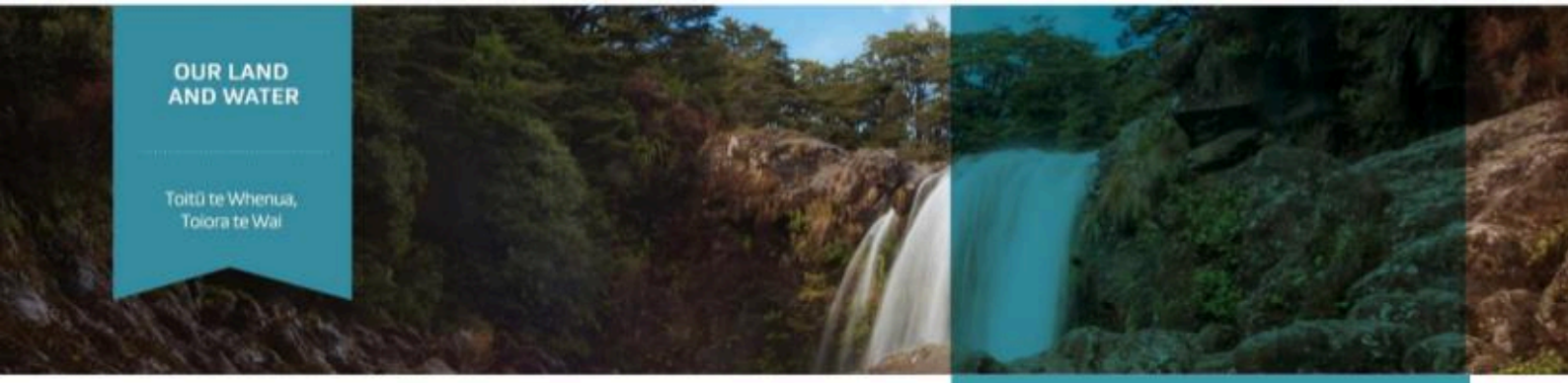
National SCIENCE Challenges



The Matrix of Drivers: 2022 Update

Timothy Driver

Simon Duff

Tiffany McIntyre

Professor
Caroline Saunders

Report for Our Land and Water National Science Challenge
Agribusiness & Economics Research Unit (AERU), Lincoln University

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The Matrix of Drivers: 2022 Update

Research team: Timothy Driver, Simon Duff, Dr Tiffany McIntyre, Professor Caroline Saunders

Agribusiness and Economics Research Unit (AERU), Lincoln University

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 fourth 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

1.1 Project background

This report is the fourth 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 2017 and 2019 to include new arising issues or drivers relevant to land use change/practice (Saunders et al., 2018; Driver et al., 2019). 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 February 2022)

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	Public Health
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.

The domestic drivers were originally 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 2022. 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 domestic 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 by international regions and in New Zealand, and a survey addressing issues relating to the drivers administered to stakeholders involved in New Zealand's primary industries. In this report, the survey has been updated, as presented below.

2.1 Survey methodology

As stated above, the three earlier Drivers reports included a survey of stakeholders (Saunders et al., 2016; Driver et al., 2018; 2019). This was repeated for this report with an updated survey, administered in October/November 2021. 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 2021 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. The second was to a list of participants from a database held by the Our Land and Water National Science Challenge. Additional reminder emails were sent following the initial distribution. The survey was distributed to 2,818 people in total, receiving 622 responses, including 251 completed surveys, thereby achieving an approximate 40 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.

The survey was expanded to include questions regarding participants' engagement with agribusiness schemes, including the number of schemes and criteria therein, across four sets of considerations – environmental, social, economic and cultural. This also included questions relating to the extent to which participants believed that these schemes improved returns for their products. In addition, a question regarding participant's view on the importance of a

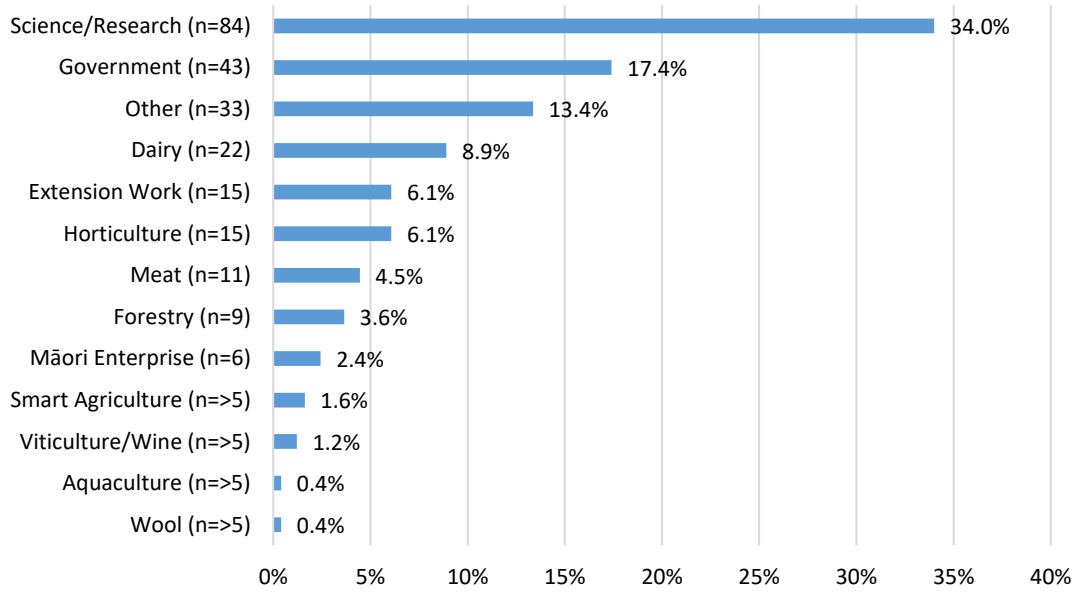
range of product attributes in achieving higher product value from lower volume was also included in this survey.

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

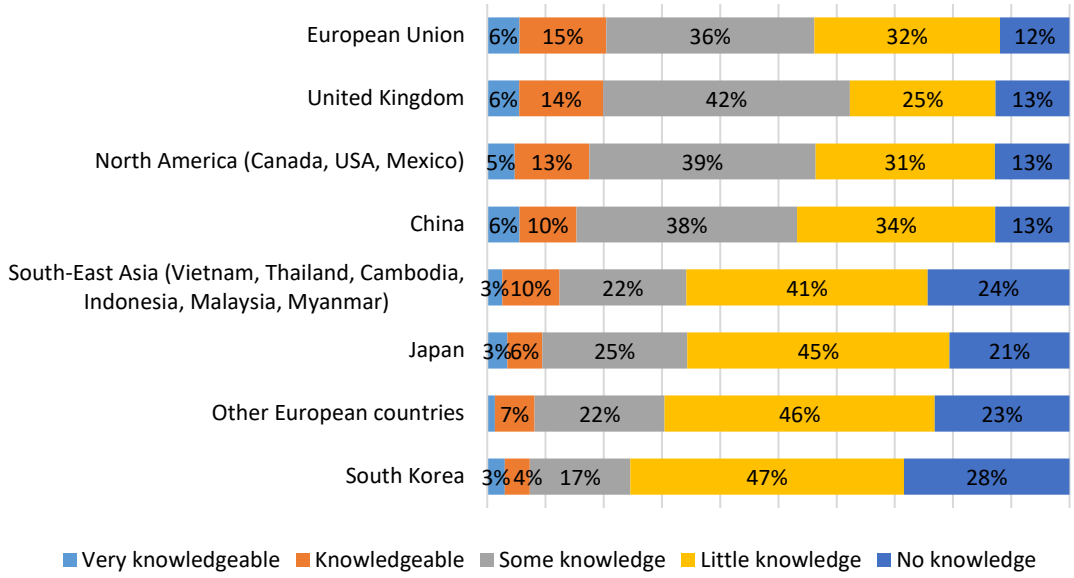
Survey participants were asked to identify the sector that they were most closely aligned with. As shown in Figure 2-1, 34 per cent of participants identified with the *Science/Research* sector, followed by *Government* and *Other* sectors (17.4 per cent and 13.4 per cent respectively). The most represented primary sector was *dairy* (8.9 per cent), followed by *horticulture* (6.1 per cent) and *meat* (4.5 per cent). Sectors stated within the *'other'* category included arable, local government, NGOs, farm consultancy, inputs, advocacy, organic dairy, education, communications, irrigation, supply chains, finance, landscape design, and conservation, as well as work across multiple sectors.

Figure 2-1: Survey participants' alignment with sectors (%) (n=247)



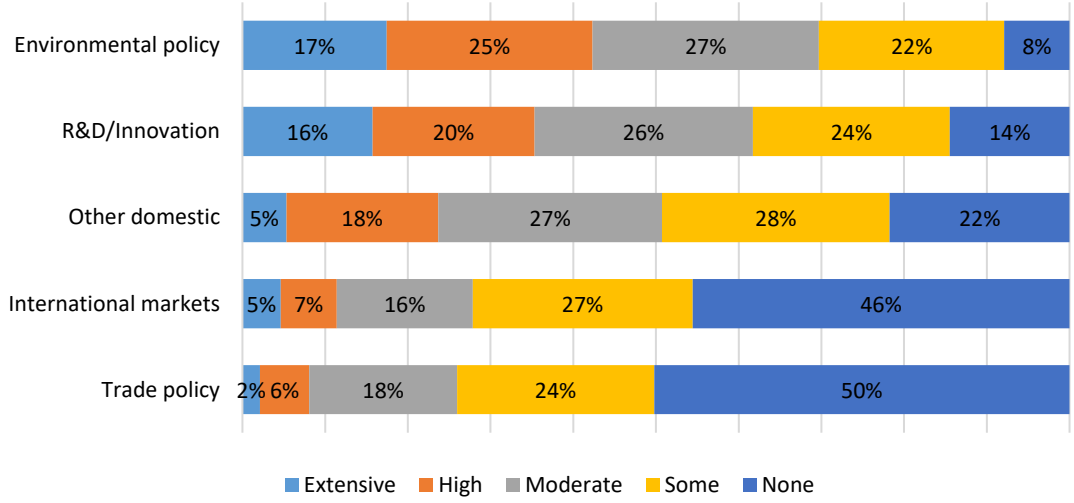
Participants were also asked to indicate their levels of knowledge regarding particular markets and regions. As shown in Figure 2-2 below, 21 per cent of participants indicated they were *'very knowledgeable'* or *'knowledgeable'* regarding the European Union, followed by the United Kingdom (20 per cent *'very knowledgeable'* or *'knowledgeable'*) and North America (18 per cent *'very knowledgeable'* or *'knowledgeable'*). Other markets/regions that participants identified as being familiar with included Australia, Pacific, Middle East, India, Ireland, South America, Brazil, Canada, and United Arab Emirates.

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. Forty-two per cent of participants had either *'extensive'* or *'moderate'* experience in environmental policy, followed by R&D/Innovation (36 per cent *'extensive'* or *'moderate' experience'*) and other domestic (23 per cent *'extensive'* or *'moderate'* experience).

Figure 2-3: Participants' level of experience in industry fields



Further analysis revealed participants' level of knowledge regarding particular markets and regions by sectoral alignment. As shown in Tables 2.1 to 2.8 below, results show that the level of knowledge of specific areas/markets shown by participants differs based on their sectoral alignment. For example, government participants indicated a higher relative level of knowledge of areas/markets such as North America (Table 2.4) and United Kingdom (Table 2.8), while primary sector participants indicated a higher relative level of knowledge of Asian markets such as China (Table 2.1).

Table 2-1: Level of knowledge (China) by sectoral alignment, % of sector participants

		LEVEL OF KNOWLEDGE				
SECTOR	Industry	*Very knowledgeable*	*Knowledgeable*	*Some knowledge*	*Little knowledge*	*No knowledge*
Primary Sector		13%	16%	39%	23%	9%
	Meat	10%	20%	40%	20%	10%
	Dairy	10%	14%	38%	19%	19%
	Horticulture	17%	17%	33%	33%	0%
	Forestry	13%	25%	38%	25%	0%
	Other Primary Sector	20%	0%	60%	20%	0%
Science/ Research		0%	10%	48%	35%	6%
Government		5%	5%	31%	36%	23%
Māori Enterprise		5%	13%	33%	40%	10%
Extension Work		0%	20%	0%	80%	0%
Smart Agriculture		0%	0%	67%	33%	0%
Other Sector		0%	0%	50%	50%	0%

Table 2-2: Level of knowledge (European Union) by sectoral alignment, % of sector participants

		LEVEL OF KNOWLEDGE				
SECTOR	Industry	*Very knowledgeable*	*Knowledgeable*	*Some knowledge*	*Little knowledge*	*No knowledge*
Primary Sector		13%	20%	35%	20%	13%
	Meat	10%	40%	20%	20%	10%
	Dairy	5%	25%	35%	20%	15%
	Horticulture	33%	0%	8%	42%	17%
	Forestry	0%	13%	75%	0%	13%
	Other Primary Sector	20%	20%	60%	0%	0%
Science/ Research		3%	10%	39%	42%	6%
Government		4%	13%	33%	34%	16%
Māori Enterprise		3%	18%	38%	33%	10%
Extension Work		0%	20%	20%	40%	20%
Smart Agriculture		7%	0%	47%	40%	7%
Other Sector		0%	0%	75%	25%	0%

Table 2-3: Level of knowledge (Japan) by sectoral alignment, % of sector participants

		LEVEL OF KNOWLEDGE				
SECTOR	Industry	*Very knowledgeable*	*Knowledgeable*	*Some knowledge*	*Little knowledge*	*No knowledge*
Primary Sector		7%	13%	24%	40%	16%
	Meat	0%	10%	40%	30%	20%
	Dairy	5%	10%	20%	50%	15%
	Horticulture	17%	17%	8%	42%	17%
	Forestry	0%	13%	38%	38%	13%
	Other Primary Sector	20%	20%	20%	20%	20%
Science/ Research		6%	3%	13%	68%	10%
Government		0%	5%	29%	34%	33%
Māori Enterprise		3%	0%	25%	55%	18%
Extension Work		0%	20%	0%	80%	0%
Smart Agriculture		7%	0%	27%	53%	13%
Other Sector		0%	0%	75%	25%	0%

Table 2-4: Level of knowledge (North America) by sectoral alignment, % of sector participants

		LEVEL OF KNOWLEDGE				
SECTOR	Industry	*Very knowledgeable*	*Knowledgeable*	*Some knowledge*	*Little knowledge*	*No knowledge*
Primary Sector		7%	16%	44%	24%	9%
	Meat	10%	10%	70%	0%	10%
	Dairy	0%	20%	45%	20%	15%
	Horticulture	17%	8%	25%	50%	0%
	Forestry	0%	25%	38%	25%	13%
	Other Primary Sector	20%	20%	40%	20%	0%
Science/ Research		3%	13%	42%	35%	6%
Government		2%	11%	33%	35%	19%
Māori Enterprise		8%	8%	40%	30%	15%
Extension Work		0%	40%	20%	20%	20%
Smart Agriculture		0%	13%	40%	40%	7%
Other Sector		25%	0%	50%	25%	0%

Table 2-5: Level of knowledge (Other European countries) by sectoral alignment, % of sector participants

		LEVEL OF KNOWLEDGE				
SECTOR	Industry	*Very knowledgeable*	*Knowledgeable*	*Some knowledge*	*Little knowledge*	*No knowledge*
Primary Sector		4%	11%	26%	43%	17%
	Meat	0%	30%	20%	40%	10%
	Dairy	0%	0%	40%	40%	20%
	Horticulture	8%	17%	17%	42%	17%
	Forestry	0%	13%	0%	63%	25%
	Other Primary Sector	20%	0%	40%	20%	0%
Science/ Research		0%	0%	26%	65%	10%
Government		1%	4%	23%	37%	35%
Māori Enterprise		0%	13%	15%	53%	20%
Extension Work		0%	20%	0%	40%	40%
Smart Agriculture		0%	7%	20%	53%	20%
Other Sector		0%	0%	25%	75%	0%

Table 2-6: Level of knowledge (Southeast Asia) by sectoral alignment, % of sector participants

		LEVEL OF KNOWLEDGE				
SECTOR	Industry	*Very knowledgeable*	*Knowledgeable*	*Some knowledge*	*Little knowledge*	*No knowledge*
Primary Sector		7%	18%	23%	32%	20%
	Meat	0%	10%	20%	50%	20%
	Dairy	10%	14%	24%	29%	24%
	Horticulture	8%	33%	25%	25%	8%
	Forestry	0%	25%	13%	38%	25%
	Other Primary Sector	20%	0%	40%	20%	20%
Science/ Research		0%	6%	16%	68%	10%
Government		1%	8%	18%	38%	36%
Māori Enterprise		3%	5%	28%	43%	23%
Extension Work		0%	0%	20%	40%	40%
Smart Agriculture		0%	7%	33%	47%	13%
Other Sector		0%	25%	25%	25%	25%

Table 2-7: Level of knowledge (South Korea) by sectoral alignment, % of sector participants

		LEVEL OF KNOWLEDGE				
SECTOR	Industry	*Very knowledgeable*	*Knowledgeable*	*Some knowledge*	*Little knowledge*	*No knowledge*
Primary Sector		7%	13%	18%	40%	22%
	Meat	0%	10%	30%	30%	30%
	Dairy	5%	10%	19%	48%	19%
	Horticulture	17%	8%	8%	42%	25%
	Forestry	0%	25%	13%	50%	13%
	Other Primary Sector	25%	25%	25%	0%	25%
Science/ Research		3%	3%	13%	63%	17%
Government		0%	3%	16%	41%	40%
Māori Enterprise		3%	0%	20%	50%	28%
Extension Work		0%	0%	20%	40%	40%
Smart Agriculture		7%	0%	20%	53%	20%
Other Sector		0%	0%	0%	100%	0%

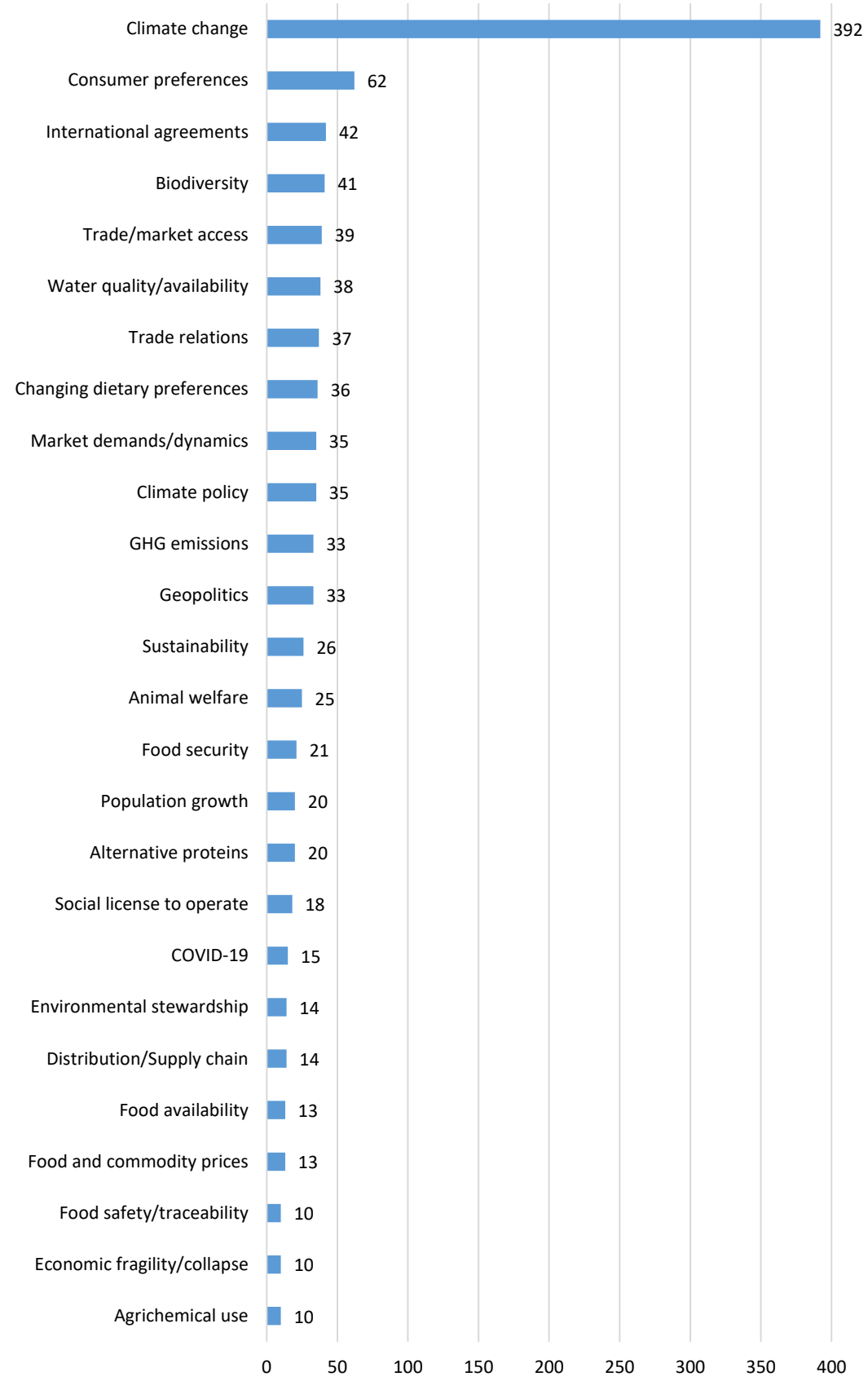
Table 2-8: Level of knowledge (United Kingdom) by sectoral alignment, % of sector participants

		LEVEL OF KNOWLEDGE				
SECTOR	Industry	*Very knowledgeable*	*Knowledgeable*	*Some knowledge*	*Little knowledge*	*No knowledge*
Primary Sector		9%	23%	38%	20%	11%
	Meat	10%	40%	20%	20%	10%
	Dairy	0%	29%	48%	10%	14%
	Horticulture	17%	17%	17%	42%	8%
	Forestry	0%	13%	63%	13%	13%
	Other Primary Sector	40%	0%	40%	20%	0%
Science/ Research		0%	13%	56%	28%	3%
Government		4%	10%	41%	27%	19%
Māori Enterprise		5%	18%	40%	25%	13%
Extension Work		0%	20%	40%	0%	40%
Smart Agriculture		7%	0%	53%	33%	7%
Other Sector		0%	25%	50%	25%	0%

2.2.1 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. These results are consistent with previous surveys in which participants identified climate change as the most highly critical international issue, with the relative importance of climate change as an international issue increasing between the previous and current surveys (Driver et al., 2018, 2019; Saunders et al., 2017). Other critical issues identified *included consumer preferences*, *international agreements*, *biodiversity*, *trade/market access*, *water quality/availability*, *trade relations*, *changing dietary preferences*, *market demands/dynamics*, and *climate policy*. The results were consistent with previous survey results (Driver et al., 2018, 2019; Saunders et al., 2017).

Figure 2-4: Critical international issues (ranked scores) (unprompted)

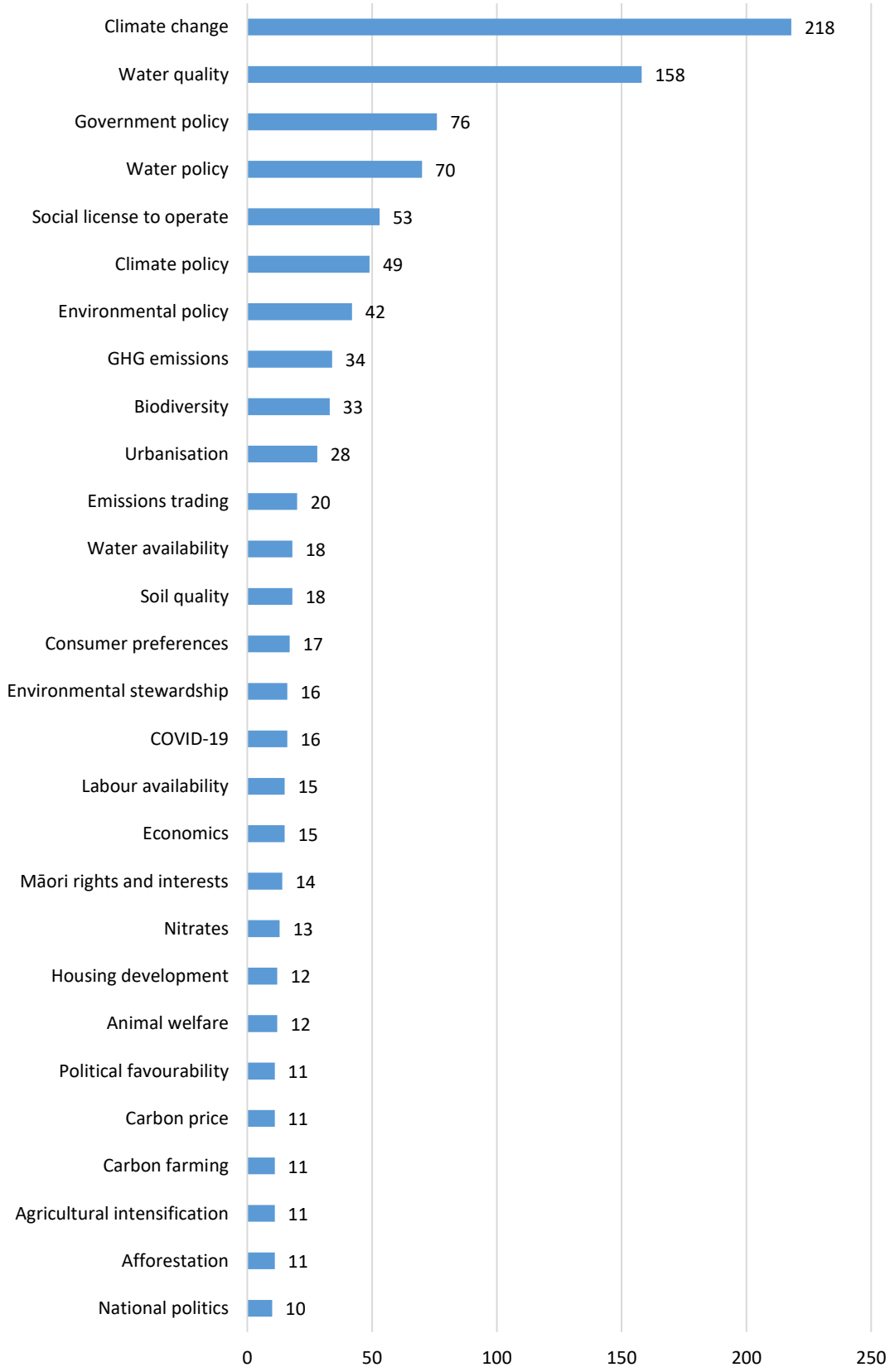


Note: Issues with scores of less than 10 are omitted from this figure.

