an increasing interest in and use of Māori knowledge systems and frameworks, collectively known as Mātauranga Māori (Harmsworth and Awatere, 2016; Manaaki Whenua, 2019). The development and success of Māori agribusiness ventures is also being supported by two MPI programmes: the Māori Agribusiness Extension programme and the Māori Agribusiness Pathway to Increased Productivity programme (MPI, 2019b, 2019c).

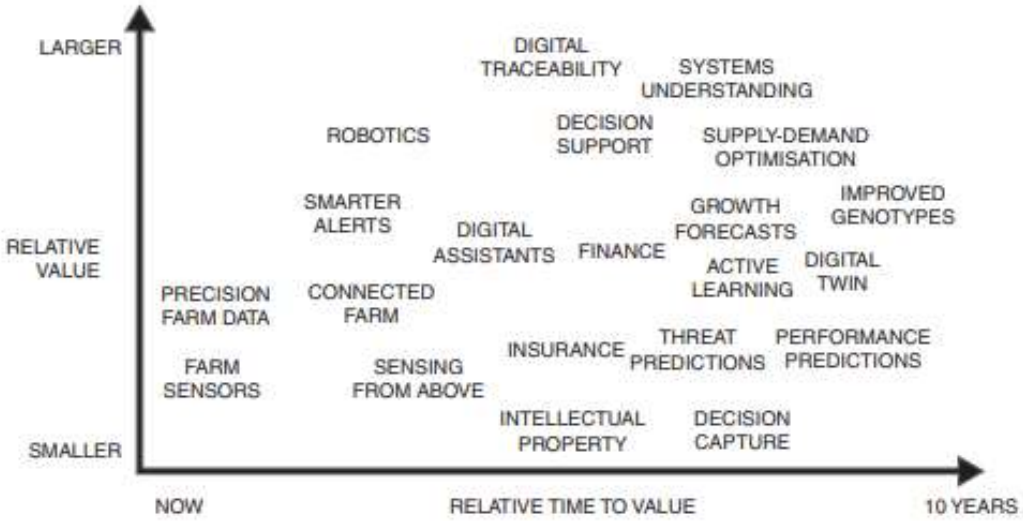
3.3 Emerging technologies

Technological advancements are already impacting the global agricultural and food sector. Bio-innovation, gene editing, robotics, big data, artificial intelligence (AI) and machine learning will provide the agricultural sector with unparalleled access to data, which will help improve production processes, reduce waste and increase yields (FAO, 2019a; WEF, 2016). These emerging technologies, as well as advancements in urban and regenerative farming, could significantly affect land use change/practice in New Zealand (Trice, 2017).

1. Artificial intelligence (AI)

AI is a radical new technology that sees computer systems performing tasks and making decisions like humans. AI has been a core driver of industrial development and a crucial factor in promoting the adoption of technologies such as cloud computing, Big Data and blockchain (see Section 3.4.3) (Lu, 2019). The AI sector has experienced significant development over the past decade, and is expected to play an important role in the long-term sustainability of global agricultural systems, having a significant impact on production efficiency. AI will also allow processes to be automated and conducted remotely, which will aid in detection of risks and issues for agile and informed decision-making (Irimia, 2016). In relation to this, Smith (2018) identified a number of key areas where AI is believed to deliver value over time to the agricultural sector (see Figure 3.2 below).

Figure 3.2: Areas of added value to agriculture from AI technology implementation over the following decade



Source: Smith, 2018.

Technology that uses AI condenses large data sources, comprising research, historical weather data, nutrient levels, crop health data, soil conditions and moisture levels to provide recommendations that will help enhance crop yields and improve land use practice (Irimia, 2016; Lu, 2019). For example, Artificial Neural Pathways (ANNs) are being used in agricultural intelligence applications, such as soil analysis and mapping, where non-invasive ground-detection radar imaging techniques are used to detect soil properties and collect signals from electromagnetic soil sensors. Analysis of the soil clay content data can determine which crop is suitable for growing in each plot (Lu, 2019). In addition, 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 used as the foundation of new predictive algorithms in AI implementation (Trice, 2017). Furthermore, automated irrigation systems that incorporate AI to predict and assess soil conditions will likely increase yields and improve water usage.

The value of AI use in the agricultural sector was estimated to be US$600 million in 2018, and expected to reach US$2.6 billion by 2025. This is based on several identified growth factors, including growing demand for agricultural products, increased uptake of information management systems and technologies to enhance crop productivity, and increased government spending on agricultural technology initiatives. A number of commercial organisations have harnessed AI to deliver cutting-edge products and services to the agricultural sector, including precision herbicide deployment systems that claim to reduce chemical application by up to 80 per cent, and associated expenditure by up to 90 per cent (Claver, 2019). In addition, AI technology is currently being integrated into international primary production systems. For example, NatureSweet has begun incorporating AI into its tomato production processes. The company uses cameras and software applications to learn and recognise dying plants and disease/pest incidence, which has already boosted productivity by between 2 and 4 per cent (McFarland, 2017).

In a New Zealand context, research has indicated that sectors with large labour forces and high technology uptake and use are most likely to benefit from AI technology. Meanwhile, sectors such as agriculture, with smaller comparative labour pools and relatively low technology penetration, can expect less direct benefit from AI-created labour efficiencies (AIFNZ, 2018).

2. Unmanned aerial vehicle technology (UAVs)

Over the past 10 years, there has been exponential growth in the development and use of Unmanned Aerial Vehicles (UAVs) in agriculture. The FAO has stated that the use of UAVs and connected analytics applications have real potential to address some of the most pressing concerns facing international agriculture. In addition, Goldman Sachs has predicted that the agricultural sector will become the second-largest user of UAVs in the world between 2018 and 2023 (Sylvester, 2018). The total value of UAV-based solutions in the agricultural sector was estimated at US$32.4 billion in 2016 (Mazur et al., 2016).

UAVs are now widely accessible for crop supervision, soil and field analysis and health assessment purposes. Drones are able to be integrated at every stage of the crop life cycle – from soil analysis and seed planting to harvesting. Drones with hyperspectral, multispectral and/or thermal sensors are now able to identify physical deficiencies in-field (e.g. water deficiency), thereby enhancing the efficiency and sustainability of production processes. Drones are also currently being used to identify bacterial or fungal incidence on trees using

visible light (VIS) and near-infrared (NIR) light (Mazur et al., 2016). In addition to detecting physical deficiencies in-field, hyperspectral imaging technology is also capable of determining the characteristics of agricultural products, including possible defects, chemical composition and similar physical properties, thereby assisting in food safety and quality compliance (Ravikanth et al., 2017).

UAV technology is likely to influence land use change/practice in New Zealand as its capabilities expand into the future. Several commercial UAV companies have emerged in New Zealand, such as Agdrone, which provides agricultural spraying services in areas where helicopters cannot fly (Dudman, 2019). UAVs will also allow farming to become a highly data-driven industry, which will likely enhance productivity and yield for New Zealand farmers. In addition, the ease-of-use and low cost of UAVs allow for time-series analysis of crop development, which could help to improve crop management (Mazur et al., 2016).

3. Robotics and autonomous vehicles

Robotics and autonomous systems (RAS) are expected to have a significant impact on global industries, including the agricultural sector. It is envisaged that these technologies will improve agricultural land use practices, reduce time-consuming processes and increase crop yields. Autonomous vehicles use sensors and global positioning devices (GPS) to plot paths and generate accurate mapping data for precision seeding and yield monitoring (Ghobadpour et al., 2019).

In 2019, three such significant technologies emerged in North America. The first, DOT Power Platform, is an autonomous vehicle capable of multiple farming tasks including seed drilling and fertiliser spraying; the second, AutoCart, is a driverless tractor developed for grain harvesting; and the third, SmartCore, is a robot soil sampler developed for quick and efficient analysis of ground conditions (Bennett, 2019). Additionally, John Deere recently announced the development of a fully electric and autonomous tractor (Allen, 2019). As autonomous vehicle technology improves and prices drop, New Zealand could see a greater uptake in the technology, thereby influence land use change/practice.