2.2.2 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, *climate change* was indicated to be important to more participants (followed closely by *water quality*) than any other domestic issues. Other critical issues identified included *government policy*, *water policy*, *social license to operate*, *climate policy*, and *environmental policy*. These results are consistent with previous surveys in which participants identified water-related issues as highly critical domestic issues, with the exception of the increase in the importance of climate change at a domestic level (Driver et al., 2018, 2019; Saunders et al., 2017). The importance of *climate change* at a domestic level overtook *water quality* in the current study for the first time, potentially indicating the increasing focus on climate change in relation to primary production in New Zealand. In addition, issues regarding government policy, particularly related to agricultural, trade and environmental policy, were shown to be of high importance as domestic drivers of New Zealand land-use change. This could be attributed to the increasing prevalence of public discussion and policy development regarding primary production's impact on the natural environment in recent years.

Figure 2-5: Critical domestic issues (ranked scores) (unprompted)

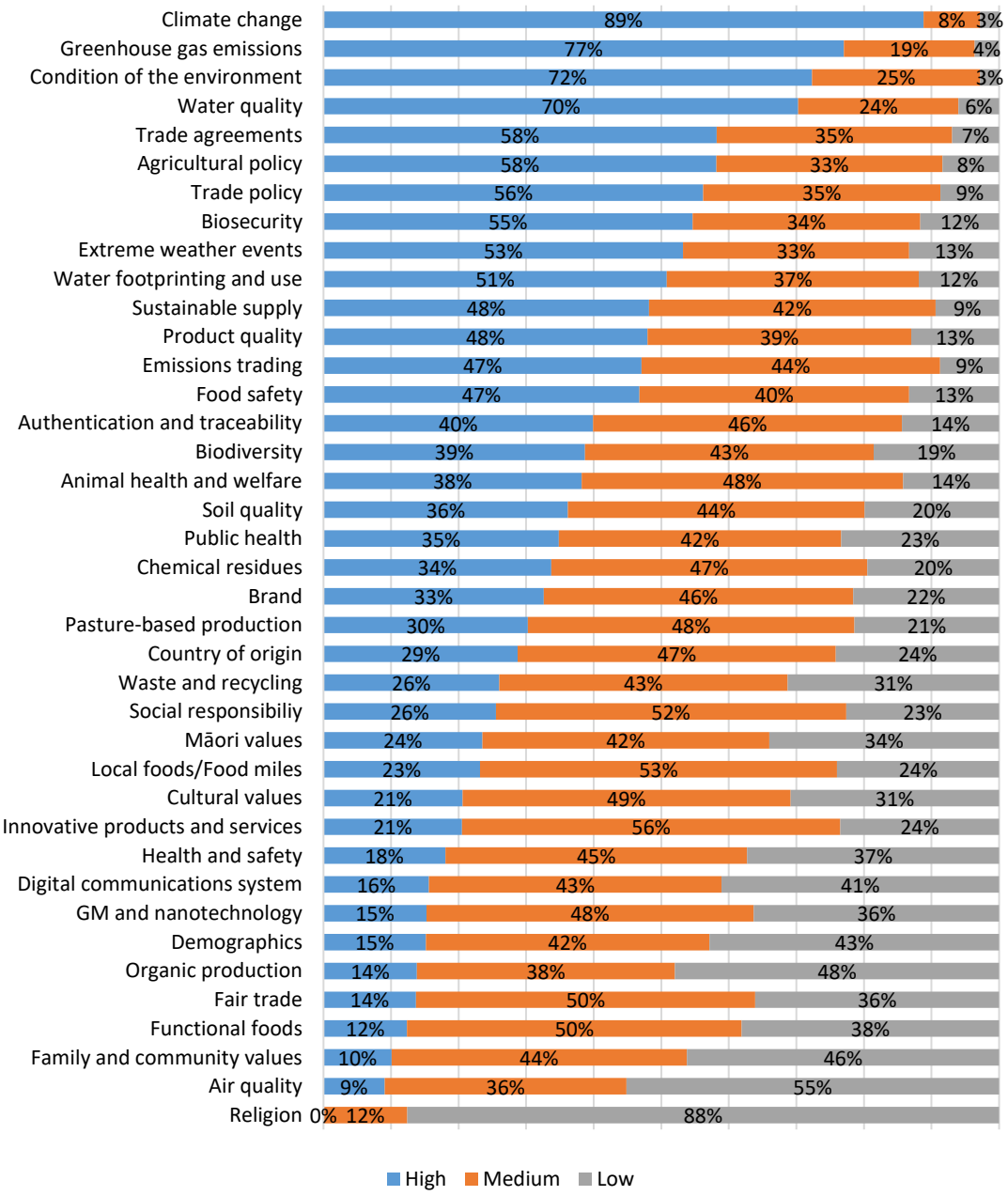


Note: Issues with scores of less than 10 are omitted from this figure.

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

Participants were then presented with a list of 39 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 89 per cent of respondents identified climate change as having a potentially high impact on New Zealand land use change/practice. This was followed by greenhouse gas emissions (77 per cent *high*, 19 per cent *medium*), condition of the environment (72 per cent *high*, 25 per cent *medium*) and water quality (70 per cent *high*, 24 per cent *medium*).

Figure 2-6: Impact of international drivers/issues on New Zealand land use change/practice

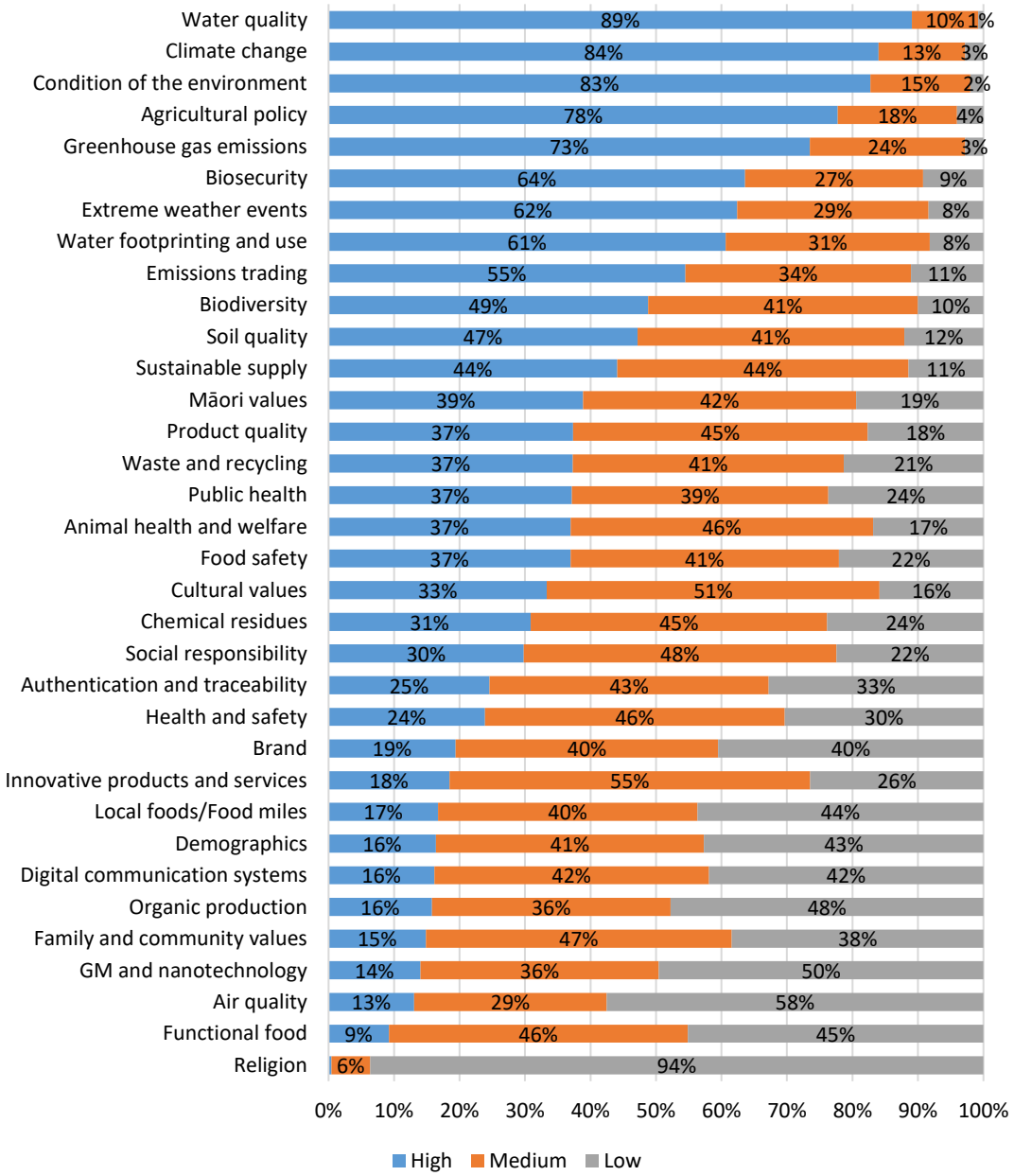


2.2.4 Impact of domestic drivers/issues on New Zealand land use change/practice

Participants were then presented with a list of 39 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 climate change (84 per cent *high*, 13 per cent *medium*) and condition of the environment (83 per cent *high*, 15 per cent *medium*).

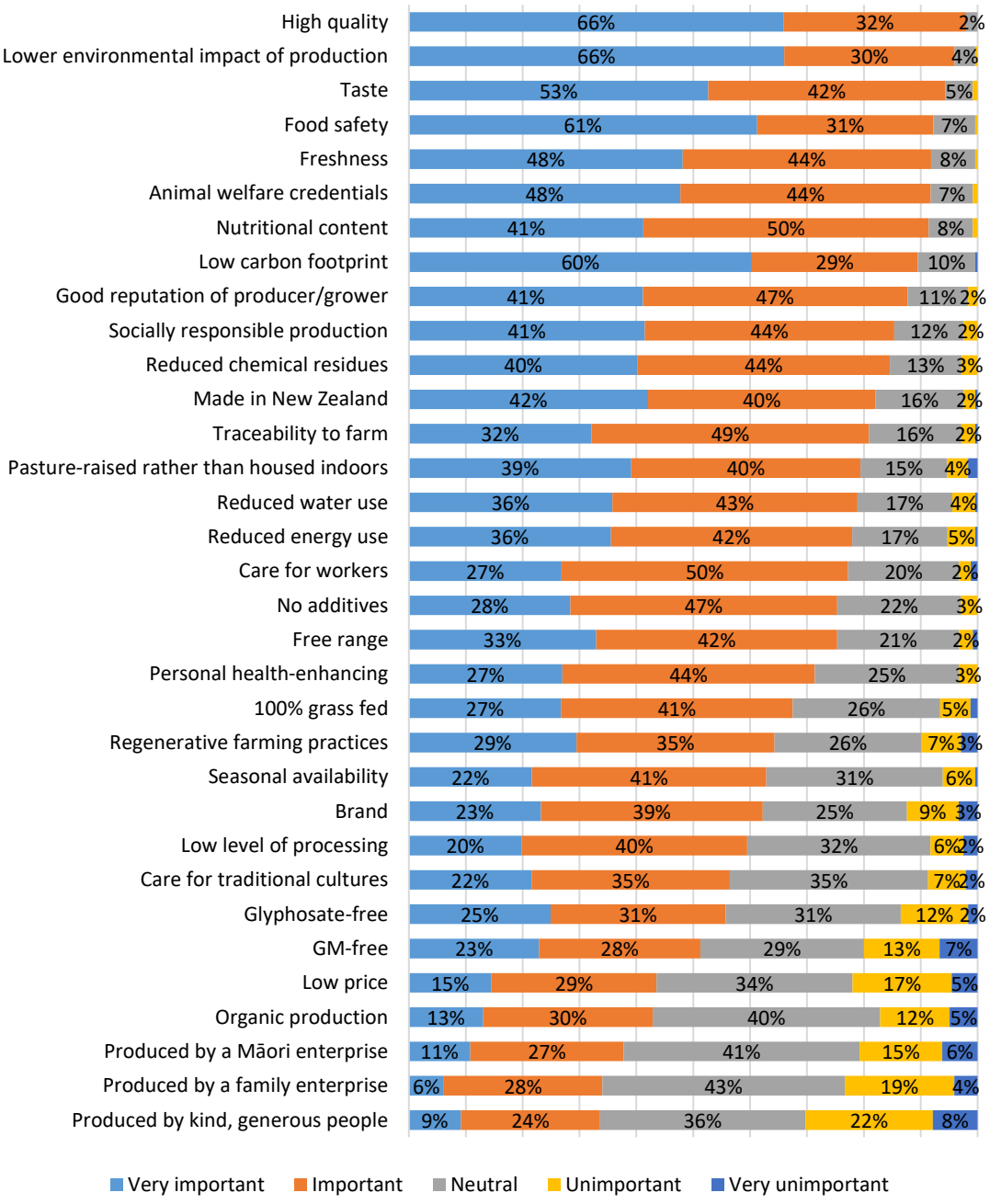
Figure 2-7: Impact of domestic drivers/issues on New Zealand land use change/practice



2.2.5 Moving from volume to value

Participants were then asked to indicate the relative importance of a range of primary product attributes in achieving higher product value from lower volume – these results are presented in Figure 2-8 below. This shows that participants rated *high quality* (66 per cent *very important*, 32 per cent *important*) as the most important product attribute in achieving higher product value from lower volume, followed closely by *lower environmental impact of production* (66 per cent *very important*, 30 per cent *important*).

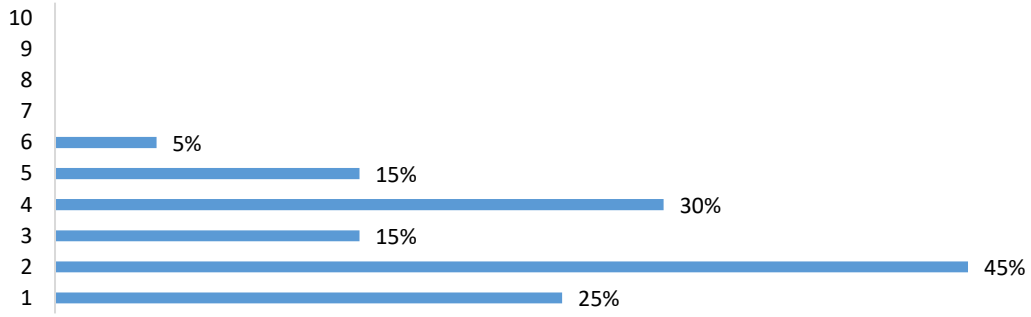
Figure 2-8: Importance of product attributes in achieving higher product value from lower volume



2.2.6 Agribusiness scheme participation

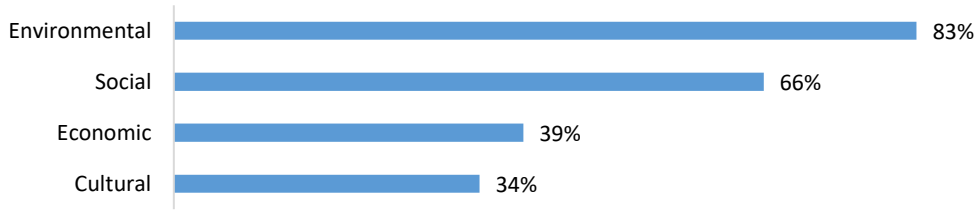
Participants were then asked to indicate their level of participation in *agribusiness schemes*. In this survey, agribusiness schemes were defined as schemes through which agribusinesses could improve quality assurance, marketing, certification, and other purposes. Examples used in the survey instrument (see Appendix) included the New Zealand Farm Assurance Programme (NZFAP) and GlobalGAP. In total, 41 participants (17 per cent) indicated that they participated in agribusiness schemes, while 205 participants (83 per cent) indicated that they do not currently participate in agribusiness schemes. Participants were also asked to indicate how many agribusinesses schemes they participated in – as shown in Figure 2-9 below, the largest proportion of participants participated in two agribusiness schemes. The responses indicate that people tend to participate in multiple schemes: only 25 per cent participated in only one scheme, while 75% participated in more than one.

Figure 2-9: Number of agribusinesses schemes participated in (n=20)



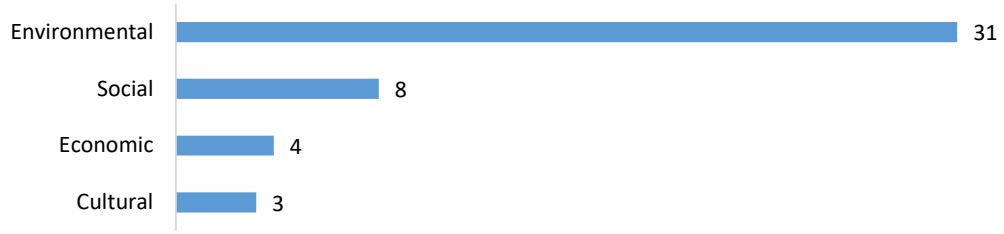
Participants were then asked to indicate whether, and the extent to which, the agribusiness scheme(s) that they participated in accounted for *environmental*, *social*, *economic* and *cultural* dimensions. As shown in Figure 2-10 below, 83 per cent of participants indicated that their scheme(s) included an *environmental* dimension, followed by social, economic and cultural dimensions.

Figure 2-10: Number of dimensions accounted for in agribusinesses scheme(s)



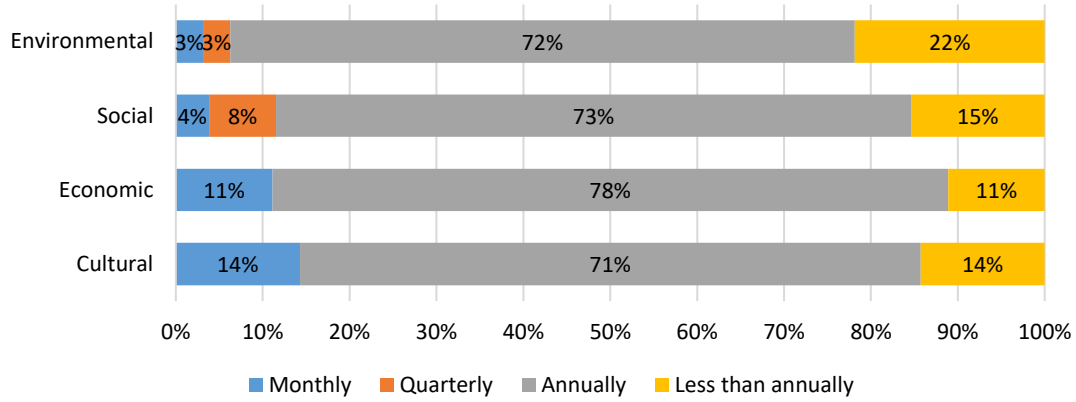
Following this, participants were asked to indicate the number of criteria considered for each dimension included within their agribusiness scheme(s) - Figure 2-11 below presents the average number of criteria indicated for each dimension. This shows that participants indicated the highest number of considered criteria within the environmental dimension (31 criteria on average), followed by social (8 criteria on average), economic (4 criteria on average) and cultural dimensions (3 criteria on average). The total range of criteria ranged for each dimension – environmental, between 3 and 300 criteria; social, between 1 and 60 criteria; economic, between 1 and 6 criteria; and social, between 1 and 6 criteria.

Figure 2-11: Number of criteria for each dimension accounted for in agribusinesses scheme(s) (average n)



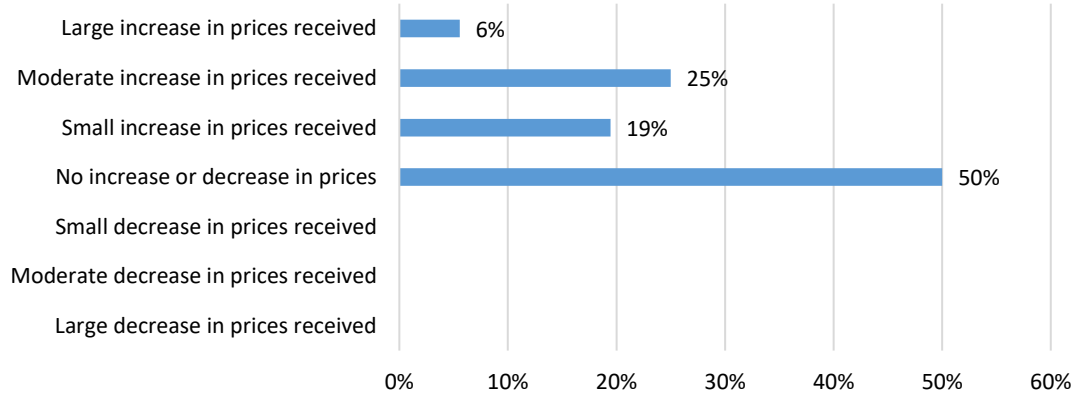
Following this, participants were asked to indicate the frequency at which they are audited for their compliance with the agribusiness scheme(s) they participate in across the above dimensions – these results are presented in Figure 2-12 below. This shows the most common audit frequency across all dimensions considered to be *annually*, followed by *less than annually*.

Figure 2-12: Audit frequency by dimension for agribusiness scheme(s)



Finally, participants were asked to indicate how their participation in agribusiness schemes affects the prices that they receive for what they sell – results are shown in Figure 2-13 below. This shows that no participants indicated a decrease in prices received for their goods as a result of participation in agribusiness schemes, with half of participants indicating neither an increase or decrease in prices received.

Figure 2-13: Impact of agribusiness scheme participation on prices received (n=36)

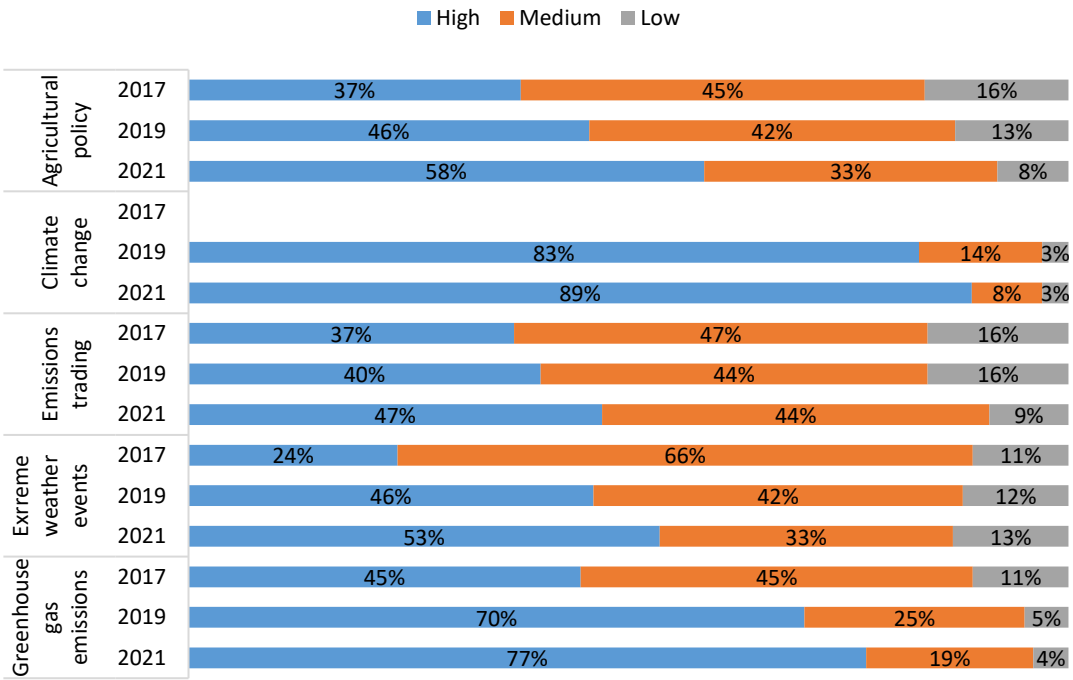


2.2.7 Discussion

A side-by-side analysis of results from previous expert surveys provides an indication of changes in the importance of international and domestic drivers of land-use change over time. In both the current and previous surveys (2017, 2019 and 2021) participants were asked to indicate the relative importance (High, Medium, Low) of a range of pre-defined international drivers of New Zealand land-use change (see Figure 2-6 above). The following analysis shows key results of changes over time across the three surveys, suggesting changing trends in the perceived importance of particular international drivers of New Zealand land-use change.

Observed across the three survey years was a shift in the importance of a range of international drivers related to climate change and associated issues – results are shown in Figure 2-14 below. This shows a relatively high importance attributed to climate change at an international level, with greatly increasing importance of related drivers, such as agricultural policy, emissions trading, extreme weather events, and greenhouse gas emissions. The increasing importance of these drivers may be related to increasing awareness of the impacts of greenhouse gas emissions from New Zealand agriculture, including the potential international reputational risk associated with greenhouse gas emissions, and New Zealand domestic policy intended to slow and sequester emissions, such as the New Zealand Emissions Trading Scheme.

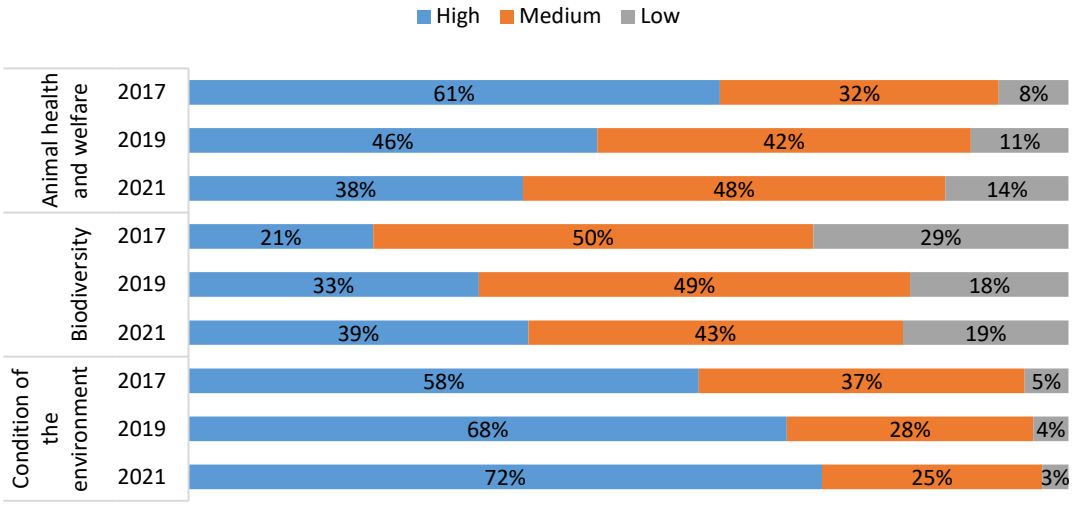
Figure 2-14: Relative importance of pre-defined international drivers of New Zealand land-use change – Climate Change



Similarly, change in the relative importance international drivers of land-use change in relation to potential consumer reputational risk over time are shown in Figure 2-15 below – specifically, animal health and welfare, biodiversity, and condition of the environment. This shows a step-wise decrease in the perceived importance of animal health and welfare as an international driver of New Zealand land-use change, and a relative increase in the importance

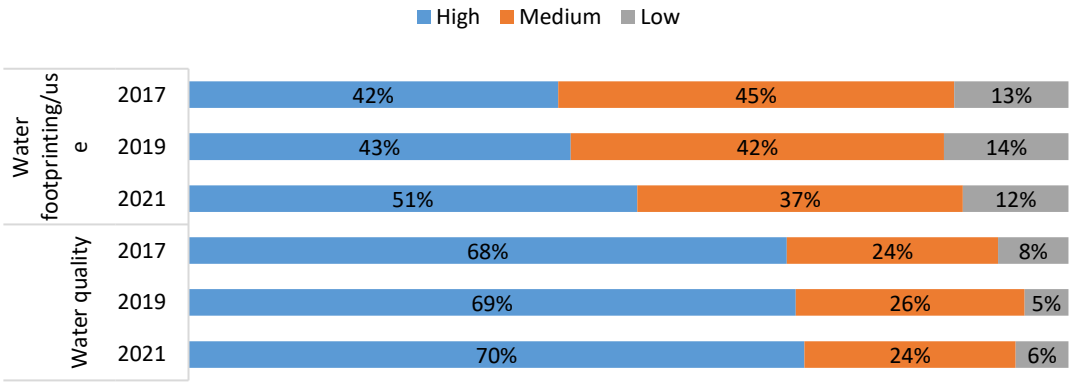
of biodiversity and condition of the environment as international drivers of New Zealand land-use change.

Figure 2-15: Relative importance of pre-defined international drivers of New Zealand land-use change – Consumer Preferences



The relative importance of international drivers of New Zealand land-use change relating to water over the three survey years is shown in Figure 2-16 below. This shows that participants rated water issues consistently highly over the three survey years, with the importance of water footprinting/use as an international driver of New Zealand land-use change increasing over time.

Figure 2-16: Relative importance of pre-defined international drivers of New Zealand land-use change – Water

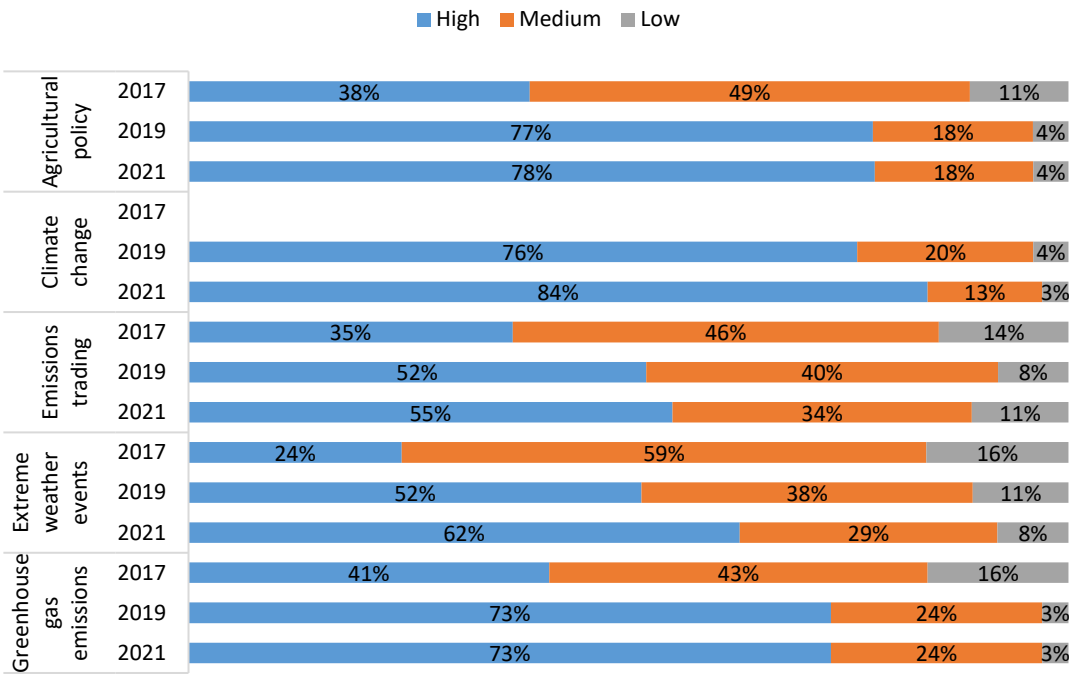


In both the current and previous surveys (2017, 2019 and 2021) participants were also asked to indicate the relative importance (High, Medium Low) of a range of pre-defined *domestic* - drivers of New Zealand land-use change (see Figure 2-7 above). The following analysis shows key results of changes over time across the three surveys, suggesting changing trends in the perceived importance of particular domestic drivers of New Zealand land-use change.

Observed across the three survey years was a shift in the importance of a range of domestic drivers related to climate change and associated issues – results are shown in Figure 2-17

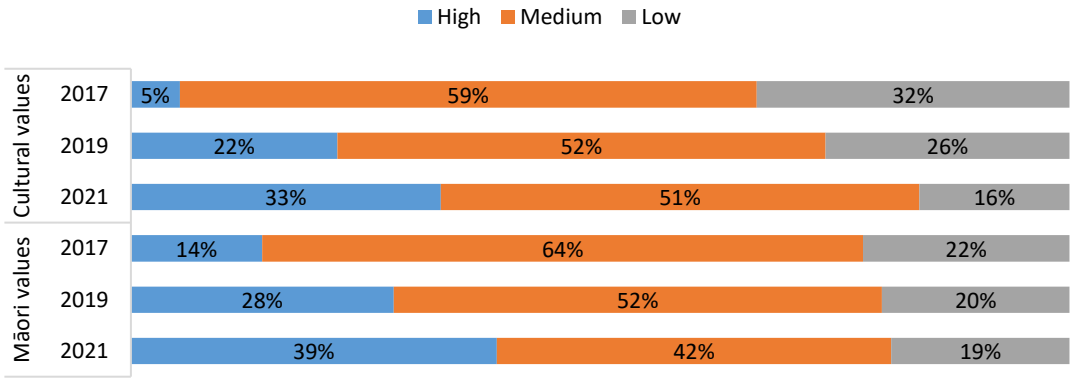
below. This shows similarly large increases in the importance of *greenhouse gas emissions* and *agricultural policy* as domestic drivers of New Zealand land-use change across the survey years. This could be attributed to increased prevalence of public discussion regarding policy approaches to curbing greenhouse gas emissions from the primary section. However, while the importance of *emissions trading* has increased over the same period, this has not kept pace with the increasing importance of *agricultural policy* and *greenhouse gas emissions*. Similarly, the overall importance of *climate change* has increased (see also Figures 2-4 and 2-5), as have *extreme weather events*, as domestic drivers of New Zealand land-use change.

Figure 2-17: Relative importance of pre-defined domestic drivers of New Zealand land-use change – Climate Change



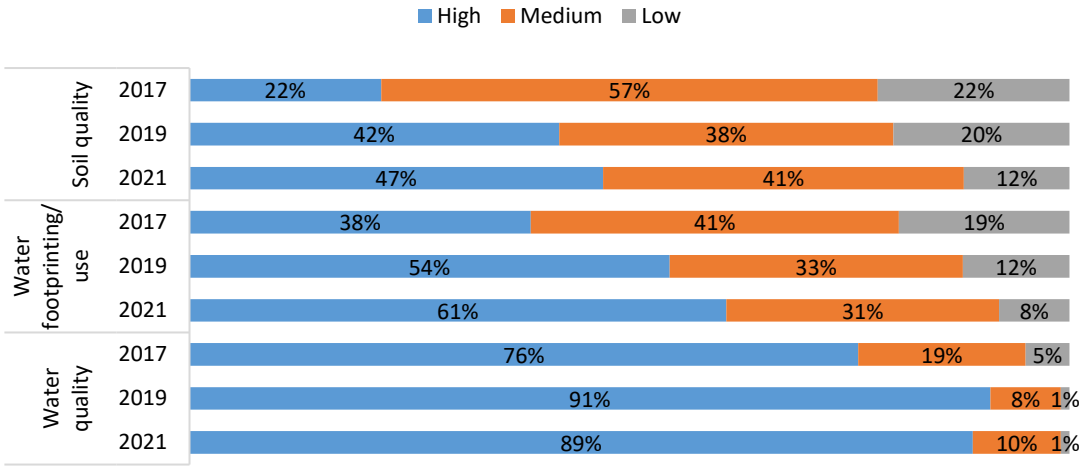
Also observed across the three survey years was a shift in the importance of cultural, and specifically Māori, values as domestic drivers of New Zealand land-use change – results are shown in Figure 2-18 below. This shows a gradual increase in the importance of both general *cultural values* and *Māori values* over time, with larger increases in the importance general *cultural values* relative to *Māori values*.

Figure 2-18: Relative importance of pre-defined domestic drivers of New Zealand land-use change – Cultural and Māori values



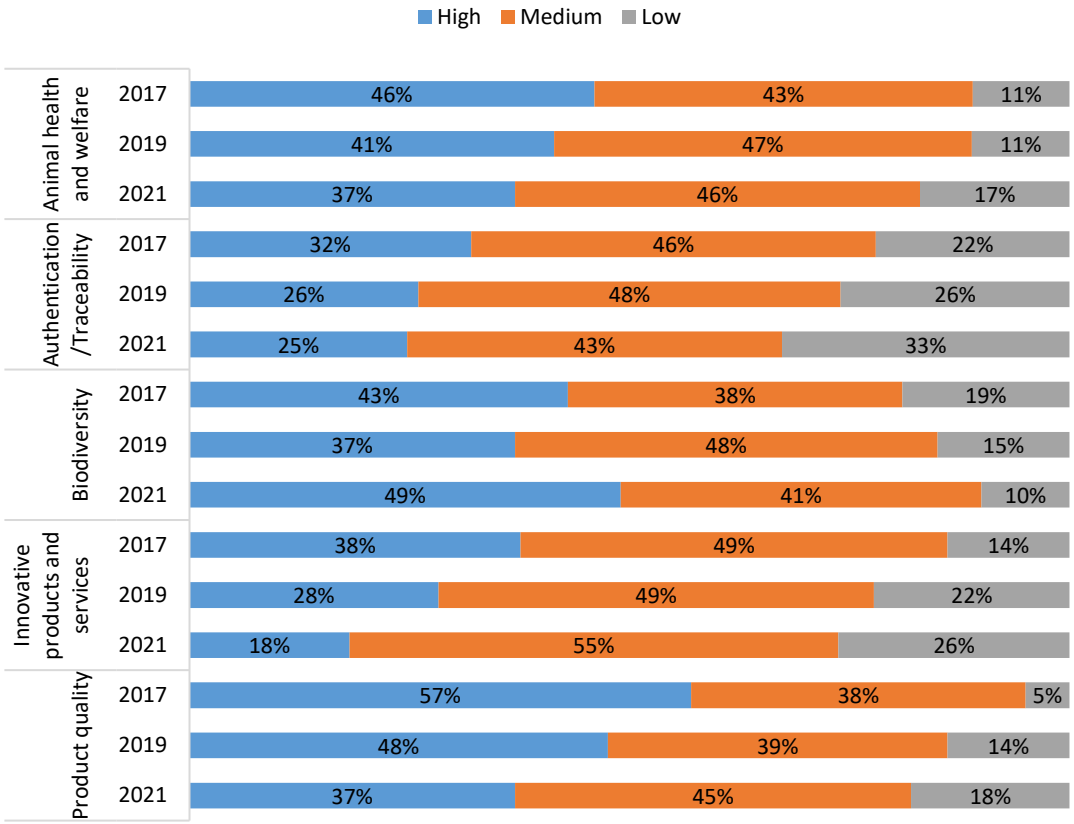
The relative importance of domestic drivers of New Zealand land-use change relating to soil and water quality/use were also examined. As shown in Figure 2-19 below, the importance of water quality as a domestic driver of New Zealand land-use change remained consistently high over the three survey years, with the relative importance of both soil quality and water footprinting/use increasing over time.

Figure 2-19: Relative importance of pre-defined domestic drivers of New Zealand land-use change – Soil and Water



Finally, domestic drivers of New Zealand land-use change relating to consumer preferences and product quality were examined – results are shown in Figure 2-20 below. This shows a relative decrease in the importance of a range of drivers, including *animal health and welfare, authentication/traceability*, *innovative goods and services*, and *product quality* over time. This could be caused by a perceived shift in consumer preferences away from traditional ethical and product quality-related attributes to more environmentally-focussed concerns, such as climate change. In addition, the relative importance of biodiversity remained high over the three survey years, with a relative uptick in importance shown between 2019 and 2021. This could be partially attributed to the development and implementation of New Zealand biodiversity policy, including Te Mana o te Taiao, and the proposed National Policy Statement of Indigenous Biodiversity.

Figure 2-20: Relative importance of pre-defined domestic drivers of New Zealand land-use change – Consumer Preferences and Product Quality



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 primary sector contributes around 8 per cent of gross domestic product (GDP), which rises to nearly 20 per cent if downstream and processing industries are included. It is a significant proportion of New Zealand's exports at nearly 80 per cent in 2018/19. The Ministry for Primary Industries (MPI) outlined the value of primary exports for the year ending June 2021, fell 1.1 per cent to NZ$47.5 billion (MPI, 2021d). It has forecast for the year ending June 2022, export revenue will rebound and reach a record NZ$49.1 billion as demand slowly recovers for the main export market products and market destinations; while revenue is estimated to reach NZ$53.1 billion by 2025 (MPI, 2021d). New Zealand's primary sector aims to continue achieving strong export returns while simultaneously addressing local and global trends and challenges. This chapter will examine the key future trends and challenges that have the potential to impact primary land use change/practice in New Zealand.

3.1 Climate Change

3.1.1 Extreme Weather Events

Climate change is likely to increase the frequency and intensity of extreme weather events such as heatwaves, fires, droughts, dust storms, precipitation, and flooding (IPCC, 2021). These have the potential to negatively affect food security and significantly impact land use change/practice. Extreme weather events are likely to cause reductions in total yield for many staple crops, thereby negatively affecting food security (IPCC, 2021). Lesk et al. (2016) estimated that extreme weather events were responsible for approximately 9-10 per cent reductions in cereal production losses internationally between 1964 and 2007 and believed the frequency and intensity of these events would likely increase under climate change. Lesk and Anderson (2021) outlined that extreme heat and drought often reduce important food crop yields around the world, putting additional stress on regional and global food security. The study suggests that the global climate is transitioning from one in which concurrent heat and drought occur rarely to one in which they occur over an important area of croplands every year (Lesk & Anderson, 2021). The Intergovernmental Panel on Climate Change (IPCC) also concluded in their latest report (2021) that anthropogenic influences have increased the chance of compound extreme events since the 1950s. The report stated that: *"human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened, [since the previous report]"* (IPCC, 2021, p. 10).

There have been several well-documented extreme weather events around the globe in recent times. Bushfires in Australia and California attracted considerable attention due to the unprecedented scale of damage and the underlying links to anthropogenic climate change. The 2019-2020 Australian bushfire season resulted in over 17 million hectares burnt across New South Wales, Victoria, Queensland, Western and Southern Australia, and Capital territories. These events claimed 28 human lives, over 1.25 billion animals, damaged over 3,000 homes, and caused a total economic loss of over AU$110 billion (Deb et al., 2020). Sanderson and Fisher (2020, p. 176) outlined that higher temperatures will likely result in

more fire-prone conditions, stating that: *"Mean warming levels are now sufficiently large that many high-temperature extreme events would be impossible without anthropogenic influence, and they can be reliably projected to become more intense in the future"*. California also experienced significant bushfires during 2021.The Californian State Department of Forestry and Fire Protection (CAL FIRE) estimated that 4.25 million acres of land was burned (more than 4 per cent of the state's total land area), making 2020 the largest fire season in the state's modern history (Department of Forestry and Fire Protection, 2021). Europe has also experienced several extreme weather events in recent years. In July 2021, flash flooding caused extensive damage for some countries on the continent. In Germany, over 100 people were reported to have died, while reconstruction costs were estimated at around EU €6 billion. Climate change will likely mean more flooding in Europe. According to the European Commission's Joint Research Centre, it is estimated that flood damages could cost as much as EU €48 billion each year by 2100, up from the current cost of EU €7.8 billion (Cornwell, 2021).

Agricultural systems are sensitive to changes, due to their dependence on stable, long-term climatic conditions in which current land-use practises were developed, and through impacts on production, yield, and quality (Cradock-Henry et al., 2020). Anthropogenic climate change will increase the frequency and intensity of extreme weather events, which will likely have a negative impact on agricultural systems and cause disruptions to existing supply chains (IPCC, 2021). For example, Beillouin et al. (2020) expressed concern that extreme weather would increase the risk of large-scale crop failures.

New Zealand's primary sector is already confronting extreme weather events/patterns. Recent flooding events in Canterbury had a significant impact on farming communities, causing extensive damage to infrastructure and livestock. It was estimated that NZ$8-10 million would be required to remove shingle on farming land brought up by the floods (Porter & McDonald, 2021). These types of extreme weather events will continue to impact future land use change/practise across New Zealand's primary industries including meat, diary, horticulture, viticulture, wool, and forestry.

3.1.2 Response to Climate Change

In August 2021, the Intergovernmental Panel on Climate Change (IPCC) released their latest report titled *Climate Change 2021: the Physical Science Basis*. This was the first instalment of the IPCC's Sixth Assessment Report (AR6), which is scheduled for completion in 2022. The report outlined that many of the climatic changes observed are unprecedented, and some of the changes set in motion are irreversible over hundreds or even thousands of years (IPCC, 2021). The authors of the report stated: *"It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred"* (IPCC, 2021, p. 5).

The report noted that strong and sustained reduction in carbon dioxide (CO_2) emissions could help to limit climate change. The associated benefits for improved air quality would likely arrive quickly; however, it could take 20-30 years to see global temperatures stabilise. The report also noted that unless there are immediate, rapid, and large-scale reductions in greenhouse gas (GHG) emissions, limiting warming to 1.5 degrees or even 2 degrees will be unattainable (IPCC, 2021). The report projected that in the coming decades climate change will intensify in all regions. For 1.5 degrees of global warming, there will be increasing heat waves, longer warm seasons, and shorter cold seasons. At 2 degrees of global warming, heat extremes would be more often reach critical tolerance thresholds for agriculture. The impact

of climate change will likely vary between regions. Climate change will also intensify the water cycle, bringing more intense rainfall and droughts. Rainfall patterns will be affected, and in the higher latitudes precipitation is likely to increase, while it is projected to decline in parts of the subtropics.

In 2021, the United Kingdom hosted the 26th United Nations Climate Change Conference of the Parties (COP26) in Glasgow. The parties are the signatories of the United Nations Framework Convention on Climate Change (UNFCCC). COP26 set out several objectives including to:

1) Secure global net zero by mid-century and keep 1.5 degrees within reach by accelerating out of the use of coal, curtailing deforestation, speeding up the transition to electric vehicles, and encouraging investment in renewables;
2) Employ adaption measures to protect communities and natural habitats;
3) Ensure that at least US$100 billion is mobilised to combat climate change in developing countries;
4) Collaborate to finalise the Paris Rulebook and accelerate action to tackle climate crisis (UKCOP26, 2021).

The COP26 summit had several notable outcomes that included a commitment from India to reach net-zero emissions by 2070, a pledge from 141 countries to halt/reverse forest loss and land degradation, and 109 counties signed to the 'Global Methane Pledge', which aims to reduce methane emissions by 30 per cent (World Research Institute, 2021). Minister of Climagte Change James Shaw announed that New Zealand had signed on to reduce its methane emissions, stating that *"New Zealand is placed to be part of a global initiaitve […]. New Zealand aims to cut biogenic methane emissions by 10 per cent on 2017 levels by 2030 and by between 24 to 47 per cent lower by 2050"* (Shaw, 2021). At present, methane contributes 43.5 per cent of New Zealand's overall GHG footprint, with agriculture responsible for 85.5 per cent of these emissions (Statistics New Zealand, 2020). The government has introduced a partnership called *He Waka Eke Noa* that will create a system to measure and price on-farm biogenic emissions.

In 2015, the Paris Climate Agreement was adopted by 195 countries, a legally binding international climate agreement, which entered into force on November 4th 2016. It was signed with the intention of participating countries to hit 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, 2021b). To date, 190 countries and the European Union have joined the Paris Agreement. At time of writing, Turkey, Iraq, Iran, Yemen, Eritrea, and Libya are still yet to ratify the agreement. In 2017, the US President Donald Trump notified the UN of the intention of the US to withdraw from the Paris Climate Agreement, claiming that participation disadvantaged the US to the exclusive benefit of other countries (Bowen et al., 2020). On November 4th 2019, the US Government initiated the withdrawal from the Agreement, which was completed on 4th November 2020. On January 20th 2021, this was reversed as newly elected President Joe Biden re-joined the agreement and announced renewed support for measures to combat climate change (White House, 2021b).

A recent report conducted by the independent group Climate Action Tracker observed that almost every country is falling short of their commitments under the Paris Climate Agreement (Climate Action Tracker, 2021b). New Zealand has committed to reducing its GHG emissions to 30 per cent below 2005 levels by 2030 (MfE, 2021d). As of September 2021, the Climate

Action Tracker views New Zealand's efforts towards cutting GHG emissions as *'highly insufficient'* (Climate Action Tracker, 2021c). This means that New Zealand's climate policies and current rate of emissions are likely to track towards the 3°C of global warming. As deadlines approach and expectations of action rise, there has been pressure on New Zealand from other countries to cut GHG emissions within New Zealand's GHG emissions profile (Newshub, 2021).

3.1.3 New Zealand Domestic Policy/Agricultural Emissions

The legislation guiding New Zealand's efforts to combat climate change is the Climate Change Response Act (2002), which was developed to meet obligations under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. In 2019, this was amended to the Climate Change Response (Zero Carbon) Amendment Act. These amendments set targets for reducing all GHG emissions (excluding biogenic methane emissions) to net zero by 2050, with targets for reducing biogenic methane emissions to 10 per cent below 2017 levels by the year 2030 (MfE, 2019). In 2020, the Climate Change Response (Emissions Trading Reform) Amendment Act was passed to support New Zealand's efforts to move to a low-emissions, climate-resilient economy (New Zealand Parliament, 2020). This introduced a new penalty regime and set out new provisions for forestry. It also included decisions to address New Zealand's agricultural emissions, committing the primary sector to have a system for farm-level accounting and reporting of agricultural GHG emissions for all farms by 2025. This framework is being developed by *He Waka Eke Noa*, a primary sector climate action partnership between the New Zealand Government, the primary sector, and iwi (MPI, 2021a). The partnership seeks to equip and empower farmers and growers to measure, manage and reduce agricultural GHG emissions, including biogenic methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2). In 2022, a report will be provided to the New Zealand Government detailing a framework for an appropriate emissions pricing system. A broad nationwide engagement will be conducted with farmers and growers, seeking feedback on the options of a *'farm-level levy'* and *'processor-level hybrid levy'*. The first option (farm-level levy) would involve farmers calculating emissions using on-farm data and require farms to pay a price for their net emissions. This approach would reward eligible on-farm sequestration, while any additional revenue would be invested to help further reduce emissions in the agricultural sector. The second option (processor-level hybrid levy) would calculate emissions at the processor level and would pass on costs based on the quantities of product supplied to processors or fertiliser brought by farms (RNZ, 2021c). The New Zealand Government has legislated that agricultural emissions will enter the New Zealand Emissions Trading Scheme if an effective and workable alternative is not put forward by the partnership (He Waka Eke Noa, 2021). The legislation of emissions reduction targets will likely impact land use in New Zealand (particularly primary production) by requiring land-users to adapt practices to meet legal requirements.