4. Genetics

Gene-editing is a form of genetic engineering that has made significant progress in recent years. This technology is far more precise and reversible comparative to older techniques, with the ability to make single nucleotide changes that mimic natural base point mutations. Gene-editing technology includes systems such as TALEN and CRISPR, which are capable of making site-specific changes to DNA sequences through the use of proteins such as zinc-finger nucleases. Importantly, gene-editing can alter genes without requiring foreign DNA sequences, which could make it a more appealing form of genetic engineering from a consumer perspective (RSNZ, 2016).

Gene-editing is already being trialled in an agricultural context internationally. In the US, maize, soybean, sorghum and rice have been altered to achieve desirable traits. Researchers in China have also been using TALEN and CRISPR to modify the genes of crops and animals, with advancements allowing them to develop goats with longer coats and higher muscle content (RSNZ, 2016). Scientists have also used CRISPR to boost the immunity of the cacao plant to a virus that has significantly negatively affected West African crops, as well as developing a more resilient variety of banana to fend off funguses that were undermining the global commercial supply (Niiler, 2018).

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 using gene-editing techniques – for example, changing chlorophyll and CO_2 absorption rates could improve the overall growth rate and yield of crops (The Economist, 2017). In 2019, USDA researchers announced that they had achieved a modification of the genetic code for photosynthesis in tobacco plants that led to a 40 per cent increase in their growth rate compared with unmodified plants. However, approval for use in commercial settings is likely to be between 5 and 10 years away due to stringent vetting and regulatory processes for genetic modifications such as these (South et al., 2019; Temming, 2019).

In 2016, the Royal Society of New Zealand convened a multidisciplinary panel of experts to examine the implications of the use of gene-editing technologies for New Zealand. The report identified that gene-editing was already playing a significant role in global primary production and impacting on land use change/practice (RSNZ, 2016). In 2019, the Royal Society released a report outlining the need to overhaul gene-editing regulations in New Zealand. At present, no genetically modified plants can be grown outside of the laboratory, with any experiment requiring approval from the Environmental Protection Agency (EPA) (RSNZ, 2019).

Several research streams has assessed the use of gene-editing techniques on New Zealand primary production. Research conducted by AgResearch found that gene-edited ryegrass could grow up to 50 per cent faster, requiring less water, and ultimately causing cattle to emit 23 per cent less methane (Hogan, 2019). In addition, Plant and Food's Chief Scientist Richard Newcomb has outlined that gene-editing technology could help to create crop varieties that are more resilient to extreme weather events, enable native trees to be better protected, and help New Zealand to reach its 2050 carbon neutral and predator-free targets (Nicol-Williams, 2019). In this way, the use of gene-editing could impact on land use change/practice in New Zealand.

5. Urban farming

Urban farming is the practice of producing food and fibre products within and around cities. There has been increasing interest in urban farming as concerns regarding urban food security and consumer demand for local foods grows internationally (FAO, 2019b, 2019c; PwC, 2017b). There is also evidence to suggest an the existence of an emerging consumer segment interested in consuming urban agricultural products (Grebitus et al., 2017; Krikser et al., 2019; Specht et al., 2016).

An example of urban farming methods, vertical farming (VF), is an innovative production model that uses controlled indoor environments to improve the efficiency of farming. VF combines building design and farming within a high-rise building, often situation within cities. VF is not vulnerable to environmental disturbances and climate, reduces water use by approximately 95 per cent, and has lower emissions compared with traditional agriculture. This is important as supply chain disruptions, seasonality, production and price fluctuations can severely impact the availability of fresh produce in urban areas, meaning that millions of people may only access produce erratically or at a high cost (Kalantari et al., 2017; Pinstrup-Andersen, 2017).

Urban planners and agricultural leaders have argued that cities will need to produce food internally to meet increasing demand, with multilateral government talks convened to discuss VF development, identifying VF as integral to the long-term sustainability of urban populations. In addition, recent advances in greenhouse technologies such as hydroponics,

aeroponics, and aquaponics have enhanced the prospects of the VF concept (Al-Kodmany, 2018). These techniques tightly control water, sunlight and nutrient loads to generate high crop yields. VF still faces significant commercial and economic challenges but is likely to play a role in addressing urban production and consumption issues in the future (Pinstrup-Andersen, 2017).

In the New Zealand context, there has been an increase in interest in and development of urban food systems, but less vertical farming. For example, multiple urban agriculture systems are in operation in Christchurch, partially due to an increase availability of urban land following the 2010/11 earthquakes. Specific examples include Roimata Food Commons, Cultivate Christchurch and Ōtākaro Orchard (Frank Film, 2019; Ineson, 2017; McDonald, 2019).

6. Regenerative agriculture

The practice of "regenerative agriculture" has emerged in response to environmental and climate concerns associated with conventional farming practices. This term loosely includes practices that seek to enhance biodiversity, soil health and water quality, as well as sequestering carbon and boosting ecosystem services while also producing food and fibre products (Gosnell et al., 2019). In particular, increased uptake and use of regenerative organic agriculture techniques could sequester CO_2 to effectively limit global warming to 1.5^{o}C, with several field trials showing significant reductions in CO_2 emissions from regenerative farms (Rodale Institute, 2013; Teague et al., 2016). Regenerative systems have also been shown to have higher yields, lower production costs, lower pest incidence and greater ecosystem service provision than their conventional counterparts (LaCanne and Lundgren, 2018).

Unlike systems such as organic farming, there is also no specific criteria or standards for regenerative agriculture, but rather a growing set of principles and practices (Chandra et al., 2017). There are also challenges associated with conversion from conventional to regenerative systems. In addition to adaptations in technical processes, management, innovation and policy, conversion to regenerative agriculture will also likely require a shift in values and cultural norms to accommodate changes in practice (Gosnell et al., 2019). Despite these challenges, regenerative agriculture is being taken up on an international level, with General Mills recently assessing the regenerative status of current production as part of a three-year US$2 million project to regenerate approximately 1 million acres of farmland in the US (Anzilotti, 2019; General Mills, 2019). In a New Zealand context, there has been increasing media coverage of agricultural production in transition to regenerative farming, with a growing awareness among farmers and growers (Eb, 2019; Merfield, 2019). Rapid adoption of or transition to regenerative agriculture would represent a clear shift in land use change/practice.

3.4 Innovative products – new food technology

1. Alternative protein sources

The heavy ecological impact of the traditional livestock industry is a major driver in the development and commercialisation of alternative protein products (Akhtar and Isman, 2018). These alternative sources can be placed into three main categories: edible insects, plant-based proteins and cellular or cultured proteins (Sexton et al., 2019).

Edible insects are becoming increasingly common. Entomophagy – the consumption of insects as food – is currently practised by around 2 billion people across Africa, Asia, Central and South

Africa, and Australia (Akhtar and Isman, 2018). While Western regions have typically consumed traditional livestock proteins, there is some evidence to suggest that insect protein consumption is increasing. Insect-based foods are also a healthy source of protein, fat, energy and fibre (Sogari et al., 2019). However, cultural attitudes regarding the palatability of insects may be a barrier to widespread consumption. In a study of New Zealand consumers' perceptions of and preferences for insect-based food products, approximately 67 per cent indicated that they would be most willing to consume insects as food if they were processed into a powder that could be added to existing foods. The researchers suggested that this indicates that an insect product with clearly detailed health and environmental benefits could be successful in New Zealand (Payne and Ryan, 2019).

A wide range of plant-based protein substitute products have entered the marketplace over the last decade. New plant-based protein products are available in supermarkets internationally, with growing interest in flexitarian, vegetarian and vegan diets likely to drive demand into the future, both domestically and internationally (RNZ, 2019b; Sakure and Manepalli, 2019). Examples of companies with an established presence for plant-based alternative protein products include Beyond Meat and Impossible Foods (Sexton et al., 2019). This market has exhibited significant growth in recent years, with Beyond Meat shares increasing from US$25.00 in May to US$234.90 per share in May 2019 (Reinicke, 2019).