The incumbent Labour Government has made changes to legislation concerning the environment and climate change. In 2020, Prime Minister Jacinda Arden declared a climate emergency and committed that by 2025 the New Zealand Government and public sector would be carbon neutral, backed by a NZ$200 million State Sector Decarbonisation Fund. In Feburary 2021, the New Zealand Government announced its decision to repeal the Resource Mangement Act 1991 (RMA) and enact new legislation based on recommendations made by a Resource Manangement Review Panel (MfE, 2021c). There were three proposed acts including the Natural and Built Environments Act (NBA), Strategic Planning Act (SPA), and the Climate Adaptation Act (CAA). The CAA will support New Zealand's response to the effects of

climate change, addressing the complex legal and technical issues associated with managed retreat and funding/financing adaption to climate change (MfE, 2021c). The SPA will provide a long-term approach to the management of land and coastal marine areas, and will identify areas vulnerable to the effects of climate change.

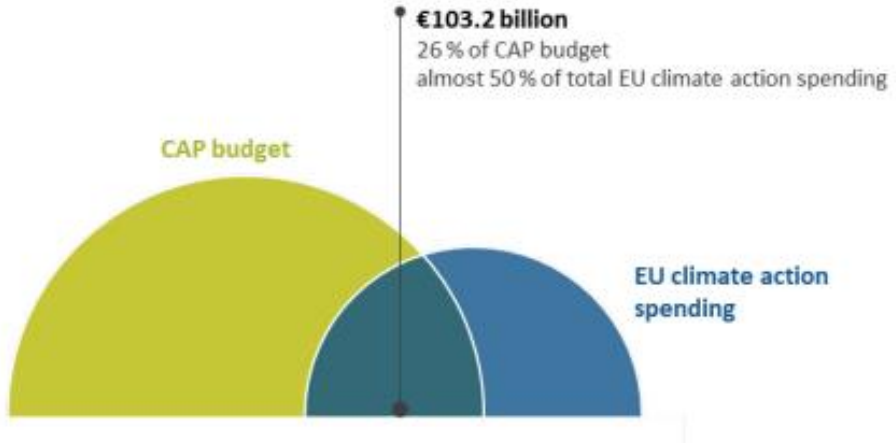
3.1.4 International Climate Change Policy/Legislation

Climate policies are being steadily implemented internationally. The United States under President Joe Biden recently re-entered the Paris Climate Agreement. As part of re-entering, Biden established new emissions reduction targets through the National Climate Task Force. Accordingly, the US seeks to achieve a 50-52 per cent reduction from 2005 levels in economy-wide net GHG emissions by 2030 (White House, 2021a). The European Union (EU) recently engaged in talks that discussed reforms to the Common Agricultural Policy (CAP). Since 2013, climate change mitigation and emissions reduction has been a primary objective of the CAP. In 2021, a special report released by the European Court of Auditors outlined that over EU €100 billion of CAP funds provided for climate change efforts during 2014-2020 had little impact on agricultural emissions since 2010 (see Figure 3-1 below) (European Court of Auditors, 2021). This was attributed to a primary focus on financing measures with low potential to mitigate climate change. The report recommended that the European Commission do the following:

1) take action to ensure that the CAP reduces agricultural emissions;
2) take measures to reduce emissions from cultivated drained organic soils; and
3) regularly report on the CAP's contributions to climate mitigation (European Court of Auditors, 2021).

In 2021, negotiations focused on reforms that would support agriculture making stronger contributions to the climate goals of the European Union's Green Deal (MFAT, 2021b). The scheme is supported financially by EU €387 billion allocated between 2021 and 2027, of which 40 per cent is required to be 'climate relevant' (European Commission, 2021a). Incoming CAP rules that seek to reduce total EU agricultural emissions by 10 per cent will apply from 2023 (Melander, 2021).

Figure 3-1: Contributions of Common Agricultural Policy to Climate Change according to the European Commission, 2014-2020.



Source: European Court of Auditors, 2021.

In 2020, the Canadian government announced a ten-year CA$3.16 billion fund to combat climate change (Department of Finance Canada, 2020). The fund will be used to support the planting of two billion trees by 2030, with aid already provided during the COVID-19 pandemic that allowed for approximately 600 million trees to be planted in 2020 (Government of Canada, 2021). In 2020, China announced its intention to become carbon neutral before 2060, proposing new climate targets (Climate Action Tracker, 2021a). China also published its 14th Five Year Plan (FYP), which included energy- and carbon-intensity reduction targets for 2025. President Xi Jinping later announced that China would be strictly controlling its coal generation until 2025, from which point it will start to slowly phase out its use. This is the first time that China has signalled a strong intent to decouple economic growth from coal, as well as the first time it has suggested a specific year for peak coal consumption (Climate Action Tracker, 2021a).

3.1.5 Climate Investment Funds/ESG Investing/Sustainable Finance

There has been a strong movement within the banking and investment sector towards sustainable finance and investing using ethical, social and governance (ESG) criteria. Investors are currently seeking to make investments that generate returns while also having positive social, economic, and/or environmental impacts. Bank of New Zealand (BNZ) chief executive Angela Mentis outlined that their bank *"will increasingly seek to use environmental, social, and governance (ESG) linked lending with New Zealand farmers, agribusinesses, and other sectors to help meet New Zealand's climate change obligations"* (BNZ, 2021). The Aotearoa Circle group has established a sustainable agriculture finance initiative (SAFI) - a programme that seeks to develop a definition and classification system for sustainable agriculture that can be used by the financial sector when considering lending and investment options (The Aotearoa Circle, 2021). SAFI will also align with emerging international frameworks and sustainability standards used by New Zealand farmers and growers. New Zealand's primary sector and land users may have to adapt existing, or adopt new, land use practises to gain investment or access to lending/credit from banks in the future.

International institutions are also seeking to enable and direct finance/capital towards initiatives and investments that will likely influence land use change and/or practise. For example, the European Union (EU) has issued a sustainable finance strategy and framework. This will help guide the flow of private finance towards sustainable economic activities and will enable the transition towards a carbon neutral economy by 2050. The EU Platform on Sustainable Finance is an expert group established to advise the European Commission on the development of a sustainable finance market. In 2021, the group released a report on transition finance that detailed how the Commission can enable financing from companies and other economic actors working to improve their environmental footprint (European Commission, 2021c). The United Nations has also launched the Land Use Finance Programme (UNLUFP) to proactively unlock and upscale private finance from banks, investors, and agribusinesses directed towards sustainable land use. It has established partnerships with banks, including BNP Paribas and Rabobank, which have contributed significant funds to preventing deforestation and promoting inclusive commodity production (UNEP, 2021a).

3.2 New Zealand's Environmental Policy

3.2.1 Significant Natural Areas (SNAs)

Significant natural areas (SNAs) are areas that contain significant indigenous flora and/or fauna, and are required to be protected under the Resource Management Act (RMA) 1991, Section 6 (RNZ, 2021f). SNAs have been under increased scrutiny across New Zealand. There

have been concerns in some sectors that SNAs on private land could affect land use practises, causing issues for current landowners. Māori have also voiced strong concerns over SNAs, citing land appropriations by previous New Zealand governments. The Far North District Council halted the establishment of SNAs after a large hīkoi protested proposed changes. In 2020, former Conservation Minister Eugenie Sage ruled out direct government compensation for landholders with large SNAs; however, pointed out that landholders could potentially use the Native Heritage Fund to facilitate the purchase of land (RNZ, 2021f). It has also been suggested that SNAs may impact land use practise/change; however, it has been suggested that existing practises (e.g. bee keeping or tourism) could potentially continue if these do not negatively affect the land. Minister for the Environment James Shaw estimated that around 60 per cent of local councils had identified potential SNAs. The draft National Policy Statement for Indigenous Biodiversity (NPSIB) is seeking to provide clarity on the identification of SNAs. Councils with existing SNAs will have three years to comply, while those that do not have SNAs will have five years to comply. SNAs will likely continue to be a pressing issue that could affect land use over the coming years as local/regional council bodies seek to implement these new policies.

3.2.2 Freshwater Management Policy

In 2020, the Labour government introduced new legislation under the banner of Essential Freshwater: Action for Healthy Waterways (New Zealand Government, 2020). This legislation package seeks to stop further degradation of freshwater resources and improve water quality within a five-year period. It also looks to reverse past damages and bring waterways and ecosystems back to a healthy state within one generation (MfE, 2021a). New rules and regulations include:

1) a National Policy Statement for Freshwater Management (NPSFM) (2020);
2) National Environment Standards;
3) stock exclusion regulations;
4) regulations for the measurement and reporting of water takes (MfE, 2021a).

The NPSFM introduces new regulations that will guide government efforts to restore waterways. These requirements include managing freshwater in a way that gives effect to Te Mana o Te Wai. This will be achieved through the involvement of tāngata whenua, prioritising the health and wellbeing of waterbodies, and working alongside tāngata whenua and communities to set out long-term visions within Regional Policy Statements (MfE, 2021b). The NPSFM expands the national objectives framework through the inclusion of two additional values – *threatened species* and *mahinga kai*. These join *ecosystem health* and *human health for recreation* as values that are compulsory to uphold (MfE, 2021b). New regulations also place tougher bottom lines for ammonia and nitrate toxicity attributes to protect 95 per cent of species (up from 80 per cent) from toxic effects.

The new National Environmental Standards regulate primary land use activities that pose risks to freshwater and ecosystem health (see Table 3-1 below). The standards set out minimum levels for feedlots and other stockholding areas, improve practises for intensive winter grazing of forage crop, and restrict further agricultural intensification (until the end of 2024). It also places limits on the discharge of synthetic nitrogen fertiliser on land and requires the reporting of fertiliser use. Regulations have also been introduced that aim to reduce damages caused by stock in waterways. These new rules apply to the owners of beef cattle, dairy cattle, deer, and pigs, and require stock to be excluded from wetlands, lakes, and rivers that are more than 1 metre wide. Stock must also be excluded from the beds of lakes, rivers, and wetlands, and

cannot be on land closer than 3 metres to these waterbodies. In addition, stock (excluding deer) can only cross waterways using dedicated bridges or culverts, unless crossing no more than twice a month (MfE, 2021a). There are also new water measurement and reporting regulations - these apply to holders of water permits that allow freshwater to be taken at a rate of 5 litres/second or more. A new staged timeline requires these holders to:

1) measure their water use every 15 minutes;
2) store their records;
3) electronically submit their records to their council every day (MfE, 2021a).

The new freshwater regulations will likely have a significant impact on primary land use practise in New Zealand as land users adopt these new requirements.

Table 3-1: Summary of implementation timeline for freshwater National Environmental Standards

Action	Period of Implementation
Interim controls on intensification	2020-2024[1]
Wetland protection (earthworks, drainage, vegetation clearance, etc)	2020-2023[2]
Winter grazing standards met (area, slope, pugging, resowing, buffers) through Intensive Winter Grazing farm plan module or resource consent	2020-2021[2]
Nitrogen fertiliser cap (190 kg N/ha/year)	2021-2022[2]
Stock holding area standards (feed, winter, standoff, loafing pads)	2020-2021[2]
Farm plans (starting with priority catchments)	2022-2026[2]
Real-time water use reporting (>20 L/sec)	2022-2024[2]
Real-time water use reporting (>10-20 L/sec)	2024-2026[2]
Real-time water use reporting (>5 L/sec)	2026[2]

[1] Ends at set date. [2]Policy will continue into future.
Source: Adapted from Federated Farmers, 2021a.

3.3 COVID-19

The COVID-19 pandemic has been a significant issue confronting the global community since late 2019. New Zealand initially adopted an elimination strategy hallmarked by a *"go hard and go early"* approach (Baker et al., 2020; Gray, 2020). The first case of COVID-19 was detected in New Zealand in February 2020, and several Level 4 lockdowns have occurred over the past 18 months. The ongoing COVID-19 pandemic has presented significant challenges for New Zealand's economy due to the emergence of new virus variants, deteriorating global economic outlooks, supply chain disruptions, and extended border closures (MBIE, 2021). The Reserve Bank of New Zealand (RBNZ) estimated that containing COVID-19 has had a considerable impact on GDP (refer to Table 3-2 below) (RBNZ, 2020). At Alert Level 4, it was estimated that GDP was approximately 37 per cent lower than it would have been without any restrictions. Over a four and half week period, this equated to NZ$10 billion of lost production, reducing New Zealand's annual GDP by 3.2 per cent (RBNZ, 2020).

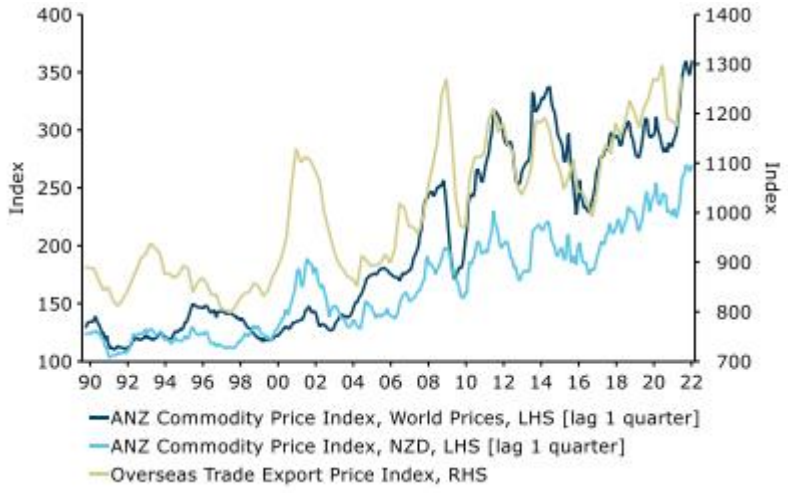
Table 3-2: New Zealand GDP reduction under COVID-19 Alert Levels

Alert Level	GDP reduction (%)
1	3.8
2	8.8
3	19.0
4	37.0

Source: RBNZ, 2020

The COVID-19 pandemic has presented significant challenges for New Zealand's primary sector; however, the sector has also shown considerable resilience and strength compared to other sectors of the New Zealand economy. In addition, there have significant commodity price increases for primary products, including dairy, meat, and fibre products, which reflected strong underlying demand (see Figure 3-2 below) (ANZ, 2021). Border closures have restricted the inflow of seasonal and skilled workers causing labour shortages that have affected industries including dairy, wine, kiwifruit, apples, and cherries (MPI, 2021d). A survey carried out in 2021 by Federated Farmers and DairyNZ showed that 49 per cent of surveyed farmers were short-staffed, while 87 per cent had made changes to attract local employees (DairyNZ, 2021). Dairy farmers found recruiting staff the most challenging of all industries, with an 18.5 per cent increase in those finding it harder to obtain workers compared to six months ago (Federated Farmers, 2021b). Shortages in labour availability are expected to be resolved over time as more workers are able to gradually enter the country (MPI, 2021d).

Figure 3-2: ANZ Commodity Price Index



Source: ANZ, 2021.

Ongoing supply chain disruptions around the world are influencing the movement of goods across border for both air and sea freight. Port congestion and shipping delays due to reduced freight capacity and a critical shortage of containers continue to be issues, domestically and abroad. COVID-19 outbreaks have also shut ports and led to slower freight processing due to necessary safety precautions (e.g. social distancing). For New Zealand, this had led to an increased risk of perishable products spoiling before they reach customers, or reduced shelf life for some of New Zealand products. Given the strong demand for shipping containers and limited shipping capacity, major trans-shipment ports are experiencing delays.

In New Zealand, the ports of Auckland have been heavily congested since December 2020, and shipping companies have been deploying additional vessels to move empty containers to other regions (MPI, 2021d). Problems with the port's automation systems have also contributed to the delays and congestion (RNZ, 2021a). Increasing shipping costs, shipping delays, and a container shortage are all putting upward pressure on import prices for key primary sector inputs, such as machinery, fertilisers, and feed - as a result, farmers, growers, and processors are facing higher production costs. Companies within the primary sector have been significantly impact by the pandemic. For example, Zespri Kiwifruit exports to China were temporally halted after products tested positive for COVID-19. Although this was resolved quickly, it highlighted some of the risks associated with the pandemic for New Zealand's primary sector (RNZ, 2021e). MPI estimated that food and fibre sector export revenue could fall 1.1 per cent in 2021 to NZ$47.5 billion (MPI, 2021d). For the year ending June 2022, MPI has forecast that export revenue will rebound to around NZ$49.1 billion as demand recovers for the country's main export products and destination markets (MPI, 2021d).

MPI has supported the primary sector during the pandemic with initiatives such as the 'Opportunity Grows Here' campaign. This sought to encourage New Zealanders into jobs in the food and fibre sector, and includes jobs such as citrus picking, kiwifruit packing, seafood processing, planning trees, and pruning vines (MPI, 2021d). In 2020, MPI launched the 'Fit for a Better World – Accelerating out Economic Potential' roadmap last year to boost productivity, sustainability, and jobs. MPI brought forward almost NZ$96 million to kick-start the delivery of the roadmap, including $84 million to upscale Sustainable Food & Fibre Futures (SFF Futures) to further boost innovation efforts, on top of the NZ$40 million already available each year (MPI, 2021d). The New Zealand Government also set aside NZ$600 million for an aviation relief package as part of the NZ$12.1 billion support package in March 2020. This resulted in NZ$372 million allocated to the air freight connectivity scheme. The Government has extended support to the aviation sector through to the end of 2021 to help keep New Zealand connected with trade partners and maintain international passenger services. The Reserve Bank of New Zealand (RBNZ) has also provided support lowering the official cash rate to 0.25 per cent, and potential facilitate the purchase of up to NZ$100 billion of New Zealand Government Bonds, Local Government Funding Agency Bonds, and New Zealand Government Inflation-Indexed Bonds in the secondary market. At the end of May 2021, RBNZ had purchased around NZ$56 billion in bonds (RNZ, 2021b). This support has helped the primary sector cope with the pandemic and positioned it to continue as an important driver of economic recovery in New Zealand.

COVID-19 has disrupted the global agricultural industry and placed existing supply chains under considerable stress, revealing their vulnerabilities to external shocks. The pandemic has resulted in changes to consumption patterns/demands due to businesses not being open. Lockdowns have affected demand for food services and products, such as venison and crayfish. In addition, there has been growth in home cooking and online shopping. It remains unclear if these changes in consumption patterns/demands will continue post-pandemic, but some will likely persist. Global supply chains will also overcome disruptions - however, this will likely take some time to come to fruition.

3.4 Global Trends and Challenges

3.4.1 Food Waste

Across global food systems, food loss and waste (FLW) is a major issue that presents a significant challenge for waste management systems, food security, and environmental sustainability (World Bank, 2021). The United Nations Food and Agriculture Organisation (FAO) estimates that approximately one third of all global food production is wasted (Barrera & Hertel, 2021). Meeting future global food demand will require action and initiatives that reduce waste and loss. Reducing FLW will be critical for achieving a zero-hunger world and developing sustainable production and consumption patterns (FAO, 2013). The 2030 Agenda for Sustainable Development reflects growing awareness of the issue concerning FLW. Target 12.3 of the Sustainable Development Goals (SDGs) seeks to make improvements in global FLW, and calls for reductions in waste at the retail and consumer level, and reductions in food waste and loss along production and supply chain (FAO, 2013). Food wastage can occur at all stages of global supply chains, while the scope and nature of food waste can differ considerably between regions and states (Roodhuyzen et al., 2017; Xue & Liu, 2019). 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.

A key barrier to reducing FLW is a lack of data at the national and international level (Barrera & Hertel, 2021). The FAO is currently developing two indices - the Food Loss Index (FLI) and the Food Waste Index (FWI). The FLI will provide estimates on food loss from post-harvest up to the retail stage. Initial estimates suggest that approximately 14 per cent of the global food supply is lost annually from post-harvest up to the retail stage. The FWI will provide global estimates on food waste at the retail and consumption level. The United Nations Environment Programme (UNEP) recently released their Food Waste Index Report 2021, which estimated that households, retailers, and the food service industry generate approximately 931 million tonnes of food waste each year, while households generate approximately 570 million tonnes each year. The report also identified that the global average for food waste was 74kg per capita (UNEP, 2021b). In 2013, the United Nations FAO estimated around 1.6 billion tonnes of food was wasted and the direct economic cost of this wastage at around US$750 billion (FAO, 2013).

The extent of New Zealand's FLW is unclear due to a lack of data. Estimates for total food to landfill have been varied. Reynolds et al. (2016) estimated that approximately 327,000 tonnes of food was wasted annually in New Zealand. In 2014, the National Food Waste Prevention Project estimated that New Zealand households sent 229,002 tonnes of food waste to landfill. The total waste that could have been avoided was estimated at 122,547 tonnes - this would generate total savings of around NZ$872 million, or NZ$563 per household (New Zealand Parliamentary Committee, 2020). In 2016, the Ministry for the Environment estimated that New Zealand's food waste was around 571,000 tonnes per year (New Zealand Parliamentary Committee, 2020). In 2018, an Environment Select Committee was appointed to explore the quantity, impact, prevention strategies and redistribution methods of food waste in New Zealand (Goodman-Smith et al., 2020). A subsequent report prepared by Associate Professor Miranda Mirosa was released, detailing recommendations for government, and setting out a three-step approach for reducing food waste: *target*, *measure*, and *act* (New Zealand Parliamentary Committee, 2020). The report suggested that the primary sector likely wasted

a significant amount of food at the production end of the supply chain. It was pointed out that Zespri alone had a self-reported wastage of 2.5 million trays of kiwifruit (New Zealand Parliamentary Committee, 2020). In 2021, the New Zealand Government announced funding to support five projects that aim to help address the issue of FLW.

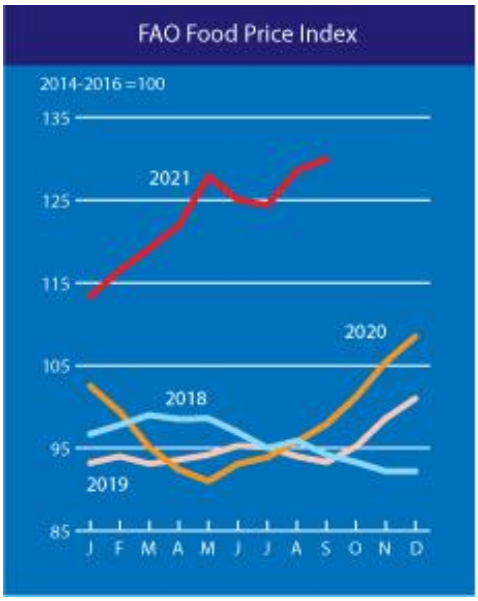
3.4.2 Sustainable Development Goals (SGDs)

In 2015, the United Nations signed the 2030 Agenda for Sustainable Development and adopted a set of 17 Sustainable Development Goals (SDGs) (UNDESA, 2021). The SDG framework consists of 17 goals, 169 targets and 247 indicators designed to reconcile the dual need of environmental protection and socio-economic development (Zeng et al., 2020). COVID-19 has disrupted globalisation and economic growth, both of which will play an important role in achieving the SDGs. The 2021 United Nations SDG report outlined that COVID-19 has contributed to the first rise in extreme poverty in a generation, and severely set back gains made in education, while the impact of climate change has continued relatively unabated (United Nations, 2021). The pandemic has exposed the fragility of the goals adopted by the United Nations, and it is expected that most goals will not be met by 2030 (Naidoo & Fisher, 2020). Moyer and Hedden (2020) argued that the world was not currently on-track to achieve the 9 human-development related SDGs. This is compounded by the fact that populations of the most vulnerable countries (MVCs) are estimated to grow from 751 million people in 2015 to 1,721 million people by 2050. Despite the lack of progress, governments are developing and integrating policy that will help address the SDGs. In 2021, the Aotearoa Sustainable Development Goals Summit was held, setting out New Zealand's current and future efforts towards meeting the SDGs. Foreign Affairs Minister Nanaia Mahuta outlined government contributions to this, including the formation of the Public Sector Act 2020, adoption of the Living Standards Framework (LSF), wellbeing-focused budgets, reforms of freshwater and climate change policy, international aid for pacific partners, and support for multilateralism (Mahuta, 2021).

3.4.3 Commodity Prices

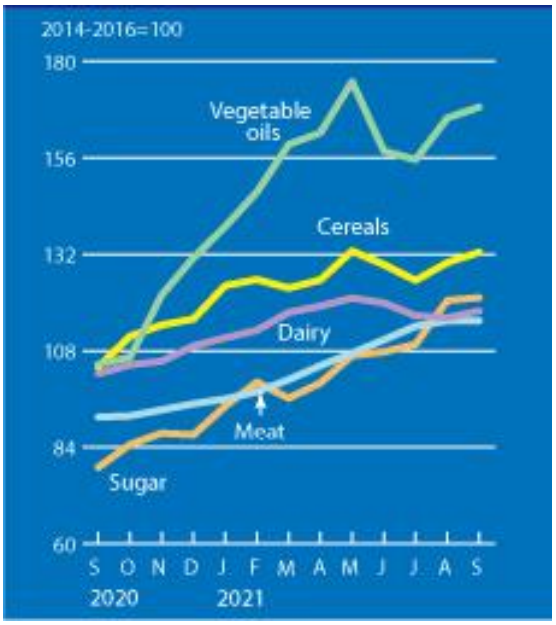
The COVID-19 pandemic has affected commodity prices since the initial outbreak (Boone et al., 2020). In early 2020, there was a major drop in commodity prices as governments moved swiftly to contain the virus – these have since recovered strongly (Ezeaku et al., 2021). The International Monetary Fund's (IMF) Global Price Index of all Commodities has increased from 83.97 in April 2020 to 177.55 in September 2021 (IMF, 2021a). The United Nations Food and Agriculture Organisation (FAO) projected record global cereal production in 2021, but believed that this would be outpaced by forecasted consumption. The FAO's Food Price Index tracks international prices for globally traded food commodities – this averaged 130 points in September 2021, the highest reading since 2011 (see Figure 3-3 below) (FAO, 2021). The price of food commodities has risen steadily since 2020, with vegetable oils, cereals, dairy, sugar, and meat prices increasing (see Figure 3-4 below). Climate change will also likely contribute to food price volatility in the future, as primary land users are confronted with increased extreme weather patterns that affect underlying production and yield.

Figure 3-3: Food and Agriculture Organisation (FAO) Food Price Index (FFPI) (2018-2021)



Source: FAO, 2021.