The emergence of alternative proteins has been projected to decrease the global market share for traditional meat products into the future. One study has suggested that by 2040 the global market share for conventional meat products is likely to be 40 per cent (down from 90 per cent in 2025), followed by cultured meat products (35 per cent) and novel vegan meat replacement (25 per cent). Alternative protein production requires less land and water, as well as produces less GHG emissions compared with conventional meat production processes (ATKearney, 2019). These potential market shifts could therefore produce positive environmental outcomes relative to conventional practices.

In a New Zealand context, there has been an increase in demand for alternative protein products, with retailer Countdown stating that demand for plant-based vegan and vegetarian meals had increased by 36 per cent between 2018 and 2019 (RNZ, 2019a). There are now several New Zealand-based plant-based alternative protein companies, including Sunfed, Craft Meat Company and the Alternative Meat Company (AMC, 2019; CMC, 2019; Sunfed, 2019). Sunfed's 'Chicken-Free Chicken' can currently be found in 250 stores in the New Zealand market, and has recently expanded to the Australian market (Keall, 2019). Plant & Food Research has identified new New Zealand consumer trends regarding plant-based foods, plant proteins and flexitarian lifestyle. They also suggest ways in which ingredients for these products could be incorporated into existing New Zealand primary production systems. Thus it is estimated that New Zealand currently has approximately 1.74 million hectares of land suitable for growing plant protein crops (Sutton et al., 2019).

2. Cultured proteins

Similar to alternative proteins, the development and future commercialisation of cultured protein products (also known as synthetic proteins) has the potential to influence land use change/practice. This process involves the in vitro propagation of animal tissue cells intended for human consumption in the place of flesh from animal carcasses (Datar and Betti, 2010). This method of production may have environmental benefits over traditional meat

production, with meat produced in this manner believed to generate 90 per cent lower GHG emissions relatively (Memphis Meats, 2017).

In 2013, the first cell-cultured meat patty was produced at Maastricht University, reportedly costing €250,000 to produce (Burton, 2019). Following this, Memphis Meats developed the first cell-cultured meatball and chicken strips from animal cells in 2017 (The Economist, 2017). At the time of writing, there are 31 companies seeking to become the first to commercialise and market synthetic animal protein products (Burton, 2019). At present, no company has been successful in bringing these products to the market for a number of reasons, including ethical and consumer acceptance uncertainties, as well as a lack of institutional, political and regulatory systems to support synthetic meat commercialisation (Stephens et al., 2018). In addition, there is an ongoing debate regarding the naming of such products (i.e. *laboratory*, *artificial*, *cell-based* and/or *cultivated* as potential nomenclatures) (Shanker, 2019). Current estimates for the arrival of lab-grown meats on supermarket shelves range between 1-20 years, with preliminary studies showing that consumers are willing to try such products and, if satisfied with their experience, incorporate them into their regular diet (Heffernan, 2017). However, a synthesis of consumer research into lab-grown meat also suggests that consumers in the US and China are concerned about the safety of such products, which could influence their willingness to purchase (Antedote, 2018).

The New Zealand Treasury has stated that it will be monitoring the global synthetic protein market, concluding that while these products do not currently have the potential to significantly disrupt traditional meat markets, they could pose risks into the future (New Zealand Treasury, 2018). Similarly, New Zealand meat industry bodies have previously stated that they do not consider synthetic meat products to be a risk to the industry (RNZ, 2018). However, if a feasible international market for synthetic protein products were to emerge, this could influence land use change/practice in New Zealand.

3. Alternative dairy

Closely related to the above alternative protein products is the emergence of alternative dairy products. This includes alternatives to milk, butter, cheese, yoghurt and ice cream, based on plant ingredients, such as soy, nuts and other plant products. The global market for dairy alternatives was valued at US$15.5 billion in 2017, and is expected to reach US$38.9 billion by 2025 (FM, 2019). In 2018, alternative dairy products represented over 50 per cent of worldwide sales in the vegan alternative product category. Reflecting interest in alternative dairy products, global dairy company Danone has recently invested approximately US$60 million in plant-based production to improve its overall product portfolio and compete in the alternative dairy category (ARC, 2019).

The production of alternative dairy products has also been shown to have lower environmental impacts compared with traditional dairy production. In particular, the production of ingredients and product processing for alternative dairy products has been shown to require significantly less water and land area, as well as producing significantly less GHG emissions compared with traditional dairy production (Guibourg and Briggs, 2019; Poore and Nemecek, 2018). In a New Zealand context, Fonterra has invested in Motif Ingredients, a US-based innovative foods developer involved in alternative milk production, to diversify their product portfolio (Fonterra, 2019). Growth in the alternative dairy market could potentially influence New Zealand land use change/practice by diversifying the dairy market and altering market shares for traditional dairy products.

3.5 Consumer Trends

1. Vegetarianism, veganism and consumer diet trends

Related to the above, vegetarianism and veganism have grown significantly over the last 20 years, overcoming scepticism and prejudice (Leitzmann, 2014). It was estimated that in 2018 approximately 73 per cent of international consumers identified as omnivorous, alongside flexitarian (occasional meat and fish consumption) (14 per cent), vegetarian (5 per cent), vegan (3 per cent) and pescetarian (3 per cent) (Ipsos, 2018). Vegetarian and vegan movements are influencing retailers, who are responding by increasingly stocking a wider range of alternative proteins and substitute products, with vegan foods growing ten times faster than all other food categories in the US in 2018 (The Economist, 2019). It is estimated that by 2026, the vegan food market will be worth approximately US$24.3 billion, with a compound annual growth rate of 9.1 per cent between 2019 and 2026 (ARC, 2019).

In line with this trend is an increase in the number of consumers seeking to reduce their overall meat consumption, otherwise known as *flexitarians* or *meat reducers*. Adherents to this type of diet still eat meat and fish products, but make a conscious effort to reduce the amount of these products that they regularly consume. As mentioned above, flexitarians currently comprise 14 per cent of the global population (Ipsos, 2018). Nielsen (2019) found that, of those US consumer who had purchased meat alternatives, approximately 98 per cent also purchase meat products, with approximately 27 per cent purchasing meat alternatives five or more times per year.

Increasing interest in and adherence to vegetarian, vegan and flexitarian diets could have environmental implications. In particular, adherence to a diet that lowers overall consumption of animal-sourced foods has been shown to have environmental benefits, including significant reductions in food-related GHG emissions. In addition, a mass transition to these diets is likely to have global economic savings equivalent to between US$1 and $13 trillion (between 0.4 and 13 per cent of global gross GDP in 2050) in terms of both the cost of negative health impacts mitigated by dietary change and the value of output of those no longer affected by negative health (Springmann et al., 2016). This has been corroborated by a multitude of studies (Chai et al., 2019; Fresan and Sabate, 2019; Lynch et al., 2018; Rosi et al., 2017). Reductions in meat consumption (as in the flexitarian diet) has also been shown to be driven by consumer concerns regarding the environmental implications of traditional meat production (Nielsen, 2019). It is also likely that the promotion of alternative diets via social media platforms and meat reduction campaigns will drive growing consumer interest in these trends (Grassian, 2019; Puranen and Jansson, 2017).

The Keto (*ketogenic*) diet is a consumer diet trend that has increased in popularity in recent years. Keto is a low-carbohydrate, high-fat diet that is designed to stimulate *ketosis* – a metabolic state in which the human body burns fat for energy. The diet is purported to support several health benefits, including weight and fat loss, reduced blood sugar and insulin, increased brain health and acuity, and faster metabolism. As the diet suggests a restriction in foods high in carbohydrates, it encourages higher consumption of foods such as meat, fish, eggs, dairy, nuts and seeds, and low-carbohydrate vegetables (Healthline, 2018). This could influence land use change/practice by affecting shifts in consumer consumption of particular types of food products.

Intermittent fasting (IF) is another consumer diet trend that has grown in popularity in recent years. IF involves deliberating inhibiting caloric intake on between 1 and 3 days per week, or

only eating within a particular time window every day of the week (Barnosky et al., 2014; Healthline, 2017). One popular method of IF is known as the 16/8 method, whereby eating is restricted to an 8-hour window every day (e.g. between 12pm and 8pm). The diet specifies no restrictions on the type of foods that can be consumed, rather on the times at which food can be consumed. The diet is purported to have significant health benefits, including reductions in blood sugar and insulin levels, increases in human growth hormone, weight and fat loss, and metabolic benefits (Healthline, 2017). As adherence to this diet implies an overall restriction in the amount of calories consumed, more widespread consumer adoption could influence land use change/practice by reducing overall food demand in specific segments.