Figure 3-4: Food and Agriculture Organisation (FAO) Food Commodity Price Indices (2020-2021)



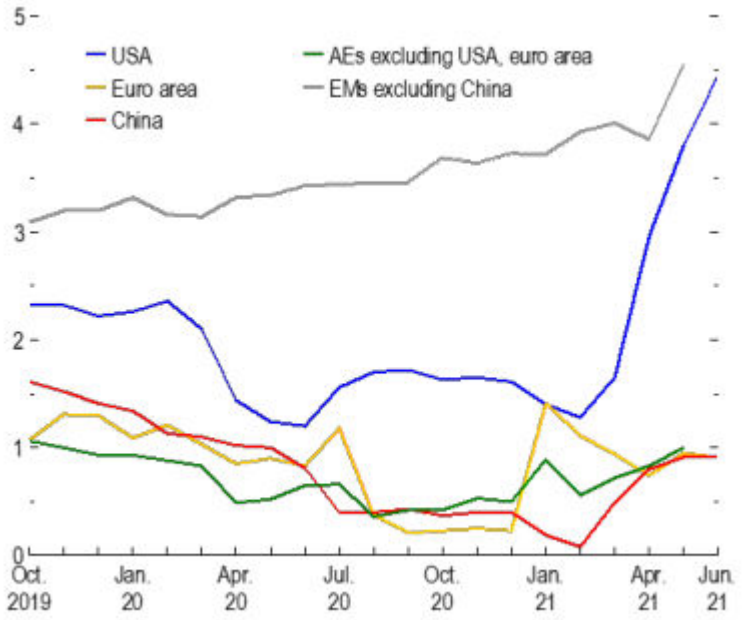
Source: FAO, 2021.

3.4.4 Global Economic Growth, Inflationary Pressures and Dietary Changes

Global agriculture and food systems have proven resilient against the COVID-19 pandemic compared to other sectors in the economy. However, income loss and strong inflationary price pressures have made it more difficult for many people to access healthy diets (OECD-FAO, 2021). The global economy suffered an economic contraction at the outset of the pandemic but has since started to show signs of an economic recovery. The International Monetary Fund

(IMF) projected that the global economy will grow six per cent in 2021 and 4.9 per cent in 2022 (IMF, 2021b). The current price pressures reflect unusual pandemic-related issues, significant fiscal support stemming from monetary policy, supply chain disruptions, and supply-demand mismatches (see Figure 3-5 below) (IMF, 2021b). Inflation has risen, but is expected to return to pre-pandemic levels for most countries in 2022/23 once disruptions are worked through - though uncertainty does remain high, particularly if pressures remain persistent (IMF, 2021b). The annual rate of inflation in the United States from October 2020 to October 2021 as measured by the consumer price index (CPI) was 6.2 per cent (Edelberg, 2021). CPI inflation in New Zealand hit a 10-year-high annual rate of 4.9 per cent for the September Quarter 2021 (RNZ, 2021d). The global economic recovery could also be influenced by social unrest, geopolitical tensions, cyberattacks on critical infrastructure, and extreme weather events (which have increased in frequency and intensity due to anthropogenic climate change) (IMF, 2021b).

Figure 3-5: Annual percentage change in core inflation across global economies (2019-2021)



Note: AEs = advanced economies; EMs = emerging market economies.
Source: IMF, 2021b

The OECD-FAO Agricultural Outlook 2021-2030 report outlined that global demand for agricultural commodities (includes non-food uses) is projected to grow at 1.2 per cent per annum over the coming decade, well below the growth experienced over the past decade (2.2 per cent per annum) (OECD-FAO, 2021). This is mainly due to an expected slowdown in demand growth in China (0.8 per cent per annum compared to 2.7 per cent per annum over the last decade) and other emerging economies, and lower global demand for biofuels (OECD-FAO, 2021). It is expected that population growth will be the major driver of overall demand growth for commodities over the coming decade. Global food demand is estimated to increase 1.3 per cent per annum over the coming decade, driven primarily by rising populations and per capita income. Global food availability per person is projected to increase by four per cent over the next ten years, reaching just over 3025 kcal/day in 2030 (OECD-FAO, 2021). This, however, masks differences across regions, with consumers in middle income countries expected to increase their food intake more significantly, while food consumption

patterns in low-income nations are projected to remain largely unchanged. For high-income countries, per capita consumption of animal protein is projected to plateau. This levelling off is attributed to health and environmental concerns, and will likely be replaced by poultry and dairy products. Middle-income nations' preferences for animal protein will remain strong, and is projected to increase by around 11 per cent over this period.

3.5 Emerging Technologies

3.5.1 Alternative Energy

To produce the food supply, the agricultural sector undertakes various practices across the agri-food chain (e.g. soil ploughing, sowing, spraying and weeding, storage, and packaging), and to do this a secure energy source is required (Gorjian et al., 2021). Machinery, including tractors, combines, loaders, trucks, all-terrain vehicles (ATVs), and motorbikes, perform important roles and help carry out these land use activities for the primary sector (Gorjian et al., 2021; Malik & Kohli, 2020). Fossil fuels generally power this machinery, which further contributes to GHG emissions and the carbon footprint of primary industries globally. The Consultative Group on International Agricultural Research (CGIAR) outlined that agri-food chains consume around 30 per cent of total global energy and release around a third of annual GHG emissions (Gorjian et al., 2021). Therefore, decreasing dependency on traditional fuel sources will be an important step reducing GHG emissions (Li et al., 2018).

EVs for farming represents a move towards a more sustainable agricultural future (Lombardi & Berni, 2021). They offer high torque, low maintenance, low operational costs and zero emissions - however, there are high initial costs, lack of charging infrastructure and low awareness of the technology (Malik & Kohli, 2020). The use of electricity in agriculture has increased from three per cent in 1970 to nine per cent in 2018, with a projection of 22 per cent in the near future (Harchaoui & Chatzimpiros, 2018). There are several companies that have developed operational electric tractor machinery. German manufacturer Fendt has launched the *e100 Vario*, an all-electric tractor that can operate for up to five hours under working conditions. US manufacturer John Deere has unveiled an electric tractor called *SESAM*, while Swiss manufacturer Rigitrac has introduced the *Rigitrac SKE 50*. Indian manufacturer Escorts has also launched *Farmtrac 26E* for use around vineyards and horticultural production operations.

Photovoltaic technology (PV) also offers a promising renewable energy source for sustainable agriculture practises. Barriers preventing solar powered tractors are the cost of PV modules and battery units, along with limitations associated with storage capacity and battery charging times (Gorjian et al., 2021). Solar power must also account for environmental parameters including solar radiation intensity, ambient temperature, dust accumulation, air humidity, bird fouling, and shading (Gorjian et al., 2021; Mustafa et al., 2020). Improvements in technology and reduced costs could generate an uptake in the use of solar powered farm vehicles. The automotive industry and companies including Tesla, Lucid, Rivian, and Ford have shown the transition to alternative energy is not only possible, but rapidly occurring around the world.

3.5.2 Blockchain Technology

The use of data and information is being increasingly used by the primary sector to improve productivity and sustainability. Existing technologies have already considerably increased the effectiveness and efficiency of collecting, storing, analysing, and using data in agriculture (Walter et al., 2017; Xiong et al., 2020). Blockchain technology allows for a secure and reliable ledger of accounts and transactions to be written and stored by all participants. Iansiti and

Lakhani (2017, p. 4) described blockchain technology as an *"open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way"*. Blockchain technology can offer a secure and reliable source of information on the state of farms, inventory supply and contracts in agriculture. It can track the provenance of food and help create trustworthy supply chains. It offers smart contracts that settle payments between different stakeholders and can detect issues in real-time (Xiong et al., 2020).

Blockchain technology has several potential applications and use-cases for agriculture and food sectors. Conventional farm/crop insurance systems are complicated and not often economically feasible, and farmers can be reluctant to get insurance for their farm/crops due to a lack of trust in insurance firms and a fear of delayed or non-payment for their claims (Jha et al., 2021). A blockchain-based insurance system could help detect fraud and enable quick processing and settlement of claims using smart contracts. Smart contract can integrate external data using smart oracles such as Chainlink. This technology could be particularly useful as extreme weather events will likely threaten agricultural production and food security (Xiong et al., 2020). The first blockchain-based insurance prototypes are being prepared, or have already launched. For example, Etherisc, a Swiss company, provides crop insurance using blockchain technology and weather data to provide payments using Decentralised Insurance Protocol tokens (DIP) (Xiong et al., 2020). Another key issue confronting smart agriculture is the development of a comprehensive security system that enables the use and management of key data (Xiong et al., 2020). Traditional methods are centralised and can include inaccurate or distorted data, and may be prone to cyber-attacks. Blockchain technology can store data and information for all stakeholders across the supply chain. It can ensure all recorded data is transparent and immutable for all stakeholders involved (Xiong et al., 2020). Agricultural and food supply chains are often long and complex, and face issues including food traceability, food safety and quality, food trust, and supply chain inefficiency. The blockchain characteristics of transparency, security, and decentralisation make it possible to track food quality across the entire supply chain (Xiong et al., 2020; Xu et al., 2020). This can help prevent fraud in food transactions and reduce supply chain costs. Several companies are utilising this technology to enhance the food security and safety of their supply chains, with companies currently developing these systems including Walmart, Carrefour, Nestle, Tyson Foods, Kelloggs, and Raw Seafood Inc (Xu et al., 2020). In 2016, Walmart established the Walmart Food Safety Centre in Beijing, investing US$25 million to develop a blockchain solution for food safety. 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.

3.5.3 Robotics and Autonomous Systems

The agricultural sector has been active in digital innovation for decades, and continues to exhibit growth in the use and application of robotics and autonomous systems (Lezoche et al., 2020). Artificial intelligence, and robotics and autonomous systems (RAS) are expected to have a significant impact on global industries, including the agricultural sector. These technologies have the potential to improve agricultural land use practises and increase crop yields (Roshanianfard et al., 2020). Autonomous vehicles use a range of technologies, including global positioning systems (GPS), light detecting and ranging (LIDAR) systems, neural networks, and machine learning. Over the past decade, there has been considerable progress made in autonomous technology. Tesla has launched full self-driving beta and recently

updated its software to version 10.5. The advanced driver-assistance system (ADAS) offers Level 2 vehicle automation with features including lane centring, traffic-aware cruise control, automatic lane changes, semi-autonomous navigation, self-parking, auto-park, smart summon, traffic, and stop sign control (Tesla, 2021). This underlying technology will likely make its way into the agricultural sector over time. Autonomous systems are currently being used in farm equipment such as tractors, combine harvesters, utility vehicles, and transplanters. At the 2021 Consumer Technology Association (CTA) conference, John Deere unveiled autonomous vehicles for the agricultural sector. As autonomous vehicle technology improves and prices drop, New Zealand could see a greater uptake in the technology, thereby influencing land use change/practice.

3.5.4 Climate Change Mitigation Technology

There are technologies emerging that seek to mitigate the impacts of agricultural GHG emissions, with considerable research and investment carried out regarding these technologies. The New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) is leading a research programme that is seeking to reduce methane emissions. The programme has identified genetic markers in low methane emitting sheep and is incorporating these into breeding indices (NZAGRC, 2021). New Zealand breeders can now measure and rank sheep according to their methane emissions. Work is also currently underway to identify low-emitting dairy cattle and develop a national breeding programme. Research has also shown that some supplementary feeds can produce different fermentation effects in an animal's rumen and produce less methane per unit of feed consumed. Research and development on methane inhibitors and vaccines is also currently underway in New Zealand. Methane inhibitors are chemical compounds that be given to livestock to reduce methane production, while a methane vaccine introduces antibodies into a cow's saliva, which is then passed on to the animal's rumen/stomach, binding with the methanogens that convert hydrogen into methane (NZAGRC, 2021). Fonterra has partnered with a Dutch-based company DSM that developed a methane inhibitor product called *Bovaer* (also known as *3-NOP*), which has been shown to reduce methane emissions across a range of ruminant breeds (DSM, 2019). These technologies, if successful, could be crucial in helping New Zealand meet its ambitious 2030 and 2050 methane reduction targets, and may influence primary land-use practise and decisions in New Zealand.

3.5.5 Precision Agriculture

Precision agriculture is a management strategy that gathers, processes and analyses temporal, spatial, and individual data, and combines it with other information to support management decisions according to estimated variability for improved resource use efficiency, productivity, quality, profitability, and sustainability of agricultural production. The satellite and space sector are contributing to the expansion of internet connectivity in rural areas, with companies SpaceX and their subsidiary Starlink making significant contributions to the industry. The Starlink internet constellation currently contains over 1,600 satellites, and paperwork has been filed for another 42,000. The company is seeking to provide global internet coverage, and this will likely greatly benefit rural regions. As of September 2021, the beta service is available in 17 countries, including New Zealand. New Zealand still has some areas that do not have access to wireless broadband or fibre optic connections. Southland District councillor Margie Ruddenklau operates a beef and cattle farm in Hokonui, and found that the Starlink service considerably improved their access to high-speed internet, enabling them to be online when weighing calves (Jackson, 2021). The technology will continue to help

connect farms and bring high-speed connectivity to areas without internet access. In 2020, the United States Federal Communications Commission announced a US$9 billion federal support fund to develop rural 5G networks and precision agriculture (FCC, 2020). The fund was later put on hold until mapping had been conducted to identify the areas most in need. John Deere is also seeking to incorporate 5G technology into their tractors. Improvements in connectivity, low latency and additional bandwidth will enable farmers to eventually have fully autonomous tractors, and gather real-time data without being physically present in their tractor (Marek, 2021). This technology will likely influence primary land users' decision-making and land use practises as they incorporate additional data derived from enhanced connectivity.

3.5.6 Genetics

Humans have been altering the genomic make-up of plants and animals for years using traditional breeding techniques (Phillips, 2008). Artificial selection, for example, has resulted in a variety of different organisms, but has been limited to natural occurring traits (Phillips, 2008). In recent times, however, advances in genetic engineering have been made that allow for precise control over genetic changes introduced/made to an organism/species (Phillips, 2008). Genetically modified crops cover approximately 190 million hectares, which is equivalent to the size of Mexico (Turnbull et al., 2021). These crops contain genetic modifications that have often boosted yield and/or improved resistance to disease/pests (Redden, 2021). Soybeans (50 per cent), maize (30 per cent), cotton (13 per cent), and canola (5 per cent) make up the four primary crops that are cultivated using GM technology (Turnbull et al., 2021). There are currently five tools employed for gene editing purposes:

1) *Oligonucleotide Directed Mutagenesis (ODM)*;
2) Zinc-Finger Nucleases (ZFNs);
3) Meganucleases;
4) Transcription Activator-Like Effectors Nucleases (TALENs); and
5) Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) systems (Turnbull et al., 2021).

In 2021, the first genome-edited product was launched in Japan by Sanatech Seed - the *Sicilian Rouge* High GABA tomato - using CRISPR/Cas9 technology (ISAAA, 2021). The tomato contains up to five times the amount of gamma-aminobutyric acid (GABA) compared with a regular tomato. GABA is an amino acid that is believed to help relaxation and lower blood pressure.

Extensive research is being carried out globally using genome editing techniques. In 2021, the United Kingdom's Rothamsted Research was granted permission by DEFRA to run a series of field trial of genome-edited wheat (UKRI, 2021). These are the first field trials of regularly interspaced short palindromic repeats (CRISPR) edited wheat in the UK/Europe. The wheat variant has been modified to reduce levels of the naturally occurring amino acid asparagine, which is converted to acrylamide (carcinogen) when baked or toasted. The edited plants have shown reduced levels of asparagine, with one line showing a 90 per cent reduction (UKRI, 2021). In 2020, the United States, regulations were introduced that eased restrictions on genetic engineering of food crops. The USDA Animal and Plant Health Inspection Service (APHIS) will now focus on gene traits rather than the technology used to create them (Stokstad, 2020). These regulations will likely ease the path for GMO products to enter the market.

New Zealand does not currently cultivate GM crops and takes a strong line against crops/animals developing using gene editing techniques (Turnbull et al., 2021). Such regulations are contained in the Hazardous Substances and New Organisms Act 1996 (HNSO) and are administered by the Environmental Protection Agency (EPA) (Parliamentary Counsel Office, 2021). Genetically modified organisations (GMOs) are defined as *any organism in which any of the genes or genetic material have been modified in vitro techniques, or are inherited or derived from any other genes or genetic material that has been modified by in vitro techniques* (MPI, 2021b). There are strict minimum standards set for any GMO approval. In the assessment, the EPA must consider whether the benefits outweigh the risks, and particular focus is given to the impact the novel organism may have on Māori culture, values, and traditions (Hudson et al., 2019). In 2016, the Royal Society of New Zealand convened a multidisciplinary panel of experts to examine the implications of using gene-editing technologies in New Zealand, which reported that gene-editing was emerging in global primary production and influencing land use change/practice (RSNZ, 2016). In 2019, the Royal Society released a report titled *Gene Editing Legal and Regulatory Implications*, which outlined that there was a need to overhaul existing gene-editing regulations, arguing that New Zealand had an ethical obligation to contribute to global knowledge on gene editing technology, adding this could not be left to other countries (RSNZ, 2019). At present, no genetically modified plants can be grown outside of the laboratory, with any experiment requiring approval from the EPA (MPI, 2021b).

Researchers are currently assessing the use of gene-editing techniques on New Zealand primary production. AgResearch employs genomic-based research tools to improve growth rates, health, meat and milk production, and fecundity, and to reduce use of chemicals in livestock (Pantoja, 2021). The organisation has identified that gene-edited ryegrass could grow up to 50 per cent faster, require less water, and reduce cattle methane emissions by 23 per cent (Hogan, 2019). Plant and Food's Chief Scientist Richard Newcomb suggested 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). If regulations change, the use of gene editing could have a significant impact on land use change/practice in New Zealand.

3.5.7 Regenerative Agriculture

Regenerative agriculture is an approach to producing food that advocates claim may have lower – or even net positive – environmental and/or social impacts (Newton et al., 2020). It is viewed as a potential solution to address climate change, biodiversity loss, poor water quality and health of freshwater ecosystems, wellbeing crises in rural and farming communities, and food system dysfunctions (Grelet et al., 2021; Gosnell et al., 2019). Paustian et al. (2020) argued that regenerative agriculture could contribute significantly to emission reductions and CO_2 removal, as well as improve soil health. The authors pointed out evidence that supports claims that regenerative agricultural practises will help minimise soil degradation and improve the yield stability (Paustian et al., 2020). Regenerative organic agriculture techniques can sequester CO_2, thereby helping combat global warming (White, 2020). Field trials have shown significant reductions in CO_2 emissions from farms practising regenerative agriculture (Rodale Institute, 2013). LaCanne and Lundgren (2018) argued that promoting soil biology and biodiversity on farms means regenerative farmers also required less costly inputs (e.g. pesticides and insecticides) and can more effectively manage their pest populations, while organic soil matter is seen the key driver of farm profitability rather than yield.

There is growing support for regenerative agricultural practises on a domestic and international level. Danone and Nestlé have committed around US$1.4 billion to support regenerative agriculture across their supply chains over the next five years (Yu, 2020). These funds will support farmers and suppliers to transition to more sustainable land use practises. In 2020, Beef and Lamb New Zealand (B+LNZ) and New Zealand Wine (NZW) commissioned Alpha Food Labs using financial support from the MPI Sustainable Food and Fibres Futures fund to improve understanding on the current state and future market potential of regenerative agriculture in wine and food across three of New Zealand's international markets, including the United States, Germany and the United Kingdom (Beef+Lamb, 2021b). Their report noted that there was no clear or consistent definition of regenerative agriculture in New Zealand; however, outlined that the regenerative agriculture movement was gathering momentum internationally and will likely become a significant trend across the international food and fibre sector (Beef+Lamb, 2021b). The report pointed out that regenerative agriculture is a significant opportunity for the primary sector, which is well positioned to take advantage of this emerging global trend. This will require defining the term *regenerative* in a New Zealand context, ensuring that regenerative attributes are embedded in a New Zealand story, develop and implement standards that are verifiable/relevant and linked with international supply chains, and ensure that all claims are underpinned by science (Beef+Lamb, 2021b). Research has shown that consumers are willing to pay for regeneratively produced food, especially if their social and environmental benefits can be verified by science. Growing awareness and adoption of regenerative agricultural practises will likely contribute to shifts in land use change/practise in New Zealand.

3.6 Innovative Products/New Food Technology

3.6.1 Alternative Protein Sources

Alternative protein sources have emerged as a significant alternative to traditional sources of protein such as meat or fish, this has been driven by changing consumer preferences and the climate impacts of traditional livestock production systems (Akhtar & Isman, 2018; Driver et al., 2020a). These alternative sources of protein can generally be placed into three categories: *edible insects*, *plant-based proteins*, and *cellular/cultured proteins* (Sexton et al., 2019).

The consumption of insects as food is currently practised by around 2 billion people across Africa, Asia, Central and South Africa, and Australia (Akhtar & Isman, 2018; Baiano, 2020). Baiano (2020) outlined that the tropics provide the most insect biodiversity, while insect eating declines at higher latitudes. The research estimated that humans consume approximately 2,300 different types of insect species, with entomophagy (eating insects) practised by approximately 3,000 ethnic groups in over 100 countries (Baiano, 2020). There is some evidence to suggests that awareness of insect protein is growing in Western regions that have traditionally obtained protein from livestock - however, cultural attitudes regarding the palatability of insects may be a barrier to widespread consumption. Dagevos (2021, p. 258) conducted a broad literature review of consumer research on edible insects and concluded that *"many Westerners remain hesitant to include insect eating in their daily diet, and consequently, the evidence suggests that the eating of insects is anything but widespread and common but rather surrounded by unfamiliarity and reluctance"*. Nevertheless, insects can offer a healthy source of protein, energy, fat, and fibre (Sogari et al., 2019). Payne and Ryan (2019) assessed New Zealand consumers' perceptions of and preferences for insect-based food products, finding that approximately 67 per cent of consumers indicated a willingness to consume insects as food if they were processed into a powder that could be added to existing

foods. The researchers suggested this indicates that an insect product with clearly detailed health and environmental benefits could be successful in New Zealand (Payne & Ryan, 2019).

The global food sector is increasingly turning towards addressing sustainability issues. Aschemann-Witzel et al. (2020) identified several key issues and trade-offs connected to protein production and consumption. Firstly, there is an increasing demand for protein. Secondly, there is an uneven distribution of protein consumption globally with overconsumption occurring in many developed countries, while poorer regions often have insufficient protein intake. Thirdly, animal-based protein, particularly meat, has a high environmental impact (Aschemann-Witzel et al., 2020; Faber et al., 2020; Westhoek et al., 2014). Plant-based protein products are seeking to address these challenges, and a wide range of products have entered the marketplace. Companies with an established presence for plant-based alternative protein products include Beyond Meat, Garden Protein International Inc, Danone SA, and Impossible Foods.

New Zealand is involved in the development of a variety of alternative proteins sources. The Ministry for Primary Industries (MPI) contributed more than NZ$95,000 through the Sustainable Food and Fibres Futures Fund to help boost Kabocha Milk Co's work to formulate, manufacture, and market kabocha milk (made from squash) to consumers across Asia. In 2020, under the New Zealand-Singapore Enhanced Partnership, the Ministry of Business, Innovation & Employment (MBIE) and Singapore's National Research Foundation (NRF) and Agency for Science, Technology and Research (ASTAR), partnered on a future foods research programme. New Zealand has contributed NZ$11.8 million to alternative protein research being undertaken by AgResearch Limited, Massey University, The Cawthorn Institute and Auckland University (MFAT, 2020). In 2021, a report titled *Emerging Proteins in Aotearoa New Zealand: What will it take for the sector to thrive?* was released, detailing the current landscape of alternative proteins in New Zealand. The report recommended adopting a New Zealand whole-of-value-chain approach, formalising and funding a national network to coordinate initiatives and bring cohesion to the discussion, establishing a cross-government working group that includes all relevant parties, and developing and implementing a New Zealand strategy for emerging proteins (Emerging Proteins NZ, 2021).

There is growing demand for alternative protein products in New Zealand. Research conducted by Colmar Brunton for Food Frontier found that 1 in 3 people were actively reducing their meat intake, while New Zealanders defined as *flexitarian* grew by 18 per cent (Food Frontier, 2019). Retailer Countdown observed that demand for plant-based vegan and vegetarian meals increased 36 per cent between 2018 and 2019 (RNZ, 2019). There has also been growth in the number of New Zealand companies producing alternative protein products (see Table 3-3 below). Sunfed Meats manufactures plant-based products including Chicken-Free Chicken, Bull Free Beef, and Boar Free Bacon, which are sold to a global market. Plant & Food Research observed that new consumer trends regarding plant-based foods, plant proteins and flexitarian lifestyles are emerging in New Zealand, and suggested that the production of ingredients for these products should be incorporated into existing primary production systems. It is estimated that New Zealand currently has approximately 1.74 million hectares of land suitable for growing plant protein crops (Sutton et al., 2018). The growth of alternative proteins is likely to influence primary land use in New Zealand as global consumers increasingly demand environmentally sustainable products.

Table 3-3: New Zealand-based companies producing alternative protein products

Company	Products
Otago Locusts	Insect products
The Green Brothers	Hemp food products
Plant Culture	Hemp seed products
Angel Food	Dairy-free cheese
Otis Milk	Oat milk
The Alternative Dairy Co	Dairy free milks and cheese
The Alternative Meat Co	Plant-based meat
Olive and Ash – Vince	Plant based meat
Sunfed Meat	Plant-based meat
The Craft Meat Co	Plant-based meat

Note: This is not an exhaustive review of existing companies in New Zealand, but instead seeks to highlight some of the organisations participating in the alternative protein market.
Source: Adapted from Downie-Melrose, 2020.