2. Products with credence attributes

An obvious contribution to consumer value are the physical qualities of the product itself, which in the case of food and beverage products include freshness, taste, texture and flavour. Another important contribution comes from qualities that cannot be seen or experienced at the point of purchase. These attributes are known as credence attributes.

Examples of credence attributes include food safety, environmental stewardship, animal welfare, social responsibility, cultural authenticity, fair trade, functional foods, organic production, GM-free, water footprint, biodiversity and local foods (Saunders et al, 2016b, p. 18). Sellers typically make claims about the credence attributes of their products on labels, perhaps reinforced by developing brands or trademarks that are trusted by consumers as assurance that claims are authentic.

A key factor that may contribute to consumer trust is the country-of-origin of the food or beverage being purchased. Indeed, country-of-origin labelling (COOL) is mandatory for at least some food products in the major countries importing from New Zealand such as the United States, China, the European Union and Australia (Miller et al, 2016a).

A number of studies have observed that COOL can support product differentiation (Carter et al, 2006) and so create a competitive advantage that is not easily copied (Baker and Ballington, 2002; FutureBrand, 2014 and 2015). In particular, country-of-origin may be used by consumers as a cue for judging attributes such as quality (Claret et al, 2012; Berry et al, 2015; Insch et al, 2015) and food safety (Cicia et al, 2011; Lim et al, 2014; Ortega et al, 2014; Lewis and Grebitus, 2016).

The New Zealand wine industry is an example of an entire land-based sector that promotes its sustainability credentials to create export value. In the year from 1 July 2016 to 30 June 2017, wine exports from New Zealand reached $1.66 billion, making it the country's fifth largest export good (New Zealand Winegrowers, 2017a, pp. 2-3). The sector maintains a commitment to quality over quantity to protect New Zealand's reputation as a premium producer of wine, including a commitment to sustainability leadership (New Zealand Winegrowers, 2017b, p. 1):

In 2002, the industry launched the Sustainable Winegrowing New Zealand label, which has developed standards and audit programmes to provide consumers with information about the sustainability practices of New Zealand vineyards and wineries. By 2016, 98% of the country's vineyard producing area was certified by Sustainable Winegrowing New Zealand facilitating the publication of the first Sustainability Report by New Zealand Winegrowers (2017c).

Another exemplar of a New Zealand exporter creating a high-value product for international consumers is Zespri, "acknowledged as the global leader in the supply and marketing of branded premium kiwifruit" (New Zealand Government, 2012, p. 19; see also Dalziel et al, 2017, chapter 3). An important part of the Zespri brand is its commitment to sustainability (Zespri, 2016).

Zespri communicates its sustainability performance to stakeholders (Zespri, 2016, p. 2). Its sustainability brochure, for example, describes specific actions being actioned under five headings (Zespri, 2016):

- Soil and Water (including pest and disease management)
- Waste management and reduction
- Managing carbon and greenhouse gas emissions
- Supporting employment and backing worker welfare
- Investing in communities and building capability

Fonterra is New Zealand's largest businesses, and the world's largest processor and exporter of dairy products (Fonterra, 2017, p. 6). In 2017, it published its first Sustainability Report. It described Fonterra's approach to sustainability.

The above examples illustrate that credence attributes such as sustainability, nutrition and community responsibility are important elements of efforts by New Zealand businesses to create high value brands.

There is a wider movement in the New Zealand primary sector focused on creating value in this way. Te Hono involves "220 Chief Executives and leaders who have a deep-seated passion and desire to develop and innovate for transformational change in the New Zealand primary sector and agribusiness" (Te Hono, 2017a). Its vision is: "Transforming the primary sector to realise the opportunity for Aotearoa, New Zealand to be recognised for our natural environment and products, as world leaders in innovation" (Te Hono, 2017b).

Te Hono was launched by the CEO of the New Zealand Merino Company, John Brakenridge, in 2012 (Brakenridge, 2016). In its own words, 'Te Hono is a journey that is unlocking the potential that exists for New Zealand to be recognised as world leaders in innovation, reputation and trust' (Te Hono, 2015, p. 2). Success is defined as 'sustainable value delivered over the long term by increasing margin and capturing value across the entire value chain, not just volume or commodity price' (idem, 2015, p. 5).

An essential element of Te Hono is the Te Hono Stanford Bootcamp, which is a week-long, intensive programme held at Stanford University in California (Te Hono, 2018). The 2015 Bootcamp agreed that New Zealand agri-food exports should attract a premium of 20 percent for their sustainability and other attributes (Holborow, 2015). This was reinforced in a presentation by David Teece, who is one of New Zealand's most pre-eminent economists as a result of his seminal research on the capability theory of the firm (see Teece, 1982, 2017a and 2017b). Teece (2015, slide 5) proposed that to improve New Zealand's current competitive advantage, businesses need to develop dynamic capabilities, which he defines elsewhere as follows (Teece, 2017a, p. 698):

For applied purposes, dynamic capabilities can usefully be broken down into three primary clusters of activities: (1) identification, development, co-development and assessment of technological opportunities in relationship to customer needs (sensing); (2) mobilization of

resources to address needs and opportunities, and to capture value from doing so (seizing); and (3) continued renewal (transforming).

In that context, Teece (2015, slide 8) noted that there doesn't appear to be a single strong New Zealand brand, other than New Zealand itself. He observed that a brand is not simply a label, but "is a story, and a customer relationship/experience built on trust that is sufficiently valuable to support a 20-30% price premium."

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, 2017). There is significant potential to increase the value of our agricultural products by marketing non-physical credence values. 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 et al., 2015; Saunders et al., 2016a). 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. Digital media and smart technology trends

On an international level, greater uptake and use of digital media and smart technology is changing the way consumer behave in-market. Access to and use of digital media and smart technology is increasing. As of July 2019, there was an approximate world average of 83 mobile broadband subscriptions per 100 people, as well as 14.9 fixed broadband subscriptions per 100 people. In addition, approximately 7.4 billion of the world population were covered by a mobile cellular network, with 7.1 billion having access to at a least 3G mobile network. This is particularly pronounced in the Asia-Pacific region (4.0 billion access to at least 3G) over all other world regions (ITU, 2019).

An increasing number of consumers are seeking information and purchasing primary products, particularly food products, online. The US food and beverage ecommerce market, for example, has been valued at approximately US$19.9 billion in 2019, representing approximately 2 per cent of total food and beverage sales in this market. This is projected to increase to approximately US$38.2 billion in 2023, representing approximately 3.5 per cent of total sales for food and beverages in the US (eMarketer, 2019). Other world regions are experiencing similar rates of food and beverage ecommerce growth, notably China. Ecommerce for food and beverages has experienced year-on-year growth in China, with food product ecommerce sales experiencing 40.9 per cent growth between 2017 and 2018, compared with 4.7 per cent total channel growth (i.e. physical and online retail) over the same period (Chemlinked, 2019). The total number of "digital buyers" in China (i.e. those consumers who have made at least one purchase using a digital channel) was estimated at approximately 485.4 million people (44.3 per cent of China's total population) in 2017, which is expected to grow to approximately 691 million people (58.8 per cent of China's total population) in 2022 (eMarketer, 2018).

In recent years, consumer patronage of alternative supply chain models for food purchasing services has been growing, enhanced by more ubiquitous digital media and smart technology use. This includes subscription models for food products, such as Amazon Prime. The current total value of the US subscription e-commerce market, for example, is estimated to be between 12 and 15 billion USD. This market has experienced rapid growth, signalling a compound annual growth rate of approximately 60 per cent since 2014 with this rate likely to

increase over time. Many of the leading services in this category are food subscription services, such as Hello Fresh and Blue Apron (Fenyo and Mitchell, 2019).

In addition to subscription models, food firms are increasingly engaging in direct-to-consumer (D2C) sales, aided by digital media and smart technology. This could include selling their products directly to consumers via their own website rather than outsourcing sales to traditional food product or online retailers. This model effectively bypasses conventional supply chain structure for food distribution and sales by removing entirely, or integrating at the producer/processor stage, the retail/sales arm of the supply chain (McKean, 2019). Direct-to-consumer models are expected to grow in market prevalence, with estimates suggesting that D2C could account for approximately 50 per cent of US consumer packaged goods sales by 2025 (Martino, 2019). While there is currently little evidence to suggest strong engagement from New Zealand food firms in D2C activities, there is an opportunity for New Zealand food exporters. Changes in the supply chain are likely to be captured in the value chain, providing higher returns for primary producers/processors.

There is also an increasing consumer demand for transparency in product purchasing. A 2017 study of US consumers by Response Media signalled the importance of product transparency in this market, with significant percentages of participants demanding transparency in ingredients listings (99 per cent), in-depth information on ingredients/materials (98 per cent), the source of ingredients (95 per cent), the production/manufacturing process (93 per cent), shipping and handling activities (90 per cent) and sustainability, charitable or labour efforts (91 per cent). In addition, participants indicated a willingness to pay for fresh food products (92 per cent of participants) and packaged foods (89 per cent of participants) with higher transparency. Food transparency is also shown to be of the highest importance when compared with all other product attributes (Response Media, 2017).

One tool that has shown promise in delivering product information to consumers is blockchain technology. This is essentially a public data tool that stores encrypted information at every stage of the supply chain, allowing users to trace items from their origin to their destination. This stored information cannot be altered retroactively, and is freely available to the public (Soon, 2019). There has been a marked increase in the use of blockchain technology to improve supply chain transparency in recent years. For example, in a bid to encourage consumer trust, retailer Carrefour and food firm Nestle have initiated the use of IBM's blockchain platform the trace the movements of the infant formula products stocked in Carrefour stores (Alexandre, 2019). Similarly, Walmart Canada will be initiating the use of a blockchain-based freight and payment network from February 2nd 2020, designed to manage stock delivered to its 400 outlets across Canada (SDCE, 2019). As the provision of transparency and traceability is associated with a market premium, the implementation of blockchain systems may provide higher returns for New Zealand primary producers. An increased need for both transparency and direct communication between producers and consumers is also emphasised in the strategic documents of New Zealand primary sector bodies (B+LNZ, 2018).

3.6 International trading environment

1. Bilateral free trade agreements

As small open economy, New Zealand relies on market access for the trade of agricultural products and the success of its primary industries. Food, beverage and animal products make up 60 per cent of total New Zealand exports by value (UN COMTRADE, 2018), with the New Zealand agricultural, forestry and fishing sectors accounting for 5 per cent of GDP, and 29 per

cent of GDP from goods producing industries (StatsNZ, 2019c). Accordingly, New Zealand has a policy of negotiating preferential trade agreements with other nations in order to lower tariff and non-tariff barriers, the most common of which are bilateral FTAs. In addition to multilateral FTAs (see Section 3.6.2), New Zealand currently has bilateral FTAs in force with China, Australia, Malaysia, Thailand, Singapore and South Korea, with FTAs under negotiation with the EU and India (MFAT, 2019a; 2019b). Free Trade Agreements (FTAs) are signed not only to reduce the tariff barriers for bi-lateral trade, but also to create market opportunities, streamline processes, reduce overhead costs, and generate more certainty and security for businesses conducting work overseas. In terms of market access FTAs can also help local businesses be more competitive in overseas markets (MFAT, 2017c). 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.

The potential for future agreements could greatly affect the trading profile and agricultural production (and thus land-use) in New Zealand. One study by Saunders et al. (2016c) projected the EU-NZ FTA would results in increases in NZ horticultural production and dairy production, alongside increased consumption of European imported cereals in NZ. Verevis and Üngör (2019) estimated that without the 2008 China-NZ FTA NZ would export 22 per cent less commodity exports (185 per cent less for the food and animal sectors). FTAs will continue to play an important role in market connectivity and the international trading environment, especially for agriculture.

2. Multilateral 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 (WTO, 2015). New Zealand's agricultural sector was well-placed to benefit and grow under the progressive Doha rounds (Cornish and Fernandez, 2005). However, with the failure of the negotiations, New Zealand could beat risk of being excluded from trade negotiations, which could result in lost market share in foreign markets.

Fortunately, New Zealand is also currently a signatory on a number of multilateral FTAs. These include:

- Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), signed by New Zealand, Australia, Singapore, Malaysia, Brunei Darussalam, Viet Nam, Japan, Canada, Mexico, Preu and Chile (MFAT, 2019c);
- ASEAN-Australia-New Zealand Free Trade Agreement (AANZFTA), signed by New Zealand, Australia, Indonesia, Singapore, Malaysia, Brunei Darussalam, The Philippines, Thailand, Cambodia, Viet Nam, Laos and Myanmar (MFAT, 2019d); and
- Trans-Pacific Strategic Economic Partnership (P4), signed by New Zealand, Singapore, Chile and Brunei Darussalam (MFAT, 2019e).

In addition to the above, a number of multilateral FTAs are currently concluded but not in force, or under negotiation, including:

- NZ-Gulf Cooperation Council FTA, including New Zealand, United Arab Emirates, Oman, Qatar, Saudi Arabia, Bahrain and Kuwait (MFAT, 2019f);
- PACER Plus, including Australia, Cook Island, Kiribati, Nauru, New Zealand, Niue, Samoa, Solomon Island, Tonga, Tuvalu and Vanuatu (MFAT, 2019g);

- Regional Comprehensive Economic Partership (RECP), including New Zealand, Australia, Indonesia, Singapore, Malaysia, Thailand, Cambodia, Brunei Darussalam, The Philippines, Viet Nam, Laos, Myanmar, India, China, Japan and South Korea (MFAT, 2019h);
- New Zealand-Pacific Alliance Free Trade Agreement, including New Zealand, Chile, Colombia, Mexico and Peru (MFAT, 2019i); and
- Russia-Belarus-Kazakhstan Customs Union FTA, including New Zealand, Russia, Belarus and Kazakhstan (MFAT, 2019j).

New Zealand has a relatively diverse profile of trading partners, with a Herfindahl export index of 0.11 (WITS, 2019). However trade with China, New Zealand's most significant bi-lateral trade partner, accounts for over 22 per cent of export trade, and 19 per cent of import trade (WITS, 2019). Thus any potential disruption of trade with China, or change in market access, political tensions, or the economy of China, would have significant ramifications for New Zealand's trading environment. These concerns are emphasised given the recent trade war between the US and China, two of New Zealand's most importance trading partners (the United States is the 3rd largest import & export market for New Zealand) (BBC, 2019b).

3. Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP)

Following the election of President Donald Trump, the United States introduced more protectionist policies in order to shield US industries, affecting trade deals such as the North America Free Trade Agreement (NAFTA) and the Trans-Pacific Partnership (TPP). The TPP was abandoned by the US in 2017, leading to the redevelopment of the TPP without the US as a signatory. Negotiations concluded in January 2018, with the CPTPP signed by Trade Ministers in Chile on March 8th 2018 (MFAT, 2019c).

CPTPP signatories represented approximately 30 per cent of New Zealand's goods exports (NZ$16.7 billion) and 30 per cent of services exports (NZ$7.3 billion) by value in June 2018. In addition, New Zealand has never had a bilateral FTA with four of the signatories (Japan, Canada, Mexico and Peru), to which New Zealand exports approximately NZ$5.5 billion of goods and services annually. It has been estimated that reductions in tariff barriers for many of New Zealand's largest primary product exports resulting from the signing of the CPTPP could be up to NZ$222 million each year (MFAT, 2019c). The signing of the CPTPP affects trade policy, tariffs and export/import quotas, which ultimately affect New Zealand's primary industries.

4. Brexit

On June 23rd, 2016, the United Kingdom (UK) voted narrowly (52:48) to leave the EU. The UK government then officially notified the EU on March 29th 2017, of its intention to leave, thus triggering Article 50 of the EU Treaty, which specifies that within two years the UK will cease to be a member. However, the date for Brexit is still unclear as EU leaders have granted the UK multiple extensions for Brexit. Consequently, the nature of the economic relationship between the UK and the remaining EU-27 is still to be defined.