The Agribusiness and Economics Research Unit (AERU) estimated values for selected credence attributes of alternative protein products by UK and US (Californian) consumers, with a focus on identifying preferences for attributes considered distinctively New Zealand (Driver et al., 2020b). Nearly half of the participants in the UK and US were shown to have reduced their overall meat consumption (46 per cent and 44 per cent respectively), with these reductions strongly motivated by health concerns. It was found that 40 per cent of UK participants consumed plant-based protein products at least *monthly*, with 11 per cent consuming edible insect products. By comparison, Californian participants' consumption of edible insects was slightly higher, and plant-based meat consumption slightly lower. The survey identified that the top four factors motivating participants to increase their consumption of alternative products are *taste*, *animal welfare*, *personal health*, and *price*. The perceived poor taste of alternative protein products was the factor most likely to impede the consumption of alternative protein sources (Driver et al., 2020b).

3.6.2 Cellular Agriculture

Cellular agriculture is an alternative farming approach for products such as meat and eggs, and differentiates itself from conventional practises due to its use of isolated cells rather than animals to produce food (Ogilvie, 2021a). There are currently two classes of cellular agriculture, both of which involve culturing cells under conditions that are controlled. The first is *acellular agriculture*, in which goods do not contain cells within the final consumer product, but instead uses proteins or compounds that have been isolated from the cultured cells. The second is *cell-based products*, which contain cultured animal cells. Proponents of cellular agriculture argue that it can address the ethical and sustainability issues of traditional animal agriculture while meeting increasing demand for animal protein (Helliwell & Burton, 2021). Cellular agriculture may also offer significant environmental benefits over traditional meat and milk production (Lynch & Pierrehumbert, 2019; Stephens & Ellis, 2020). Tuomisto and Teixeira de Mattos (2011) produced a highly influential anticipatory life-cycle assessment that supported positive environmental claims. The study modelled cellular agriculture and observed that it was considerably more efficient than conventional European livestock agriculture, and had 7–45 per cent lower energy use, 78–96 per cent lower GHG emissions, 99 per cent lower land use, and 82–96 per cent lower water use (Tuomisto & Teixeira de Mattos, 2011).

Cellular agriculture is growing quickly, but much of the technology remains in the earlier stages of development (Ogilvie, 2021a). In 2013, the first cell-cultured meat patty was produced at Maastricht University, reportedly costing €250,000 to produce (Burton, 2019). There are currently no products available in New Zealand, but there are several commercial products sold overseas. One such product is an ice cream that contains milk products produced using acellular agriculture. Perfect Day Foods and Brave Foods manufacture the ice cream product, which is currently only available in the US or online (Ogilvie, 2021a). Another product is a chicken nugget product that contains plant protein and chicken cells, and is currently only available in Singapore (Ogilvie, 2021a). Currently, there are approximately 80 start-ups commercialising cellular agriculture technology, most of which are based in North America (Ogilvie, 2021b). These organisations face considerable technical, market, regulatory and societal challenges before reaching full commercialisation of products. 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).

In 2020, the Ministry of Business, Innovation & Employment (MBIE) and Singapore's National Research Foundation (NRF) and Agency for Science, Technology and Research (ASTAR), jointly funded the New Zealand-Singapore Bilateral Research Programme on Future Foods. Research being conducted by the University of Auckland is seeking to understand the interactions between plant-based proteins and cellular agriculture (MFAT, 2020). 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 in 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. However, if a feasible international market for synthetic protein products were to emerge, this could influence land use change/practice in New Zealand.

3.7 International Trading Environment

3.7.1 Brexit

In 2016, the British public voted to leave the European Union (EU). The UK government then officially notified the EU, triggering Article 50 of the EU Treaty. The Article specified that the UK was required to leave the EU within two years. On January 31st 2020, the United Kingdom left the EU, and is no longer a Member State. A transition period was installed which kept most pre-departure arrangements in place, ending on December 31st 2020. A deal on post-Brexit trade and future EU-UK relations has since been formally ratified. This allows tariff-free, quota-free bilateral trade access for goods – but not services – and covers future competition, fishing rights, and cooperation on matters such as security. The UK's departure from the EU's Single Market and Customs Union has disrupted trade and UK exports to the EU. London and Brussels have expressed disagreement regarding fishing rights, diplomatic representation, coronavirus vaccine exports, and Northern Ireland.

New Zealand spent several years negotiating a free trade agreement (FTA) with the United Kingdom. New Zealand was one of four countries that the United Kingdom identified as being a priority partner for new trade agreements post-Brexit. There were six rounds of negotiations

between the two countries, with the most recent being held virtually between 19th and 30th July 2021. New Zealand negotiators sought market access for exporters through the removal of tariffs and the reduction of trade barriers. The United Kingdom was New Zealand's seventh-largest trading partner pre-COVID-19, with trade valued at around NZ$6 billion to March 2020. New Zealand's main exports to the UK are meat, wine, fruit, eggs, honey, and wool. Recent modelling has suggested the impact of Brexit on New Zealand will be minimal (Saunders et al., 2019). These negotiations have since concluded with a new FTA deal announced in late 2021.

3.7.2 Free Trade Agreements (FTAs)

3.7.2.1 Bilateral Free Trade Agreements

New Zealand relies on market access for the trade of agricultural products and the success of its primary industries. It seeks preferential trade agreements with other nations to lower tariff and non-tariff barriers, the most common of which are bilateral free trade agreement (FTAs). In addition to multilateral FTAs, New Zealand currently has bilateral FTAs in force with the United Kingdom, China, Australia, Malaysia, Thailand, Singapore, and South Korea, with an FTA under negotiation with the EU. FTAs are signed not only to reduce tariff barriers for bilateral trade, but also to create market opportunities, streamline processes, reduce overhead costs, and generate more certainty and security for businesses conducting work overseas (MFAT, 2021a). FTAs can also improve market access for local businesses and enable them to be more competitive in overseas markets (MFAT, 2021a).

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 primary production/land use in New Zealand. Verevis and Üngör (2021) estimated that without the FTA with China, New Zealand would experience 22 per cent less total commodity exports, and 185 per cent less for the food and animal sectors. FTAs will continue to play an important role in market connectivity within the international trading environment, especially for the agricultural sector.

New Zealand has several existing bilateral agreements including the following:

- *Australia*: Closer Economic Relations (1983)
- *China*: New Zealand-China Free Trade Agreement (2008)
- *Hong Kong*: New Zealand-Hong Kong, China Closer Economic Partnership (2011)
- *Malaysia*: Malaysia-New Zealand Free Trade Agreement (2009)
- *Singapore*: New Zealand and Singapore Closer Economic Partnership (2001)
- *South Korea*: NZ-Korea Free Trade Agreement (2015)
- *Taiwan*: Agreement between New Zealand and the Separate Customs Territory of Taiwan, Penghu, Kinmen, and Matsu on Economic Cooperation (2013)
- *Thailand*: New Zealand and Thailand Closer Economic Partnership (2005)
- *United Kingdom*: New Zealand and United Kingdom Free Trade Agreement (2021)

There have been changes to existing bilateral FTAs in recent years. In January 2021, New Zealand and China announced they had signed an upgrade of their existing agreement. This built on current commitments and improved technical barriers to trade, customs procedures, and cooperation, which will benefit the primary sector. Trade facilitation provisions will simplify export procedures, remove a level of administration, paperwork, and reduce compliance costs for red meat exporters. The New Zealand-China FTA, which came into force in 2008, has played a major part in growing the Chinese market, with tariffs on sheepmeat,

beef and associated products going to zero on 1 January 2017 (excluding wool). China is the largest market for New Zealand's agricultural exports. In 2020, agricultural exports cost NZ$3.4 billion while the sector saved over NZ$475 million on tariffs (Beef+Lamb, 2021a).

In October 2021, the New Zealand Government announced that it had secured an FTA with the UK, and the deal will provide significant benefits for the primary sector. The UK was New Zealand's seventh largest trading partner pre-COVID-19, with trade between the countries worth NZ$6 billion in year-ended March 2020 (MFAT, 2021g). Modelling has shown that once fully implemented (in Year 15), exports to the UK will increase by up to 40 per cent, GDP will increase by NZ$970 million, and exporters will save an estimated NZ$37.8 million on tariffs each year based on current volumes (MFAT, 2021g). The FTA will eventually eliminate all tariffs on New Zealand's exports to the UK, with 97 per cent eliminated from Day 1. Tariffs will be eliminated immediately on wine (export value NZ$463.1 million), honey (export value NZ$74.9 million) and onions (export value NZ$8 million). Tariffs on apples will be eliminated after three years, while tariff-free access has been granted for off-season exports for the first three years of the FTA. The fisheries sector will see tariffs on hoki (export value NZ$2.2 million) removed from Day 1, while after three years tariffs on mussels will be removed (export value NZ$6.4 million).

The NZ-UK FTA opens an important market for New Zealand's dairy exporters that have been historically constrained by high tariffs. Tariffs will be removed on butter after five years (export value NZ$1.6 million) and cheese (export value NZ$500,0000), while other dairy products will also become tariff-free (MFAT, 2021g). Transitional duty-free quotas will be established, starting at 7,000 tonnes for butter and 24,000 tonnes for cheese, and increasing to 15,000 tonnes for butter and 48,000 tonnes for cheese (MFAT, 2021e). Tariffs on meat exports will be removed after 15 years for sheep (export value NZ$336.1 million) and beef (export value NZ$4.0 million). Transitional tariff-free quotas have been agreed upon, which will see sheepmeat quotas increase over time up to between 149,205 and 164,205 tonnes annually, while beef will increase over time up to between 12,000 and 60,000 tonnes annually (MFAT, 2021e). The NZ-UK FTA also includes far-reaching trade and environmental commitments. There are provisions that address trade distortion and environmentally damaging subsidies. The FTA also includes commitments to prohibit subsidies that exacerbate overfishing and addresses the consumption/production of fossil fuels (MFAT, 2021g). Over 260 environmentally friendly products been selected for tariff elimination - the largest list ever complied for an FTA. Overall, the agreement represents a significant trade milestone for New Zealand's primary sector and will influence demand for agricultural products and services.

3.7.2.2 Multilateral Free Trade Agreements

The failure of the World Trade Organisation (WTO) to complete the Doha Development negotiations in 2015 was a setback to the development of global/multilateral FTAs (MFAT, 2021f). New Zealand was actively involved in discussions and sought the elimination of agricultural export subsidies and other trade-distorting practises that affected agriculture. The failure of the negotiations placed New Zealand at risk of being excluded from trade negotiations, which could have resulted in lost market share in foreign markets. Fortunately, New Zealand is a signatory on several multilateral FTAs including:

- Trans-Pacific Strategic Economic Partnership - Brunei (2005)
- Trans-Pacific Strategic Economic Partnership - Chile (2005)
- Trans-Pacific Strategic Economic Partnership (2005) Singapore - Auxiliary to the bilateral New Zealand and Singapore Closer Economic Partnership

- Association of Southeast Asian Nations-Australia-NZ FTA (2009)
- Comprehensive and Progressive Agreement for Trans-Pacific Partnership includes Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, Peru, Singapore, Vietnam (2018)
- Digital Economy and Partnership Agreement (DEPA) was signed by New Zealand, Chile and Singapore in June 2020 and entered into force for New Zealand and Singapore on 7th January 2021
- UKUSA Agreement (Five Eyes) between United States, Australia, United Kingdom, Canada, and New Zealand

There are several multilateral FTAs currently being negotiated, while changes have also been renegotiated on existing multilateral agreements. For example, the New Zealand-European Union FTA has been under negotiation since mid-2018. In 2020, the Regional Comprehensive Economic Partnership (RCEP) was concluded by fifteen countries in the Asia-Pacific region, including Australia, China, Indonesia, Japan, New Zealand, the Philippines, Korea, and Vietnam. This agreement will reduce tariffs on goods for the 15 participating economies by 90 per cent over two decades, and provide a framework for strengthening co-operation in the areas of standards, technical regulations, conformity assessment procedures, rules of origin, and border processes for perishable goods.

New Zealand has a relatively diverse profile of trading partners, with a Herfindahl export index of 0.11 (Van Rensburg, 2019). However, there are some concerns over New Zealand's reliance on China, especially considering the costly trade wars between Australia, the United States and China. Trade between the two countries has increased steadily over the last two decades. Currently, New Zealand exports NZ$20.1 billion and imports NZ$13.3 billion worth of goods and services (MFAT, 2021c). Any disruptions to trade, changes in market access, political tensions, or economic downturns, could have significant implications for New Zealand's trading relationship with China. Foreign Minister Nanaia Mahuta recently outlined the need for New Zealand to diversify its trading relationships and reduce reliance on China for export income (Malpass & Coughlan, 2021).

3.7.3 Geopolitical Relationships

3.7.3.1 Australia and New Zealand's relationship with China

New Zealand and Australia have in recent years been involved in growing confrontations between the 'West' and China (Köllner, 2021). New Zealand has pursued closer economic ties with China, and successive governments have emphasised the importance of FTAs that improve firm competiveness and provide opportunities for growth (Köllner, 2021). In 2008, an FTA between the two countries was signed and was subsequently upgraded in 2021. The upgraded agreement provided better conditions for services exporters, improved market access for goods, reduced export barriers, and offered new areas of cooperation (MFAT, 2021d). While New Zealand has enjoyed close and prosperous economic ties, Australia has recently been embroiled in a costly trade war. Competing strategic interests and Canberra's recent shift towards the US and other Western markets have been contributing factors to deteriorating trade relations. This was highlighted with a trilaterial security pact signed between Australia, the United Kingdom and the United States (AUKUS) in September 2021. The deal coincided with an announcement of nuclear submarines that will delivered to Australia in the future, which will likely add to growing geopolitical instability in the Pacific region.

China is Australia's largest trading partner for both the import and export of goods. Between 2019 and 2020, 39 per cent of exported goods went to China, while 27 per cent of all goods imported were from China (Australian Bureau of Statistics, 2020). The value of exports doubled from AU$75 billion in 2014-2015 to AU$150 billion in 2019-2020, with imports increasing 42 per cent over the same period (Australian Bureau of Statistics, 2020). Until recently, China accounted for 96 per cent of Australian southern rock lobster exports, worth approximately half a billion USD - however, China imposed a ban on these imports due to samples containing high amounts of heavy metals (Dobson, 2021). The trade dispute between the two countries has also affected agricultural exports, including barley, wine, and beef. China introduced tariffs of 80 per cent on barley imports and over 200 per cent on Australian wine imports. This breakdown in trade has cost Australia an estimated AU$2.3 billion (Dobson, 2021).

There has since been more retaliatory actions between the two nations, with Beijing suspending China-Australia Strategic Economic dialogue indefinitely, while Canberra suspended a Chinese infrastructure deal that was part of the Belt and Road Initiative. Growing tensions in the Pacific and South China Seas will likely continue into the future. New Zealand may be confronted with difficult decisions, particularly due to our reliance on the Chinese markets for our agricultural exports. As seen in Australia, there can be significant costs associated with geopolitical instability and positioning, which could potentially impact New Zealand primary sector.

3.7.3.2 United States and China

The relationship between the US and China has deteriorated in recent years, culminating in a costly trade war. In 2018, former President Donald Trump cited unfair Chinese trade practises and intellectual property rights (IPR) violations. Over the coming months, a series of tariffs were put in place by both sides on a variety of goods and services. This trade war had a considerable impact on the US agricultural sector. US exports of agricultural products to China declined by 63 per cent between 2017 and 2018, from US$15.8 billion to US$5.9 billion (Chinn & Plumley, 2020). In 2019, a deal titled *Phase One* was signed, in which China pledged to increase US exports and improve IPR rules (BBC, 2020). Since arriving in office, President Joe Biden has yet to remove US tariffs on US$380 billion worth of Chinese goods entering the US, citing that Beijing has failed to meet aspects of the Phase One deal. Therefore, it remains unclear how trade will proceed between the two countries. Despite uncertainty, the US agricultural sector has avoided further impacts. The USDA has forecasted that a record US$39.0 billion worth of agricultural products will be shipped to China in 2022 (USDA, 2021). The implications of further trade wars between China and the United States could influence demand for New Zealand products from the primary sector.

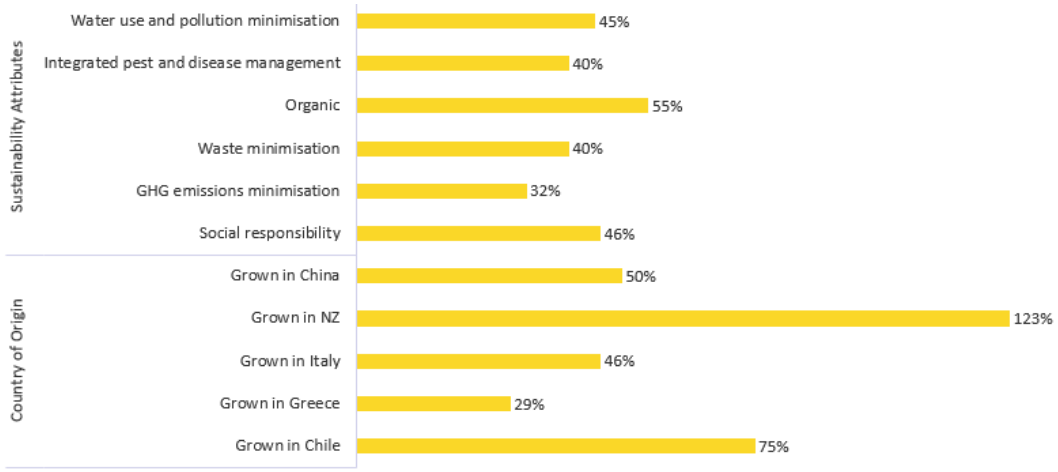
3.8 Consumer Trends

3.8.1 Demand for Social and Environmental Attributes

New Zealand has a biological economy, and a large proportion of economic activity is related to the land. Marketing social, cultural and environmental characteristics to consumers in export markets can help achieve greater value for New Zealand producers and their land-based export products. The Agribusiness and Economics Research Unit (AERU) has conducted a number of surveys and choice experiments across different countries and commodities to value consumers' willingness-to-pay (WTP) for certain product credence attributes (refer to *Appendix A*). These choice experiments reveal that country-of-origin plays an important role in kiwifruit consumers' choices. Relative to the average price of a kilogram of kiwifruit, on

average, respondents were willing to pay a 123 per cent premium for kiwifruit from NZ (¥108/kg) (see Figure 3-6 below). The most preferred production attributes were *organic*, followed by *social responsibility* and *water use and pollution minimisation* equally (Tait et al., 2020).

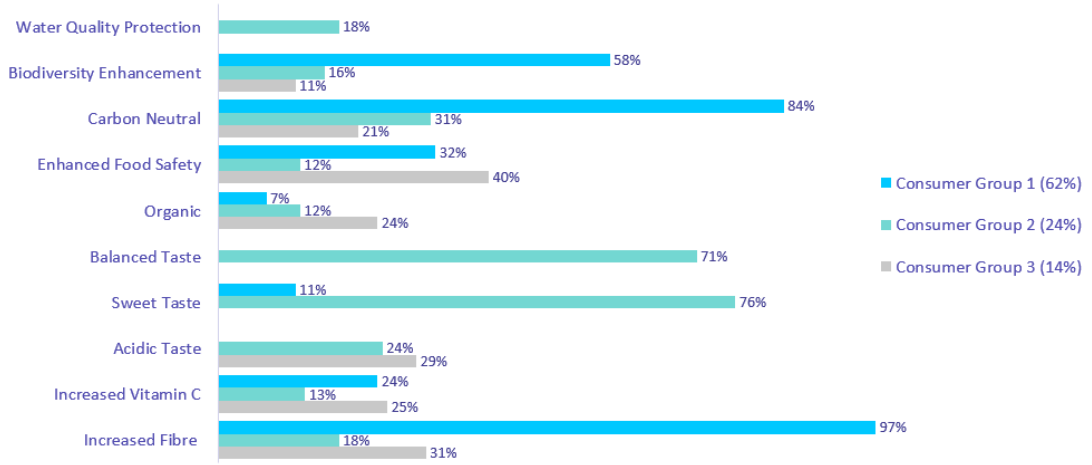
Figure 3-6: Shanghai consumer willingness-to-pay (WTP) for selected attributes of kiwifruit



Note: Willingness to pay (WTP) is the percentage of average product price as used in choice experiments.
Source: Saunders et al., 2021

A survey was also carried out with Japanese kiwifruit consumers. The consumer sample was segmented (using latent class modelling) into three groups with different characteristics and preferences (see Figure 3-7 below). The first group of consumers was shown to have the strongest preferences for environmental and health attributes. This group were more likely to believe that carbon neutral production is important when purchasing kiwifruit, believe that improving personal health is important, and were conscious of minimising harm to the environment. The second group exhibited the broadest preferences, but their choices were largely driven by taste. These consumers were likely to be older, pay higher prices, and purchase Zespri kiwifruit at least *weekly*. The third group of consumers valued enhanced food safety standards and exhibited the highest WTP for organic production.

Figure 3-7: Japanese consumer willingness-to-pay (WTP) for selected attributes of kiwifruit

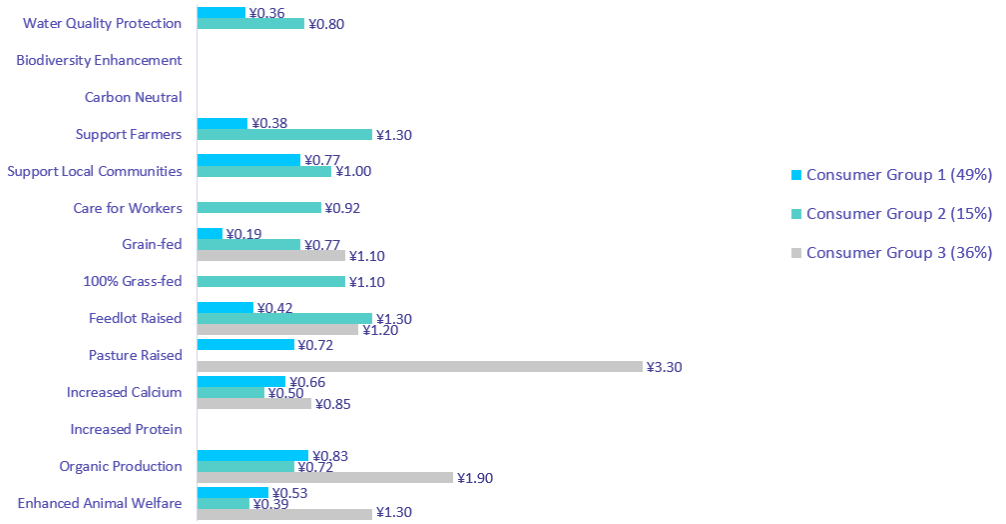


Note: Willingness to pay (WTP) is the percentage of average product price as used in choice experiments.
Source: Saunders et al., 2021

Consumer surveys have been carried out across a variety of other commodities. In 2019 and 2020, two surveys were conducted to estimate WTP values for selected credence attributes of lamb leg products by United Kingdom consumers, with a focus on identifying preferences for attributes considered distinctively New Zealand. Comparison of the results showed only small differences in consumption and preferences before and during the COVID-19 pandemic. Nevertheless, there was increase in the premiums that consumers were willing to pay for lamb from New Zealand, and for lamb from Māori farms (Saunders et al., 2021).

Surveys were also conducted to estimate Chinese consumers' WTP (located in Shanghai and Beijing) for attributes of ultra-high processing (UHT) milk (see Figure 3-8 below). The qualities associated with New Zealand-sourced UHT milk were high food safety, quality, nutritional value, organic, and environmental standards. Consumers in Group Three expressed a high WTP for *pasture-raised*, *animal welfare* and *organic production* credence attributes (Saunders et al., 2021).

Figure 3-8: Chinese consumer willingness-to-pay (WTP) for selected attributes of ultra-high-processing (UHT) milk



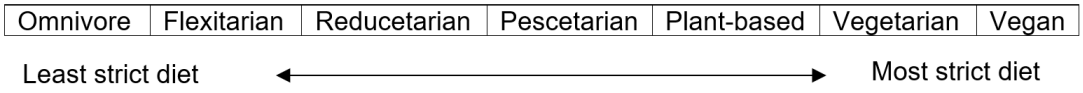
Note: Willingness to pay (WTP) is the percentage of average product price as used in choice experiments.
Source: Saunders et al., 2021

A survey of USA (California) consumers of Sauvignon Blanc showed that millennials had higher WTP across a range of social and environmental wine product attributes, including *social responsibility*, *by-product management*, *made with organic grapes*, and *100 per cent organic*, compared to Gen-X and baby Boomer consumers (Saunders et al., 2021).

3.8.2 Consumer Diets/Trends

There is a broad spectrum of consumer diets practised around the world that can range from least-strict diets (omnivorous) to the most-strict diets (vegan) (see Figure 3-9 below). Vegetarian and vegan diets are well-recognised diets that are gaining more attention and adherents. People choose vegetarian or vegan diets for a variety of reasons, including respect for animal life, health benefits, and environmental and sustainability concerns (Ploll et al., 2020). The number of Americans (US) that follow a vegan diet has increased by 500 per cent from around 4 million in 2014 to 19.6 million in 2017 (Alcorta et al., 2021). A national study conducted in the US found that two-thirds of respondents had reduced their meat consumption within the previous three years (Alcorta et al., 2021). In the UK, 21 per cent of the population identify as flexitarian, while one in eight identify as vegetarian or vegan. In Germany, the number of vegetarians grew from 1 per cent of the population in 2005 to 7 per cent in 2018, while in Italy, those not consuming meat increased by 94.4 per cent (Alcorta et al., 2021). In 2019, a global survey observed that 40 per cent of consumers were actively trying to reduce their meat consumption, while 10 per cent were avoiding red meat completely (Alcorta et al., 2021). The global growth in vegetarian and vegan diets will likely continue into the future. This is also evidenced by substantial growth in the consumption of plant-based proteins and alternative milk products in recent years. Consumers are increasingly demanding products that are sustainable, palatable, safe, nutritious, and affordable. A recent report conducted by Research and Markets estimated the size of the vegan food market could reach US$31.4 billion by 2026 (PR Newswire, 2020).

Figure 3-9: Continuum of different consumer diets

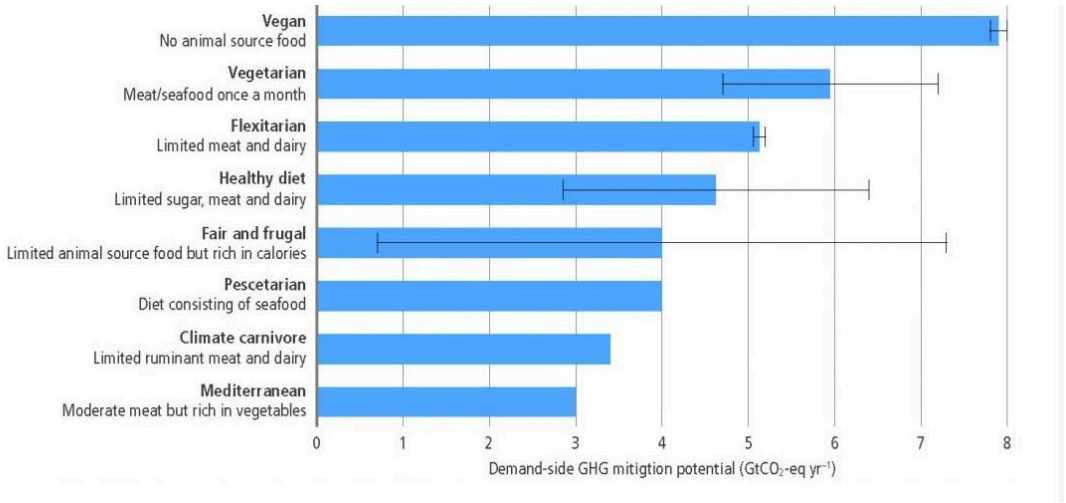


Note: Not all dietary trends are included within the continuum.
Source: Adapted from Salehi et al., 2020.

Internationally, more consumers are reducing their overall meat consumption, sometimes referred to as *flexitarian* or meat reducing diets. 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. The AERU conducted research examining alternative protein consumption in the UK and US (California). It was observed that 46 per cent of participants were actively reducing their meat intake, particularly beef, with reductions strongly motivated by health concerns (Driver et al., 2020b). Research conducted by Colmar Brunton found that one in three New Zealanders were consciously reducing their meat consumption (Food Frontier, 2019). It was also found that those that defined themselves as *flexitarian* grew by 18 per cent between 2018 and 2019, while 24 per cent of meat eaters had reduced their meat consumption (Food Frontier, 2019). Globally, agriculture and food production account for a substantial portion of the world's emissions (Drew et al., 2020; Tilman & Clark, 2015). It has been estimated that CO_2 emissions from agriculture and food production were around 18 billion tonnes in 2015, representing around 34 per cent of total global emissions (Crippa et al., 2021). The largest contributions came from agriculture and related land use/land-use change activities (71 per cent), with the remaining from supply chain activities including retail, transport, consumption, waste management, industrial processing, and packaging (Crippa et al., 2021).

Research has suggested that adherence to diets with lower consumption of animal-based proteins will reduce GHG emissions. As such, changing diets on a global scale will be a major contributing factor in combating climate change (Plackett, 2020). In the UK, it has been estimated that the elimination of meat from diets could reduce GHG emissions by 35 per cent (Hoolohan et al., 2013). In 2019, a report published by the IPCC outlined that if the global population followed a balanced diet, containing more plant-based and sustainable animal-sourced food, up to eight billion tonnes of CO_2 could be avoided each year (see Figure 3-10 below). In addition, low carbon diets on average tend to be healthier and have a smaller land footprint (IPCC, 2019). Drew et al. (2020) examined the transition towards a healthier more climate friendly food system in New Zealand. The research found whole plant foods (e.g. vegetables, fruits, legumes, and whole grains) were considerably less polluting that animal-based proteins (e.g. red meat). It was estimated that population dietary shifts could confer emission savings of between 4 and 42 per cent, depending on the scale of dietary change and food waste reduction achieved (Drew et al., 2020). It was also estimated that dietary changes could confer substantial health benefits and savings for the health care system of between NZ$14-20 billion.

Figure 3-10: Demand side greenhouse gas emissions (GHG) mitigation potential of different diets



Source: IPCC, 219.

3.8.3 Urban Agriculture

Dietary change towards a balanced vegetable-rich diet is being increasingly recognised as critical to achieving climate goals (Poore & Nemecek, 2018; Wang et al., 2021). It has been suggested that urban agriculture will play an important role in changing behaviours and transitioning consumers to more climate friendly diets (Puigdueta et al., 2021). Wang et al (2021) suggested that consumer demands are changing, and more attention is being given to the safety and freshness of food consumed daily. Puigdueta et al. (2021) outlined that urban gardens could be used as social catalysts for pro-environmental behaviour and GHG mitigation in urban areas. The study observed that participation in urban gardens had an impact on food consumption decisions and could help reduce individuals' carbon footprint by approximately 205kg CO_2 per year per capita. The largest contributing factor related to dietary changes was specifically the reduced consumption of animal-based proteins (Puigdueta et al., 2021).

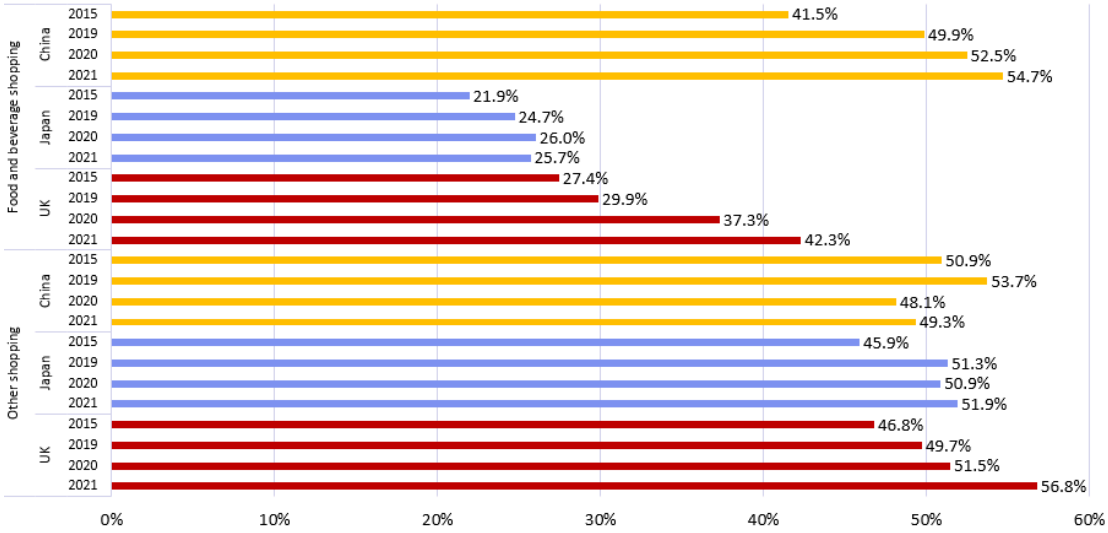
3.8.4 Impact of COVID-19 on Consumers

COVID-19 has influenced consumers' food consumption and diets (Janssen et al., 2021). Ogundijo et al. (2021) outlined that consumer eating habits have changed significantly for a variety of reasons, including heightened boredom and anxiety, change in work patterns, controlled/restricted food shopping, and inability to interact physically with friends and family. These changes in consumption often differ between groups of people. Janssen et al. (2021) found that the pandemic had different impacts on people's lifestyles and food consumption patterns in Denmark, Germany, and Slovenia. The authors observed a decline in the consumption of fresh food, except for households with children, while women were more likely than men to increase fresh fruit and vegetable intake. Attwood and Hajat (2020) suggested that the pandemic shifted public awareness of illnesses linked to animals, which resulted in short-term changes to meat consumption. It was also suggested that the pandemic could act as a catalyst towards lower meat diets that are already being seen in some high-income nations.

The COVID-19 pandemic also influenced how consumers purchased food and brought their fruit and vegetables (Chenarides et al., 2021). The move to online grocery shopping has been particularly noticeable amongst retirees and households that do not traditionally purchase

these goods from home (Charlesbois, 2020). This has important implications, as there is evidence to suggest that consumers are more likely to make healthier purchases when ordering online (Chenarides et al., 2021). Driver et al. (2021) explored consumer preferences and use of digital media and smart technology for food and beverage (F&B) information in China, Japan and the UK (see Figure 3-11 below). The study observed an increase in online F&B shopping, with the percentage of UK consumers increasing from 27.4 per cent in 2015 to 42.3 per cent in 2021, while the percentage of Chinese consumers increased from 41.5 per cent in 2015 to 54.7 per cent in 2021. COVID-19 and subsequent safety precautions are likely to have contributed to more consumers using online services rather than brick-and-mortar stores.

Figure 3-11: Food, beverage and other shopping conducted online by consumers in China, Japan and the United Kingdom between 2015-2019 (average %)



Source: Driver et al., 2021.

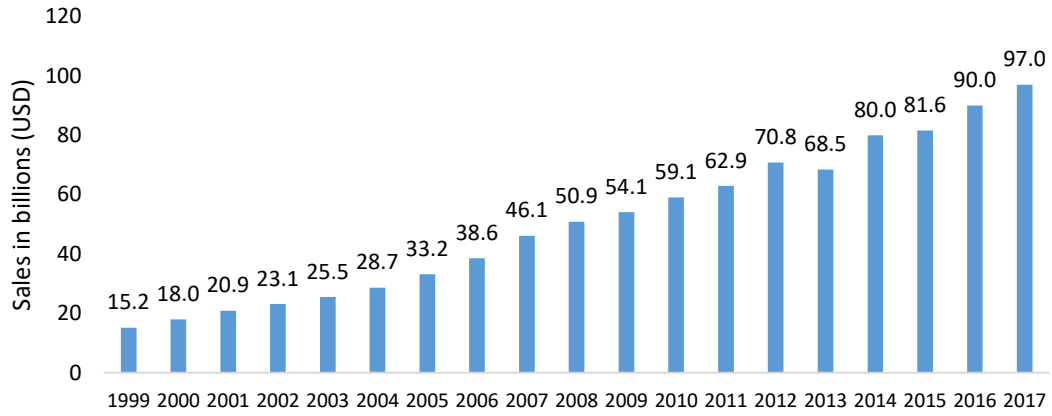
COVID-19 has severely disrupted supply chains and the flow of goods, which has influenced demand for local products (Moreno & Malone, 2021). According to the GlobalData COVID-19 Recovery Consumer Survey, 52 per cent of consumers claimed locally sourced ingredients were more important because of the pandemic (Just Food, 2020). This localism trend has been particularly noticeable in the food sector. Locally sourced foods are often associated with superior quality, safety and flavour compared to imported products (Just Food, 2020). GlobalData (2020) conducted another survey, which found that 35 per cent of consumers believed that supporting local businesses was more important than it was pre-COVID-19 (GlobalData, 2020). Mintel (2021) identified *hyper-localism*, as consumers' concept of local has shrunk. In the Asia-Pacific region, 66 per cent of consumers felt that because of COVID-19 they were willing to buy more from local businesses (Nambiar, 2021). The pandemic has significantly affected consumers over the last two years - however, it remains unclear if the changes in consumer diets and consumption patterns are long lasting.

3.8.5 Organic Foods

Consumer demand for organic products (with no fertilisers, chemicals, antibiotics, or hormones) has grown rapidly in recent decades (Wojciechowska-Solis & Barska, 2021). As shown in Figure 3-12 below, the global organic food market has increased steadily from US$15.2 billion in 1999 to US$97 billion in 2017 (Rout & Reid, 2020). This demand has likely

been driven by consumer perceptions of food quality, safety, and sustainability (Dangi et al., 2020).

Figure 3-12: Worldwide sales of organic food, 1999 to 2018 (USD billions)



Source: Adapted from Rout & Reid, 2020.

New Zealand's organic sector is growing steadily and is estimated to be a NZ$720 million industry. To support continued growth, MPI announced in February 2021 that it was providing NZ$212,500 from the Sustainable Food and Fibre Futures Fund to help develop a three-year organic sector strategy (MPI, 2021c). The industry produces NZ$620 million in export and domestic revenue, with a further NZ$100 million of imported product entering New Zealand to meet consumer demand. There has been strong demand for New Zealand's organic dairy, wine, and kiwifruit products. The US, China, Europe, Australia, and Japan are the largest export markets for New Zealand's organic products. The US currently accounts for NZ$86.8 million or 20.6 per cent of all organic exports, although this is just a small portion of their organic market, which totals over US$55.1 billion, and is growing at 4.6 per cent per annum (OANZ, 2021). According to Organics Aotearoa New Zealand (2021), over the past three years, the New Zealand organic sector has experienced an average annual growth rate of 6.4 per cent (OANZ, 2021). Even during the global COVID-19 pandemic the New Zealand organic sector has continued to grow. There is currently 86,000 hectares of land under organic certification, with the average earnings approximately NZ$7,250 dollars per hectare (OANZ, 2021). The growing demand for organic products has been met with increased production. Since 2017, the number of certified organic operators has increased by 105, while the number of organic operations has increased by 198 (OANZ, 2021). In addition, a further 6,000 hectares is currently being converted for organic dairy, wine, and horticultural production. This data suggests the growth in domestic and global demand for organic products will likely continue to influence land use practise/change in New Zealand.

3.8.6 Indigenous/First Nations/Māori Enterprise - Cultural Attributes

Western consumers are increasingly demanding to understand the provenance of their food (Reid & Rout, 2016). New Zealand agri-food producers are aware that they can earn significantly more export revenue by improving the communication of underlying cultural qualities of their products to consumers (Rout & Reid, 2020). This is an integral part of a broader argument that suggests that New Zealand's primary sector needs to focus on adding value rather than volume (Rout & Reid, 2019). Culture can be understood as the collective set of rules, understandings, and practises that help a group of people live as a society, though

even within a society culture can vary (Rout & Reid, 2019). Therefore, the cultural attributes of food can be understood as a society's particular beliefs, values and behaviours regarding the production, preparation, and consumption of food. Consumers have been increasingly distanced from their food, both physically and psychologically. Yet consumers may want a genuine connection to their food, one that not only reassures them of its safety and environmental sustainability etc., but also one that has an intangible legitimacy and meaning (Rout & Reid, 2020).

Māori agribusinesses are emerging as leaders amongst producers and processors in New Zealand, implementing production practises/protocols that embrace indigenous values emphasising environmental, social, and economic sustainability (Rout & Reid, 2020). Māori enterprises are doing this authentically and this reflects their own understanding of place and expresses their own indigenous perspective (Reid & Rout, 2016). It is recognised that transitioning to alternate food production, processing, and supply-chain arrangements can provide premiums for agribusinesses. The food produced by Māori agribusinesses has unique value propositions, i.e. the indigenous principles underlying production sets it apart from other food. Māori agribusinesses and their products have attributes that are substantively different from traditional Western approaches, and these are well-positioned and resonate with many cultural traditions and food movements around the world (Rout & Reid, 2020). AERU research has shown an increased consumer WTP for cultural attributes, e.g., produced on a Māori farm, across multiple international markets for New Zealand commodities such as lamb (Saunders et al., 2021; Tait et al., 2020). Embracing cultural attributes will be a crucial part of New Zealand's journey towards adding value to its primary exports and will likely influence future primary land use practises.

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 to provide an evidence base to 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 Our Land and Water National Science Challenge by identifying the likely impact of these drivers in the future.

The current report has been informed by three 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 35 key drivers. Links to updated summaries of the key drivers are provided, along with an evidence base comprising 1,500 unique sources (1,152 international and 348 domestic sources) across the four 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 2,818 individuals in total, receiving 251 completed surveys.

The survey asked participants (unprompted) to identify important domestic and international issues that could influence New Zealand land use change/practice. Climate change was viewed as the most critical international issue, while other critical issues included consumer preferences, international agreements, biodiversity, trade/market access, water quality/availability, trade relations, changing dietary preferences, market demands/dynamics, and climate policy. These findings were consistent with findings from the prior surveys. Climate change was also viewed as the most critical domestic issue, while water quality was also regarded as a significant issue. Other critical issues included government policy, water policy, social licence to operate, climate policy, and environmental policy. These findings were also consistent with results from the prior surveys.

Survey participants provided their perspectives on the impact that key international drivers/issues would have on land use change/practise in New Zealand. Most individuals viewed climate change as likely having a high impact on land use change/practise. Greenhouse gas emissions, condition of the environment, and water quality were also viewed by a large proportion of participants as having a high impact. Survey participants also provided their perspectives on the impact key domestic drivers/issues would have on land use change/practise in New Zealand. Most individuals viewed water quality as likely having a high impact land use change/practise. Climate change, condition of the environment, agricultural policy, and greenhouse gas emissions was also viewed by a large proportion of individuals as having a high impact.

The survey prompted participants to consider the importance of primary product attributes in achieving higher product value from lower volume. Most participants viewed the attributes of high quality, lower environmental impact of production, food safety, and low carbon footprint as very important. The survey followed on by asking individuals to provide an indication of their participation in agribusiness schemes. The findings showed that 17 per cent of the sample group were involved in a scheme. These schemes often had an environmental

and social dimension, and in some cases did increase the prices received for their goods/services.

This report also addressed some of the future trends and challenges that would likely impact land use change/practice in New Zealand. These were grouped under eight broad headings: climate change, COVID-19, global trends and challenges, New Zealand environmental policy, emerging technologies, innovative products, international trading environment, and consumer trends. Climate change is likely to have a significant impact on future land use change/practice in New Zealand. It will likely produce more frequent and intense extreme weather events and influence domestic and international policy. Climate change is pushing the banking and investment sector towards sustainable finance and investing using ethical, social and governance (ESG) criteria. International institutions are also seeking to enable and direct finance/capital towards initiatives and investments likely to influence land use change/practise. COVID-19 has disrupted the global agricultural industry and placed existing supply chains under considerable stress, revealing their vulnerabilities to external shocks. The pandemic has resulted in changes to consumption patterns/demands due to businesses not being open. Although the pandemic has presented significant challenges for New Zealand's primary sector, it has shown considerable resilience compared to other sectors. Emerging technologies are likely to enhance access to data and improve practices, both on-farm and in-market. Many consumers in developed countries are consciously reducing their meat consumption, and are turning to vegetarian, vegan, flexitarian diets, and consuming alternative protein products. The international trading environment will continue to be crucial for New Zealand's primary product exports. The recent UK-NZ FTA and updated FTA with China provide important market access. However, growing tensions between the United States, China and Australia could affect New Zealand's trading relationships.

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, 2022). 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 likely 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 2021. 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.

Previous reviews also identified product quality (and associated indicators) as another 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.

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). 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 38 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

Yang and Renwick (2019) conducted a meta-analysis of credence attributes for livestock products. To do this, the authors conducted a systematic literature review and applied a meta-regression analysis in an effort to introduce some generality to WTP studies. 566 WTP estimates from 94 studies were initially identified. However, 11 of these were negative and excluded from the meta-analysis, but controlled for using a dummy variable in the meta-regression. Table A1 shows the frequency of estimates across a number of variables.

Table A1: Frequency of study characteristics (papers N=94) (estimates N=555)

Category	Variable	Frequency[a]
Product	Beef	283
	Lamb	44
	Dairy	206
	Other products	22
Labelling & perception	Labelled	399
	Perceived	156
Data collection time	Before 2000	22
	2000-2004	116
	2005-2009	239
	After 2010	178
Estimation method	Choice experiment	276
	Contingent valuation	39
	Conjoint analysis	63
	Hedonic	26
	Others	151
Valuation method	Hypothetical	405
	Non-hypothetical	150
Credence attribute	Environment-friendly	42
	Animal welfare	108
	Organic	62
	Hormone/antibiotic free	38
	Grass-based	49
	Food safety	43
	PDOs/PGIs	27
	ROOs/COOs	102
	Traceability[b]	18
	Mixed attributes	66
Region	North America	152
	Europe	280

	Asia	72
	Australasia	6
	Other regions	45

Notes: (a) Frequency refers to the number of observations in each category. (b) Traceability is sometimes relevant to geographical information, but it is different from GIs. This attribute can also be called 'identity preservation', and is defined as the ability of a system to maintain a credible custody of identification for animals or animal products through various steps, from the farm to the retailer.

The authors (Yang and Renwick, 2019) created two subsamples within the data to separate red meat from dairy. The applied regression model highlighted that in the red meat sample there is a higher WTP for beef products than for lamb, with organic production associated with the highest price premium, and environmentally friendly attributes values the least by consumers. In terms of dairy products, food safety was associated with the highest price premium, and environmentally friendly the lowest. In addition, WTP estimates were modelled based on the meta-regression results with the study year was set after 2010 to capture recent market demand for livestock products. A2 shows the results WTP results for the whole model, red meat, and dairy estimates, with a 95 per cent confidence interval.

Table A2: WTP estimates of a price premium for livestock products (%)

Model credence attributes	Whole sample model	Red meat model	Dairy model
Environment-friendly	24.1 [6.1, 42.1]	18.9 [3.7, 34.2]	25 [11.2, 38.9]
Animal welfare	31.9 [5.6, 58.2]	19.3 [3, 35.6]	31 [0.5, 61.5]
Organic	35.8 [8.1, 63.5]	31.37 [8.1, 54.5]	28.5 [9.2, 47.9]
Hormone/ antibiotic free	32.2 [4.5, 60]	24 [1.5, 46.6]	34.3 [3.8, 64.8]
Grass-based	24.9 [-3.8, 53.6]	22.3 [0.5, 44.1]	25.1 [4.5, 45.7]
Food safety	29.9 [5.3, 54.6]	23 [2.4, 43.6]	39.2 [18.8, 59.6]
PDOs/PGIs	24.7 [7.3, 42]	22.4 [6.1, 38.7]	25.7 [4.3, 47]
COOs/ROOs	29.8 [9.4, 50.3]	22.5 [7.8, 37.2]	29.9 [11.3, 48.4]
Traceability	20.1 [-2.5, 42.7]	17.7 [-3.3, 38.7]	26.1 [-1.8, 50.3]
Mixed attributes	25.68 [1.7, 49.7]	19.2 [1.8, 36.6]	25.8 [2.2, 48.8]

European studies

The current review includes 18 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.

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 A3, 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 A3: 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.

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 A4 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 A4: 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 A5, following the presentation of this information, consumer preferences and WTP for each system changed based on the type of information presented.

Table A5: 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 A6 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 A6: 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 A7 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 A7: 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 A8 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 A8: 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 A9 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 A9: 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 A10 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 A10: 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 A11 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 A11: 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 A12 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 A12: 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 A13 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 A13: 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 A14 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 A14, 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 A14: 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 A15 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 A15: 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 A16 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 A16: 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 A17) 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 A17: Willingness to pay for beef attributes, Sweden (N = 1,070*; n = 630 "no-price sample" and n = 440 "price sample")

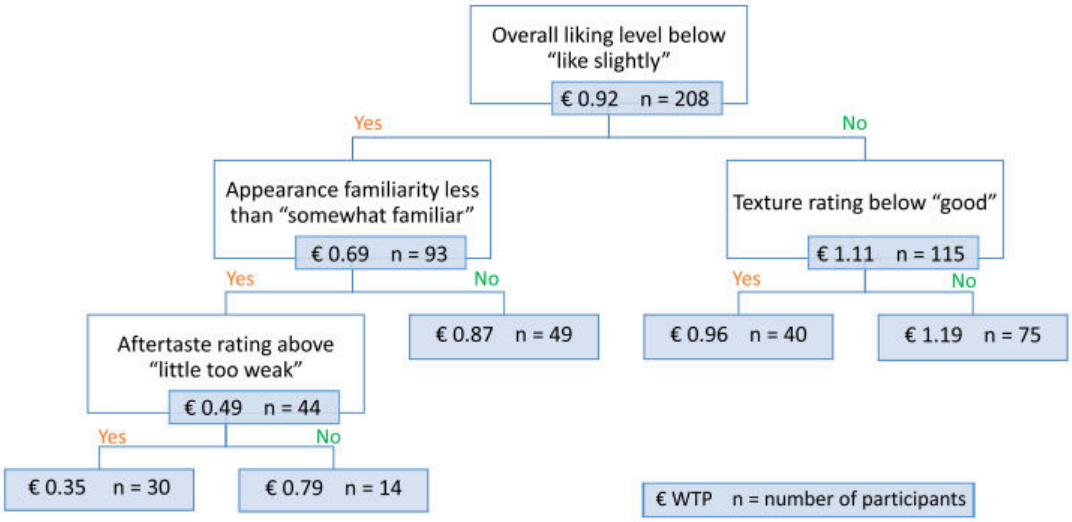
		"Price sample"		"Price sample"	"No-price sample"
		WTP SEK/kg	*Premium (%)***	*Attribute ranking*	
Origin Information (vs. zone of origin inside or outside EU)	COO (inside or outside EU)	113.7	43%	1	1
Animal specific Reference code (vs. not present)	Information on package	15.0	6%	12	12
Traceability to 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)

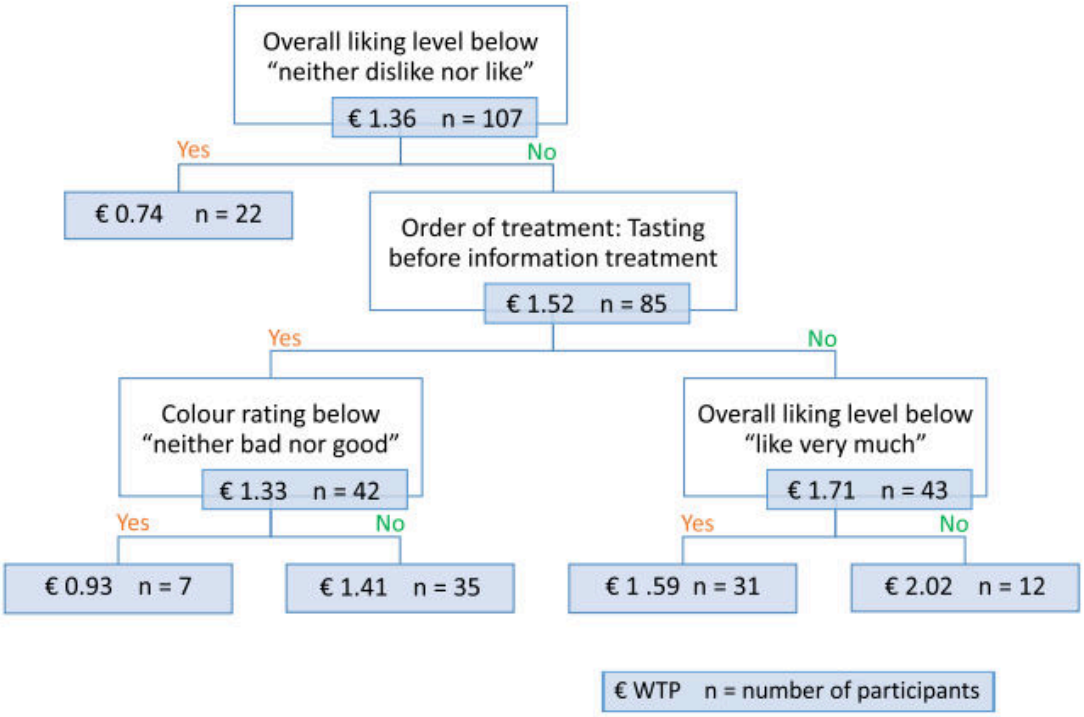
Paci et al. (2018) examined Italian consumers' WTP for the inclusion of environmental and health attributes in fresh fish burger products, finding a WTP of up to an additional 0.57 Euro for the "environment" attribute and 0.37 Euro for the "health" attribute.