Brexit is likely to change the domestic and trade policies affecting agriculture in the UK and have implications for agricultural commodity trade worldwide. Trade policy changes are key factors in determining the consequences of Brexit for agricultural markets in Europe and elsewhere. Therefore it is difficult to assess the impact of Brexit on New Zealand until the more detailed policies are known. The UK is still an important export market for New Zealand,

especially for sheep meat. However, modelling suggests that the impact of Brexit on New Zealand will be minimal (Saunders et al., 2019). Since 1973, New Zealand's agricultural exports to the UK were subject to EU trade policy, hence, the UK exiting the EU will affect trade between the UK, the EU and third party countries like New Zealand.

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. The relaxing of NTBs is a significant component of trade agreements, 70 per cent of the projected benefit from the proposed TPP RTA were expected to come from reductions in NTBs (NZIER 2017). 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.

4. Conclusion

Enhancing primary sector production and productivity while maintaining and improving our land and water quality for future generations is a key outcome of the Our Land and Water National Science Challenge. It is therefore important to identify 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 that 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 current report has been informed by two previous iterations, in which workshops, stakeholder surveys and extensive literature review produced a series of 32 key drivers of land use change/practice. This was later expanded to 34 key drivers. Links to updated summaries of the key drivers are provided, along with an evidence base comprising 1,097 unique sources

(850 international and 247 domestic sources) across the three iterations of this project, are included in this report.

The current report modified and extended a survey of New Zealand primary sector stakeholders, designed to identify which drivers they believed to be the most important for land use change/practice domestically and internationally. The survey was distributed to 335 participants in total, receiving 226 completed surveys.

Using an unprompted, open text entry, the survey results showed that a highly significant percentage of stakeholders thought that climate change was the most important driver of land use change/practice on an international level, and the second-most important driver of land use change/practice on a domestic level (below water quality). Participants also identified environmental condition, GHG emissions, water quality and trade agreements as international drivers that would have a high impact on land use. Furthermore, participants identified water quality, nitrate limits, environmental condition, GHG emissions and biosecurity as domestic drivers that would have a high impact on land use.

This report also examined future trends and challenges and their likely impact on New Zealand land use change/practice. These were grouped under six broad headings: climate change, global trends and challenges, emerging technologies, innovative products/new food technology, consumer trends, and international trading environment.

Climate change is most likely to be highly impactful on land use change/practice into the future, producing significant disruptions to regional production trends, biosecurity, ecosystem integrity and social conditions, as well as producing higher frequency and intensity extreme weather events and heavily influencing domestic policy regarding land use. A growing global population, coupled with the challenges of maintaining a social license to operate, combating food waste and maintaining stable markets, are seen as challenges on a global scale. Greater development and use of new technologies designed to provide data and improve practices, both on-farm and in-market, are also highly likely to influence land use trends. Consumer preferences are also changing, with an increased market presence for alternative protein products, as well as increasing consumer interest in vegetarian, vegan and flexitarian diets. The international trading environment will also continue to contribute to the success of New Zealand's primary product exports, particularly with the development of bilateral and multilateral free 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, 2018). 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 was also examined. The future of sustainable and productive primary land use will require identifying and adapting to 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 and 2 of the Drivers Project for the Our Land and Water component of the National Science Challenge (Saunders et al., 2016b; 2018), and covers mainly academic CE literature published between 2003 and 2019. 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 35 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 16 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.

Kallas et al. (2019) used a discrete choice experiment to determine Spanish consumers' WTP for health-enhancing properties in pork patty products before and after a hedonic taste test of product types. Specifically, this involved innovative pork patty products with enhanced health claims through the addition of Porcini (added dietary fibre) and blueberries (added antioxidants). Initially, the researchers determined the "food neophobia" (degree of aversion to innovative food products) of the participants, subsequently segmenting participants into three groups – low, average and high food neophobic (LN, AN and HN respectively). WTP values were calculated prior to and following taste testings of each of the products, deriving a range of premiums associated with each product – these are shown in Table A4 below. This showed a generally higher WTP for both traditional and innovative pork products by

consumers with lower food neophobia, as well as a perceived higher WTP prior to tasting for those innovative products including blueberries over Porcini (Kallas et al., 2019).

Table A4. Willingness-to-pay (€) for traditional and innovative pork products before and after tasting, Spanish consumers (2018) (N = 121)

Segment	Product Type	WTP (€) Expected Before Tasting	WTP (€) Experienced After Tasting
Low Food Neophobia (LN) (n = 24)	Traditional Pork Product	3.87	4.31
	Innovative Pork Product 1 – Porcini	3.60	2.70
	Innovative Pork Product 2 – Blueberries	4.60	2.34
Average Food Neophobia (AN) (n = 41)	Traditional Pork Product	3.71	3.38
	Innovative Pork Product 1 – Porcini	3.50	2.79
	Innovative Pork Product 2 – Blueberries	3.71	1.86
High Food Neophobia (HN) (n = 55)	Traditional Pork Product	2.88	3.43
	Innovative Pork Product 1 – Porcini	2.88	2.41
	Innovative Pork Product 2 – Blueberries	3.34	1.89

Source: Kallas et al., 2019.

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 A5 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 A5: 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 A6 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 A6: 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 A7 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 A7: 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 A8 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 A8: 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 A9 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 A9: 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 A10 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 A10: 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 A11 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 A11: 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 A12 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 A12, 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 A12: 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 A13 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 A13: 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 A14 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 A14: 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 A15) 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 A15 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 A15: 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)

Paci et al. (2018) examined Italian consumers' WTP for the inclusion of environmental and health attributes in fresh fish burger products, finding a WTP of up to an additional 0.57 Euro for the "environment" attribute and 0.37 Euro for the "health" attribute.

North American studies

The current review includes 8 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).

Merritt et al. (2018) undertook a choice experiment to examine US consumers' WTP for a range of beef product attributes, including quality assurance, region of origin and various production practices, as well as a combination of these attributes. Specifically, these attributes were *Tennessee Certified Beef*, *Certified Angus Beef*, *grass-fed*, *Master Quality Raised Beef* and *no hormones administered*. In addition, WTP estimates were carried out for two types of beef products – USDA Choice boneless ribeye beef steak, and USB Choice ground beef (85% lean/15% fat). Furthermore, participants undertaking a choice experiment for either product were evenly distributed into either a control treatment (who were shown no additional information about the attributes of each product) and an information treatment (who were shown additional information about the attributes of each product). Estimates of WTP for each attribute within and between each of the above groups is shown in Table A17 and A18 below. Both tables show a generally higher WTP for all attributes by those in the Information Treatment segment, with the highest overall WTP for both product types across both segments to be for a combination of *Tennessee Certified Beef (TCB)* and *grass-fed* attributes (Merritt et al., 2018).

Table A17. Willingness-to-pay for USDA Choice boneless ribeye beef steak product attributes (USD ($) per pound (lb)) (2018) (N = 408 total)

Attribute	Control Treatment (n = 204)	Information Treatment (n = 204)	WTP Treatment Difference
Tennessee Certified Beef (TCB)	2.42	2.89	0.47
Certified Angus Beef (CAB)	1.19	1.43	0.24
Grass-fed	0.95	1.43	-0.48
Master Quality Raised Beef (MQRB)	1.39	1.67	0.28
No hormones administered	2.35	2.71	0.37
TCB and CAB	2.51	3.36	0.85
TCB and grass-fed	3.93	3.56	-0.37
TCB and MQRB	2.62	3.67	1.05
TCB and No hormones administered	4.37	3.28	-1.10

Source: Merritt et al., 2018.

Table A18. Willingness-to-pay for USDA Choice ground beef (85% lean/15% fat) product attributes (USD ($) per pound (lb)) (2018) (N = 408 total)

Attribute	Control Treatment (n = 204)	Information Treatment (n = 204)	WTP Treatment Difference
Tennessee Certified Beef (TCB)	1.15	1.53	0.38
Certified Angus Beef (CAB)	0.41	0.73	0.33
Grass-fed	0.81	0.59	-0.22
Master Quality Raised Beef (MQRB)	0.65	0.91	0.26
No hormones administered	1.27	1.59	0.33
TCB and CAB	1.29	1.61	0.31
TCB and grass-fed	1.76	1.98	0.21
TCB and MQRB	1.45	1.72	0.27
TCB and No hormones administered	1.63	2.41	0.78

Source: Merritt et al., 2018.

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 A19 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 A19: 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 A20 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 A20: 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 A21 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 A21: 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 A22 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 A22: 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 A23 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 A24, 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 A23: 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 A24: 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 7 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 A25, 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 A26 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 A25: 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 A26: 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 A27 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 A27: 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.

Lai et al. (2018) used a series of choice experiments to determine Chinese consumers' (Beijing and Shanghai) WTP for a range of attributes of pork products, including environmental, food safety and animal welfare standards, as well as country of origin. Results showed a range of premiums associated with different attributes, as shown in Table A28 below. This shows

generally higher WTP for all attributes from Shanghai participants, with *food safety*, *Chinese origin* and *environmental standards* having the highest associated WTP values (Lai et al., 2018).

Table A28. Willingness-to-pay for pork product certification attributes by Chinese consumers (Beijing and Shanghai) (2018) (N = 480 total)

Attribute	Mean WTP (RMB) – Beijing (N = 259)	Mean WTP (RMB) – Shanghai (N = 221)
Food Safety	32.01	32.32
Animal Welfare	7.65	13.11
Environmental Standards	11.81	20.73
Country of Origin: United States	4.31	9.61
Country of Origin: China	13.26	30.11

Source: Lai et al., 2018.

Wang et al. (2018) used a discrete choice experiment to determine urban Chinese consumers' WTP for pork products with certified attributes. Specifically, this included certified labels for organic production, green food production, food safety, location of origin, and free from veterinary drug residues. Choice experiments were carried out in two Chinese provinces (Jiangsu and Anhui) with results reported for each – these are shown in Table A29 below. This shows a greater WTP for all attributes by Jiangsu consumers, with generally higher WTP for *organic food*, followed by *green food* and *free from veterinary drug residues* across both provinces.

Table A29. Willingness-to-pay for pork certification attributes, Jiangsu and Anhui provinces, China (2018) (Yuan/550g)

Attribute	Jiangsu (N = 475)	Anhui (N = 369)
Safe Food	8.10	7.21
Green Food	20.22	17.63
Organic Food	26.78	18.94
Location of Origin shown	12.77	10.99
Free from veterinary drug residues	23.18	15.40

Source: Wang et al., 2018.

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 A30 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 A30: 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 A31 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 'v*ery concerned*' (59% of the sample), 'm*oderately 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 A31: 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 A32, 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 A32: 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 A33. 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 A33: 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 A34, 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 A34: 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 A35 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 A35: 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 6 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 A36 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 A36: 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 A37 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 A37: 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 A38 and A39 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 A38: 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 A39: 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 A40) and the segmented-based approach (Table A41). 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 A41). 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 A40: 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 A41: 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)

Grashuis and Magnier (2018) used two choice experiments to assess US consumers' WTP for a range of attributes associated with cheese and cereal products. Specifically, this included type of company ownership (cooperative, firm), product origin (local, Wisconsin/Iowa), and family ownership status. The researchers assessed consumers' WTP using three models for

each choice experiment, rendering different sets of results for each (i.e. Model 1 includes the main attributes, Model 2 includes more detailed analysis of ownership type in combination with origin, and Model 3 includes more detailed analysis of ownership type in combination with family-owned status). Results are shown in Table A42 and A43 below. In general, WTP for both products was shown to be higher for firm-owned production, with generic *local* production favoured over specified locations (Grashuis and Magnier, 2018).

Table A42. Willingness-to-pay for cheese attributes, US (N = 298)

Attribute	Mean WTP (USD/8oz) (Model 1)	Mean WTP (USD/8oz) (Model 2)	Mean WTP (USD/8oz) (Model 3)
Ownership: Cooperative	0.766	1.374	0.655
Ownership: Firm	1.453	1.908	1.365
Origin: Local	0.728	1.156	0.735
Origin: Local (Cooperative)		-0.672	
Origin: Local (Firm)		-0.489	
Origin: Wisconsin	0.406	1.186	0.410
Origin: Wisconsin (Cooperative)		-1.289	
Origin: Wisconsin (Firm)		-0.916	
Family-Owned	0.501	0.504	0.385
Family-Owned (Cooperative)			0.211
Family-Owned (Firm)			0.170

Source: Grashuis and Magnier, 2018.

Table A43. Willingness-to-pay for cereal attributes, US (N = 394)

Attribute	Mean WTP (USD/12oz) (Model 1)	Mean WTP (USD/12oz) (Model 2)	Mean WTP (USD/12oz) (Model 3)
Ownership: Cooperative	1.001	1.014	1.400
Ownership: Firm	1.153	1.099	1.257
Origin: Local	0.411	0.335	0.404
Origin: Local (Cooperative)		0.253	
Origin: Local (Firm)		-0.139	
Origin: Iowa	0.067	-0.255	0.063
Origin: Iowa (Cooperative)		0.092	
Origin: Iowa (Firm)		0.648	
Family-Owned	0.513	0.580	0.885
Family-Owned (Cooperative)			-0.894
Family-Owned (Firm)			-0.327

Source: Grashuis and Magnier, 2018.

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 A44 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 A44: 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 8 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 3 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 A45). 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 A45: 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 A46) 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 A46: 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)

Ceschi et al. (2018) used a choice experiment to analyse Italian consumers' WTP for apple attributes, specifically their variety, production method(s) and region(s) of production. As shown in Table A47 below, the authors found a range of premiums associated with specific regions of production, with consumers willing to pay a higher premium for apples produced in Trentino-Adige (+€1.44 per kg) and Emilia-Romagna (+€1.41 per kg) over imported apples (-€2.12 per kg). Similarly, the organic attribute was shown to have only marginal increased WTP relative to conventional apples (+€0.18 per kg) (Ceschi et al., 2018).

Table A47. Willingness-to-pay for apple attributes, Italy (N = 301)

Attribute	WTP (€/kg)
Organic	+0.18
Bicolour	-0.34
Green	-1.00
Red	-0.94
Trentino-Alto Adige	+1.49
Emilia-Romagna	+1.44
Imported	-2.12

Source: Ceschi et al., 2018

North American studies

There have been some, but limited, studies of consumer WTP for attributes of fruit and vegetable products in North American countries.

Grebitus et al. (2018) used a series of online choice experiments to determine US consumers' WTP for Medjool dates with associated GMO, pesticide use and region of origin credentials. In general, this showed that participants were willing to pay positive premiums for all attributes, particularly those with GMO- and pesticide-free status, as well as a preference for dates grown in the state of Arizona over California. Table A48 below shows the range of premiums associated with the above attributes.

Table A48. Willingness-to-pay for date attributes, US (N = 1,411)

Attribute	Mean WTP (US$/ounce)
Arizona grown	+0.14
California grown	+0.03
Pesticide-free	+0.55
GMO-free	+0.17
GMO- and pesticide-free	+0.53

Source: Grebitus et al., 2018.

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 A49 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 A49: 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.

While not strictly a fruit and vegetable product, Gao et al. (2019) used a series of choice experiments to examine urban Chinese consumers' WTP for country of origin and genetically modified organism status of different orange juice products (*orange juice drink* (OJD), *orange juice from concentrate* (FCOJ) and *orange juice not from concentrate* (NFC)). As shown in Table A50 below, WTP estimates were produced against alternatives (e.g. a series of origins versus Chinese origin), producing a range of premiums associated with different orange juice product attributes. In particular, the results show a range of discounts associated with country of origin and GM status, with price premiums associated only with changes in product types.

Table A50. Willingness-to-pay for orange juice products by type, production method and country of origin, China (N = 646)

Category	Attribute	Mean WTP (RMB)
Product Type (vs 10% Orange Juice Drink)	50% Orange Juice Drink	5.38
	Orange Juice From Concentrate	9.81
	Orange Juice Not From Concentrate	13.27
Conventional Juice (Imported vs China)	US	-4.61
	Brazil	-1.55
	Israel	-2.13
	Australia	-3.70
GM Juice (GM vs conventional juice from the same country)	US	-4.87
	Brazil	-13.60
	Israel	-14.52
	Australia	-4.59
	China	-12.12
Brand and Manufacturer Country of Origin (other vs Chinese brand, made in China)	US brand, made in United States	-3.05
	US brand, made in China	-4.66
	US brand, made in Florida	-5.47
	Taiwanese brand (China), made in China	-1.45
	Australian brand, made in Australia	-0.05

Source: Gao et al., 2019.

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 A51 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 A51: 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 demographics 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 A52, 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 A53 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 A52: 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 A53: 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 3 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 A54, 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 A55 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 A54: 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 A55: 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 A56, 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 A56: 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)

Pomarici et al. (2018) used an experimental auction method to assess younger Italian consumers' (n = 200) WTP for a range of water-related attributes of wine products. Specifically, this included three different wine products – a conventional wine product (i.e. no water saving), a water saving front-of-pack labelled product, and a water saving back-of-pack labelled product. The authors showed that participants bid a median price of €4.16 for the conventional wine product, and a median price of €4.51 (€0.35 premium) and €4.32 (€0.16 premium) for the front-of-pack and back-of-pack labelled wine products respectively (Pomarici et al., 2018).

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 A57 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 A57: 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 A58 shows differences in WTP estimates produced through the use of each method.

Table A58: 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 A59), 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 A59: 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 A60, 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 A60: 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 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 A61 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 A61: 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 A62 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 A62: 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 A63, 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 A63: 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 A64, 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 A64: 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 A65 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 A65 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 A65: 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 A66 and A67. As shown in Table A66, 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 A67, 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 A66: 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 A67: 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)

Boccia et al. (2019) conducted a number of choice experiments to examine Italian consumer preferences and WTP for brand, corporate environmental and social responsibility programme participation in relation to ready-meal products. Results indicated approximate WTP for the inclusion of these attributes, with participants willing to pay a €2.46 premium for products with recognisable brand names that also participate in the above programmes. In addition, participants were willing to pay a €1.53 premium for products participating in environmentally friendly social responsibility programmes, while they were only willing to pay a €0.19 premium for only social responsibility programme participation (Boccia et al., 2019). A summary of these results is shown in Table A68 below.

Table A68. Willingness-to-pay for ready meal attributes, Italy (N = 1,083)

Attribute bundles	WTP (€/product)
Brand (well-known/recognised vs unknown); environmental programme participation; social responsibility participation programme	2.45895
Environmental programme participation; social responsibility participation programme	1.52860
Social responsibility participation programme	0.19325

Source: Boccia et al., 2019

North American studies

The current review includes 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 A69 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 A69: 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 A70 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

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

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.

Table A70: 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 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 A71 shows, consumers on average preferred chicken with a lower food safety risk and improved animal welfare, regardless of the presence

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

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

Table A71: 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 A72, 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 A72: 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 A73). 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 A73: 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 69 international CE and other WTP studies regarding food and beverage choices and associated credence attributes from 2010 to 2019. 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 (35), following by wine (8), fruit and vegetable (8) and dairy products (6). Another 12 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 next phase of the Our Land and Water National Science Challenge.

This survey takes about 5 minutes to complete. You are free to skip 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 ***international*** issues which have the potential to influence **New Zealand land use change/practice or land management practices?**

- ❍ 1 (Most critical) _____
- ❍ 2 _____
- ❍ 3 _____

Q3: **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 or land management practices?**

- ❍ 1 (Most critical) _____
- ❍ 2 _____
- ❍ 3 _____

Page Break

Q4: **International Issues**

Below are some key issues that stakeholders and the team have previously identified.

Please indicate whether you think the following **international** issues and drivers will have a high, medium or low impact on **New Zealand land use change/practice or land management practices** 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)	❍	❍	❍	❍

	High (1)	Medium (2)	Low (3)	Don't know (4)
Emissions trading (14)	❍	❍	❍	❍
Extreme weather events (15)	❍	❍	❍	❍
Fair trade (16)	❍	❍	❍	❍
Family and community values (17)	❍	❍	❍	❍
Food safety (18)	❍	❍	❍	❍
Functional foods (19)	❍	❍	❍	❍
GM and nanotechnology (20)	❍	❍	❍	❍
Greenhouse gas emissions (21)	❍	❍	❍	❍
Health and safety (22)	❍	❍	❍	❍
Innovative products and services (23)	❍	❍	❍	❍
Local foods/food miles (24)	❍	❍	❍	❍

Page Break

	High (1)	Medium (2)	Low (3)	Don't know (4)
Māori values (25)	❍	❍	❍	❍
Nitrate limits (26)	❍	❍	❍	❍
Organic production (27)	❍	❍	❍	❍
Pasture-based production (28)	❍	❍	❍	❍
Product quality (29)	❍	❍	❍	❍
Religion (30)	❍	❍	❍	❍
Soil quality (31)	❍	❍	❍	❍
Sustainable supply (32)	❍	❍	❍	❍
Trade agreements (33)	❍	❍	❍	❍
Trade effects (34)	❍	❍	❍	❍
Waste/recycling (35)	❍	❍	❍	❍
Water footprinting/use (36)	❍	❍	❍	❍
Water quality (37)	❍	❍	❍	❍

Page Break

Q5: **Domestic**

Please indicate whether you think the following **domestic** issues and drivers will have a high, medium or low impact on **New Zealand land use change/practice or land management practices** 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)	❍	❍	❍	❍
Climate change (9)	❍	❍	❍	❍
Condition of the environment (10)	❍	❍	❍	❍
Country-of-Origin (11)	❍	❍	❍	❍
Cultural values (12)	❍	❍	❍	❍
Demographics (13)	❍	❍	❍	❍
Digital communications systems (14)	❍	❍	❍	❍

	High (1)	Medium (2)	Low (3)	Don't know (4)
Emissions trading scheme (ETS) (15)	❍	❍	❍	❍
Extreme weather events (16)	❍	❍	❍	❍
Fair trade (17)	❍	❍	❍	❍
Family and community values (18)	❍	❍	❍	❍
Food safety (19)	❍	❍	❍	❍
Functional foods (20)	❍	❍	❍	❍
GM and nanotechnology (21)	❍	❍	❍	❍
Greenhouse gas emissions (22)	❍	❍	❍	❍
Health and safety (23)	❍	❍	❍	❍
Innovative products and services (24)	❍	❍	❍	❍
Local foods/food miles (25)	❍	❍	❍	❍

Page Break

	High (1)	Medium (2)	Low (3)	Don't know (4)
Māori values (26)	❍	❍	❍	❍
Nitrate limits (27)	❍	❍	❍	❍
Organic production (28)	❍	❍	❍	❍
Pasture-based production (29)	❍	❍	❍	❍
Product quality (30)	❍	❍	❍	❍
Religion (31)	❍	❍	❍	❍
Soil quality (32)	❍	❍	❍	❍
Sustainable supply (33)	❍	❍	❍	❍
Trade agreements (34)	❍	❍	❍	❍
Trade effects (35)	❍	❍	❍	❍
Waste/recycling (36)	❍	❍	❍	❍
Water footprinting/use (37)	❍	❍	❍	❍
Water quality (38)	❍	❍	❍	❍

Page Break

Q6: Which primary sector are you most aligned with:

- ❍ Meat (1)
- ❍ Dairy (2)
- ❍ Wool (3)
- ❍ Viticulture/Wine (4)
- ❍ Horticulture (5)
- ❍ Forestry (6)
- ❍ Aquaculture (7)
- ❍ Government (8)
- ❍ Māori enterprise (9)
- ❍ Science/Research (10)
- ❍ Extension work (11)
- ❍ Smart agriculture (12)
- ❍ Other (please specify) (13)

Page Break

Q7: 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)	❍	❍	❍	❍	❍

Q8: 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)	❍	❍	❍	❍	❍

Q9:

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