Hung and Verbeke (2018) conducted a WTP analysis of the sensory attributes of cooked sausage and cooked ham in Belgium and the Netherlands respectively. They found that WTP was positively influenced by a higher overall liking, appearance familiarity and a better colour, and negatively influenced by a stronger experience of aftertaste and darker colour. Figure A1 shows a pruned regression tree to highlight relative WTP for attributes.

Figure A1: Pruned regression tree showing willingness to pay for sensory attributes of cooked sausage from Belgium (n=208), and cooked ham from the Netherlands (n=107).



Pruned regression trees for predicting the WTP for new cooked sausage in Study 1 (Belgium (BE), n = 208). Complexity parameter (Cp) = 0.0283; cross-validated error = 0.853.



Pruned regression trees for predicting the WTP for new cooked ham in Study 2 (the Netherlands (NL), n = 107). Complexity parameter (Cp) = 0.0245; cross-validated error = 0.822.
Source: Hung and Verbeke (2018)

Dudinskaya et al. (2021) conducted a large scale willingness to pay study for red meat (beef, lamb, and goat) attributes across seven countries (Finland, France, Greece, Italy, Spain, Turkey and the UK). The authors received 2866 valid survey responses, with Beef T-bone, goat chops, lamb chops, and lamb leg cuts the selected cuts in the discrete choice experiment. Results showed that national origin was important to consumers, being one of the most important attributes. New Zealand was used as a reference for origin and EU origin was viewed as preferable to New Zealand meat, with the exception of the UK. Table A18 shows the estimated WTP for all countries in the study.

A18: Estimated WTP for red meat label attributes for seven European countries: Finland (n=413); France (n=414); Germany (n=400); Italy (n=417); Spain (n=417); Turkey (n=391); and UK (n=414). In local coin.

Estimates	Countries						
	FI (EUR)	**FR (EUR)**	**GR (EUR)**	**IT (EUR)**	**ES (EUR)**	**TR (TRY)**	**UK (GBP)**
LL[a]	-6587.84	-6864.38	-6984.07	-7018.80	-7071.07	-6696.65	-6858.30
BIC[b]	13,379.88	13,933.02	14,171.57	14,242.03	14,346.58	13,596.18	13,920.87
Adj. Rho-square	0.1711	0.1385	0.0928	0.1255	0.119	0.11	0.1392
Mean estimates (normal distribution)							
Halal	-0.693 (0.011)	-2.041 (0.000)	0.183 (0.493)	-0.542 (0.008)	-1.335 (0.000)	13.230 (0.000)	-0.713 (0.001)
National origin	2.277 (0.000)	3.737 (0.000)	2.299 (0.000)	3.052 (0.000)	2.584 (0.000)	11.070 (0.000)	0.433 (0.038)
EU origin	0.636 (0.022)	1.695 (0.000)	0.082 (0.783)	0.557 (0.018)	1.068 (0.002)	-0.993 (0.575)	0.143 (0.449)
PGI/PDO	0.035 (0.895)	0.357 (0.138)	0.973 (0.000)	0.815 (0.000)	0.472 (0.058)	6.857 (0.000)	0.302 (0.032)
Carbon footprint	0.330 (0.056)	0.495 (0.015)	0.412 (0.027)	-0.032 (0.827)	0.516 (0.022)	3.853 (0.001)	0.047 (0.681)
Organic	0.839 (0.000)	2.058 (0.000)	1.265 (0.000)	0.657 (0.000)	0.463 (0.036)	4.458 (0.000)	0.491 (0.004)
Low fat	0.330 (0.102)	1.134 (0.000)	0.181 (0.245)	0.554 (0.002)	0.357 (0.069)	0.242 (0.856)	0.137 (0.310)
High protein	-0.332 (0.049)	-0.147 (0.496)	-0.147 (0.011)	0.183 (0.257)	-0.150 (0.405)	-3.048 (0.001)	-0.136 (0.260)
Ready to cook	0.310 (0.101)	-0.705 (0.043)	-0.816 (0.000)	-0.200 (0.287)	-1.300 (0.000)	-1.646 (0.222)	-0.285 (0.097)
Standard deviations estimates (normal distribution)							
Halal	2.634 (0.000)	6.167 (0.000)	2.746 (0.000)	1.920 (0.000)	3.802 (0.000)	20.804 (0.000)	2.613 (0.000)
National origin	3.350 (0.000)	4.050 (0.000)	3.296 (0.000)	3.561 (0.000)	3.545 (0.000)	21.133 (0.000)	0.231 (0.826)
EU origin	1.105 (0.029)	1.421 (0.002)	1.803 (0.000)	0.185 (0.013)	2.273 (0.001)	11.164 (0.000)	0.009 (0.981)
PGI/PDO	0.407 (0.337)	0.361 (0.594)	0.893 (0.020)	0.667 (0.000)	0.784 (0.194)	5.862 (0.007)	0.514 (0.220)
Carbon footprint	0.250 (0.755)	1.180 (0.000)	1.536 (0.000)	0.768 (0.015)	1.495 (0.000)	8.220 (0.000)	0.388 (0.047)
Organic	2.101 (0.000)	3.065 (0.000)	1.731 (0.000)	0.987 (0.000)	2.065 (0.000)	6.354 (0.000)	1.449 (0.000)

Low fat	1.562 (0.000)	1.322 (0.000)	1.084 (0.000)	1.264 (0.000)	1.363 (0.000)	4.309 (0.084)	1.019 (0.000)
High protein	0.358 (0.101)	0.914 (0.088)	1.015 (0.019)	-0.083 (0.550)	0.545 (0.074)	0.979 (0.569)	0.194 (0.361)
Ready to cook	1.846 (0.000)	3.302 (0.000)	1.752 (0.000)	2.004 (0.000)	4.043 (0.000)	3.431 (0.001)	1.879 (0.000)

Numbers in parentheses are robust p-values. a LL: Value of Log Likelihood function b BIC: Bayesian information criterion.

North American studies

The current review includes seven 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) or 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 A19 and A20 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 A19: 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 A20: 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 A21 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 A21: 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 A22 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 A22: 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 A23 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.

Table A23: 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 A24 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.

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

Table A24: 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	0.90	(26%)
				Occasional	3.33	(97%)
				Habitual	8.37	(244%)
	Generic organic label	1.19	(35%)	Non-buyer	-1.01	(-30%)
				Occasional	1.22	(36%)
				Habitual	5.02	(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 A25 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 A26, 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 A25: 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 A26: 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 seven 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 A27, 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 A28 complement those presented above, including that WTP for quality certification appears slightly higher than for others, apart from the '*appearance 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 A27: 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 A28: 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 A29 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 A29: 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 A30 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 A30: 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 A31 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 A31: 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 A32 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 A32: 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 A33 shows, the analysis resulted in three consumer segments based on the respondent's choices regarding concerns in relation to GM-beef and the use of antibiotics in production. These segments were labelled as '*very concerned*' (59% of the sample), '*moderately concerned*' (32%) and the smallest group of '*not too concerned*' (9%). Thus, over half of the sample were very concerned about the use of GM and antibiotics with WTP around $4.4/lb (20 per cent premium), and about product's origin with WTP around -$8/lb (37 per cent premium) for imported meat. This '*very concerned*' segment held generally higher WTP values than other segments, and generally these were higher than the weighted averages. Overall, these results suggest that there exists major heterogeneity in Korean (Seoul) consumer preferences towards meat choices, in particular, regarding the use of GM ingredients and antibiotics in production.

Table A33: 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 A34, 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 A34: 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 four CE and other WTP studies examining the attributes of meat and seafood products in other regions, including Australia, Peru 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 A35. 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 A35: 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 A36, 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 A36: 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)

Morales and Higuchi (2018) investigated how consumer beliefs about health and nutrition affect the WTP more for fish than beef, chicken, and pork in Modern Metropolitan Lima, Peru. Factors explored were all in relation to fish, *exploring knowledge, health and nutrition, familiarity, taste preference, negative effects, and price*. Based upon this it was found that higher household income increases premiums for beef and chicken, while larger household sizes had the opposite effect. In addition, those who were older were less likely to be willing to pay a premium for fish. Taste preference was a significant driver for an increase in WTP for fish versus chicken and pork, while perceptions of health and nutrition for the family increased the WTP for fish compared to beef and chicken. A summary of the WTP extra is shown in Table A37.

Table A37: Willingness to pay for fish versus other meat in Peru (N=444)

	Model I: Fish vs. beef		**Model II: Fish vs. chicken**		**Model III: fish vs. pork**	
	Coef.	FC/OR	Coef.	FC/OR	Coef.	FC/OR
Constant	1.625***	5.078***	1.628***	5.094***	2.200***	9.025***
Socio-demographic characteristics						
Gender	0.055	1.057	0.106	1.111	0.018	1.018
Age	0.002	1.002	0.004	1.005	0.000	1.000
Years of education	0.017	1.017	0.028*	1.028*	0.005	1.005
Have children	0.056	1.057	-0.090	0.914	0.133	1.142
Household size	-0.036	0.964	-0.063*	0.939*	-0.099***	0.906***
Household income (in hundred PEN)	0.005***	1.005***	0.005*	1.005***	0.003	1.003
Belief factors						
BF1: Knowledge of fish	0.019	1.019	0.056	1.057	0.043	1.044
BF2: Health and nutrition of eating fish	0.082*	1.086*	0.103**	1.109**	0.026	1.026
BF3: Familiarity with fish	0.030	1.030	-0.010	0.990	0.053	1.054
BF4: Taste preference of fish	0.032	1.032	0.086**	1.090**	0.174***	1.190***
BF5: Negative affects of fish	0.001	1.001	0.003	1.003	0.030	1.031
BF6: Price of fish	-0.036	0.964	-0.036	0.965	-0.020	0.980
Over dispersion coefficient	-1.078***		-0.962***		-1.154***	
Mean willingness to pay extra (PEN)	7.214		8.777		5.732	
Total observations	444		444		444	

PEN = Sol. The currency of Peru; USD 1 = PEN 4.06

FC/OR is factor change in the expected premium/odds ratio of being an always-zero respondent versus being a non-always-zero respondent for the negative binomial and logistic components, respectively. *, **, and *** indicate the coefficient is statistically significant at 10%, 5% and 1% level, respectively.

Source: Morales and Higuchi (2018)

Hastie, Ashman, Torrico, Ha and Warner (2020) compared perceptions towards sheepmeat and beef in Australia. The authors used a mixed methods approach combining perceptual mapping and sensory methodologies. Whilst not the CE method, the research offers an interesting comparison of dry-aged and wet-aged meat, as well as different animal species within a WTP framework. In terms of sensory perceptions, the authors asked consumers about *tenderness, overall liking, flavour, juiciness, odour liking, quality, healthiness, and premiumness*. Concentrating on quality, the authors combined WTP and likelihood to purchase for dry-aged and wet-aged meat, as shown below in Table A38. Wet-aged beef was most likely to be rated as "better than everyday quality", while the dry-aged beef was most likely to be rated as "good everyday quality". This pattern was also seen in sheepmeat consumption. On average, consumers were willing to pay up to 50–60 AUD per kg for premium quality beef, and 30–40 AUD per kg for premium quality sheepmeat, with prices decreasing with quality grade.

Table A38: Willingness to pay and Likelihood to Purchase based on quality and price, Australia (n=75)

Meat Species	Quality Grade	Relative frequency of quality grade selection (%)		Median price category (AUD Per kg)	Average likelihood of purchasing (%)
		Dry-aged	Wet-aged		
Sheep	Unsatisfactory	0	3	0-10	16
	Good everyday quality	47	22	20-30	53
	Better than everyday quality	33	56	30-40	53
	Premium quality	19	19	30-40	58
Beef	Unsatisfactory	3	8	10-20	32
	Good everyday quality	42	21	20-30	58
	Better than everyday quality	25	44	30-40	66
	Premium quality	31	28	50-60	67

Source: Hastie et al (2020)

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 A39 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 A39: 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 eight 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 four 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 A40 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 A40: 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 A41 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 A41: 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 A42 and A43 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 A42: 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 A43: 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)

Yormirzoev et al (2021) investigated whether milk certification makes a difference to consumers by examining WTP for organic versus all-natural milk in Russia. 608 consumers were surveyed about the variables of *frequency of consumption, awareness of organic farming, belief of Russian certification adherence, belief of Western certification adherence, food safety versus money saving, and risk attitudes*. The authors found that 51 per cent of respondents had a positive WTP for organic versus conventional milk. The major factors in this being perceived health and environmental benefits. However, there was no statistical difference between all-natural and organic milk – highlighting a lack of awareness of the two products with them being used interchangeably.

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 A44) and the segmented-based approach (Table A45). 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 A45). 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 A44: 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 A45: 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 A46 and A47 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 A46: 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 A47: 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 A48 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 A48: 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)

Tait et al (2018) explored Chinese consumers WTP for New Zealand yogurt products. This study was targeted specifically to consumers in Shanghai, with a sample size of 837. The attributes included in the choice experiment were enhanced *animal safety, enhanced animal welfare, organic production, environmental sustainability, social responsibility, COO, price per kg, and yogurt type.* Based on these, Table A49 highlights the willingness to pay of these attributes. This is expressed in the local currency, and as a percentage of the average price used in the choice experiments (prices were determined by the distribution of observed market prices in Shanghai, December 2017).

Table A49: Shanghai consumer WTP for selected yogurt attributes (n=837)

Attributes	WTP ¥/kg
Enhanced food safety	¥44 (54%)
Enhanced animal welfare	¥37 (45%)
Environmentally sustainable	¥39 (47%)
Social responsibility	¥31 (38%)
Organic	¥42 (51%)
China	¥77 (93%)
Germany	¥70 (85%)
Spain	¥48 (58%)
Thailand	¥-9 (-11%)
New Zealand	¥118 (143%)

Note: ¥ average WTP (95 per cent confidence interval)
Source: Tait et al (2018)

A1.3 Fruit & vegetable products

The current review includes 11 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 three 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 A50). 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 A50: 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 A51) 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 A51: 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 A52 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 A52: 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 A53 below shows the range of premiums associated with the above attributes.

Table A53: 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.

Tait et al (2021) investigated apple consumption by Californian consumers. The researchers investigated a number consumer preferences such as brand, sensory and credence attributes before conducting a WTP analysis using a choice experiment methodology. Attributes explored in this were *appearance, social responsibility, organic production, reduction in greenhouse gas emissions, genetic engineering, and price*. The choice experiment highlighted three distinct apple consumer groups in California representing 17 percent, 27 per cent, and 56 per cent of those surveyed. Table A54 shows the results of the WTP analysis, broken down by consumer group.

Table A54: Willingness to pay for apple attributes (USD per pound), California, USA (N=1000)

Consumer Group	Attribute		WTP (USD)
One	Appearance	Moderately blemished	-0.51
		Significantly blemished	-1.19
		Moderately misshapen	-0.59
		Significantly misshapen	-1.75
	Reduction of GHG	15% less GHG	-
		30% less GHG	-
	Organic	Organic	0.54
	Social responsibility	Care for workers	-
		Contribute to local communities	-
		Support farmers	0.30
Two	Appearance	Moderately blemished	-
		Significantly blemished	-0.29
		Moderately misshapen	-0.16
		Significantly misshapen	-0.56
	Reduction of GHG	15% less GHG	-
		30% less GHG	0.26
	Organic	Organic	0.32
	Social responsibility	Care for workers	0.20
		Contribute to local communities	0.41
		Support farmers	-
Three	Appearance	Moderately blemished	-2.72
		Significantly blemished	-4.99
		Moderately misshapen	-2.59
		Significantly misshapen	-3.88
	Reduction of GHG	15% less GHG	-
		30% less GHG	1.42
	Organic	Organic	1.85
	Social responsibility	Care for workers	1.11
		Contribute to local communities	1.35
		Support farmers	1.80

Source: Tait et al (2021)

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 A55 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 A55: 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 A56 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 A56: 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.

Nishimura (2021) investigated the effect of greenhouse pollination methods on consumers WTP for tomatoes in Japan. The study was driven by the phasing out of non-native bumblebees as greenhouse tomato pollinators in Japan. This was largely related to the ecological risks of non-native species and the results of the WTP survey of 1250 consumers found that consumers valued the use of non-native bumblebees' more than hormonal treatment, and native more than non-native bees. This WTP was further increased by informing consumers of the ecological risks of non-native bumblebees to the Japanese ecosystem. The attributes used in this research were *cultivation method, pollination method, functional ingredients, and price.* The results of the WTP are shown in Table A57.

Table A57: WTP for greenhouse pollination methods of Japanese tomatoes. (N=1250).

WTP estimates (Japanese ¥)				
	No information	Only information on quality improvement	Only information on ecological risk	Information on both
HALVE	18.24	21.76	17.55	23.72
	[12.84, 23.63]	[17.71, 25.81]	[13.45, 21.66]	[16.39, 31.04]
HORMONE	-16.95	-17.00	-9.48	-13.59
	[-23.25, -10.66]	[-22.45, -11.55]	[-14.68, -4.29]	[-21.28. -5.90]
NATIVE	9.81	14.57	20.29	30.64
	[4.63, 15.00]	[9.30, 19.83]	[14.38, 26.20]	[20.22, 41.05]
ENRICHED	8.29	7.50	4.56	6.59
	[4.40, 12.19]	[3.64, 11.35]	[0.84, 8.27]	[1.52, 11.67]

The value of each WTP is presented with 95% confidence intervals for the mean in brackets. All values for WTP are in Japanese yen.
Source: Nishimura (2021)

Wang, Wang and Huo (2019) conducted a double hurdle analysis to investigate consumers' WTP of organic fruits in China. 407 surveys were collected across nine Chinese cities and the Willingness-to-pay a premium was modelled as a function of a series of demographic, socio-economic variables, plus fruit attributes, perceptions of fruit safety, and risk attitudes. The results showed that the most important factors influencing willingness to pay a premium involved positive attitudes toward organic label, attention to fruit safety, the perception of importance of fruit attributes. Moreover, the more income consumers earn, the more likely they would be willing to pay a premium for organic fresh fruits.

In terms of fruit attributes, two consumer groups were identified; those willing to pay a premium (n=250) and those unwilling to pay a premium (n=157). Taste and appearance were regarded as the most important attributes in both groups. Purchase convenience and the variety of fruits were perceived as the second most important attributes by WTP consumers (60.4%). The respondents in the WTP group rated the nutritional value (47.6%) comparatively highly when compared to the UWTP group (18.5%). Further, the majority of UWTP believed that sales price was very important (72.0%), potentially explaining their unwillingness to pay for organic fruit (75.8%), stating it was unimportant in contrast to WTP consumers (42.0%). In addition, wrapping appears to be less acute for all interviewees.

Other regions

The current review includes two 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 A58 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 A58: 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 A59, 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 A60 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 A59: 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 A60: 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 12 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 four 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 A61, 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 A62 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 A61: 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 A62: 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 A63, 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 A63: 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).

A study in Portugal investigated the effect of region of origin on consumers WTP for wine. Ferreira et al (2020) conducted an experimental auction in three different Portuguese wine regions. Extrinsic cues tested were *region of origin, profile sensory, food pairing, grape variety, front label design, bottle form, wine history, winemaker, brand, and medals/awards*. An experimental auction methodology was used where participants were placed in two scenarios: a blind tasting with no information and; blind tasting with information. Results showed that participants placed more value on wine attributes when they had previous knowledge of the region of origin. This is likely due to the influence of wine acceptability and expected quality. Further, as the information available to consumers increased, so too did the WTP. Purchase frequency and less self-reported wine knowledge had a negative effect on WTP, while taste had a positive effect.

Asian studies

The current review includes two 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 A64 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 A64: 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 A65 shows differences in WTP estimates produced through the use of each method.

Table A65: 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 four 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 A66), 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 A66: 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)

Tait et al (2020) explored New York wine consumers WTP for Sauvignon Blanc wine. Using a choice experiment methodology, the authors received 495 testable survey responses, assessing the attributes of *biodiversity management, water management, by-product management, energy management, pest and disease management, greenhouse gas management, organic production, social responsibility, origin, Māori production, critic rating, and price.* Most respondents were concerned about pesticides and additives, and interested in improved sustainability reporting. However, a substantial number found that reporting was not easy to understand, and couldn't access the information they wanted. In addition, the researchers identified three distinct consumer groups with each group made up of 47 per cent, 22 per cent, and 31 per cent of respondents, and each of these had differing WTP for attributes. Table A67 below shows the WTP for attributes in USD.

Table 67: New York Wine Consumer WTP (USD) for Sauvignon Blanc Wine (n=495)

Wine attributes	Group one (47%)	Group Two (22%)	Group Three (31%)
Biodiversity Management	1.11 (0.23, 1.99)		2.99 (1.43, 4.55)
Water Management			
By-Product Management			
Energy Management	1.14 (0.38,1.91)		
Pest And Disease Management	1.59 (0.75, 2.42)	2.04 (1.21, 2.89)	1.84 (0.57, 3.12)
Social Responsibility	1.52 (0.59, 2.44)	0.78 (-0.11, 1.66)	
Greenhouse Gas Management	1.80 (0.95, 2.65)	1.01 (0.14, 1.89)	2.59 (1.25, 3.90)
Made with Organic grapes			
100% Organic	1.76 (0.69, 2.84)	2.64 (1.33, 3.95)	
Critic Rating (per point >80)		0.26 (0.10, 0.50)	0.25 (0.03, 0.08)
Made in New Zealand	17.24 (10.35, 24.15)	18.86 (13.75,23.97)	5.62 (1.48, 9.77)
Made in NZ by Māori enterprise	15.15 (9.34, 20.10)	20.01 (16.10, 23.93)	4.37 (0.80, 7.94)
Made in USA	13.33 (7.55, 19.10)	17.61 (12.94, 22.27)	5.90 (2.43, 9.38)
Made in France	16.73 (9.39, 24.10)	15.04 (9.19, 20.89)	4.61 (0.35, 8.87)
Made in Australia	15.12 (9.10, 21.15)	16.50 (11.96, 21.04)	4.29 (0.75, 7.83)
Made in Italy	11.20 (5.85, 17.16)	16.60 (12.12, 21.08	

Mean WTP per 750ml bottle (95% confidence interval). USD, 2019
Source: Tait et al (2020)

Another study based in the USA investigated the WTP of consumers to pay for local muscadine wine (a variety of grape often used to make sweet red and white wines) (Everett et al., 2018). The authors used a choice experiment methodology of wine consumers residing in Tennessee, comparing North Carolina muscadine wine with Tennessee muscadine wine. Variables investigates were whether the consumer likes muscadine wine, a preference to drink red (over white), purchases from a winery, importance of purchasing local wine, and preparedness to pay a premium for local foods.

The survey highlighted that while muscadines were a regionally important wine, many consumers had never tried them. Those that had were more likely to be older, live in rural areas, purchase from wineries, and prefer red wine. Overall there was a WTP a premium for locally produced wine, and weekly wine drinkers were more likely to have tried muscadine wine. Two consumer groups were identified: the first group viewed local wine as a 1, or “not important at all”, and the second group viewed local wine as a 4, or “very important”. The results showed that for each increase in the importance level of buying local wines, the WTP increased by USD 1.48. In contrast, each percentage point increase in premiums paid for local food held a WTP of USD 0.38 (see Table A68).

Table A68: The WTP per bottle of local Muscadine wine in Tennessee (USD) (N=500)

	Willingness to pay per bottle*		
Variable	**Mean**	**Lower level**	**Upper level**
Sample mean	17.14	15.29	21.88
Group 1	13.46	11.75	16.23
Group 2	19.80	16.93	26.66
Effect on WTP of local wine	1.48	0.46	3.10
Effect on WTP of premium local foods	0.38	0.06	0.90

*95% confidence interval. All prices are in USD.
Source: Everett et al, 2018.

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 A69, 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 A69: 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 10 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 A70 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 A70: 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

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 A71 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 A71: 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 A72, 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 A72: 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 A73, 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 A73: 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 A74 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 A74 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 A74: 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 A75 and A76. As shown in Table A75, 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 A76, 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 A75: 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 A76: 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 A77 below.

Table A77: 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

Guney and Giraldo (2020) conducted a discrete choice experiment to understand consumer attitudes and WTP for organic eggs in Turkey. Aside socio-demographic characteristics, the authors investigated the egg attributes of *production method, brand, colour, and price.* Conducting a survey across seven regions of turkey, the researchers gathered a total of 552 responses by the household member responsible for purchases. The results showed that consumers perceive organic eggs to be healthier, more nutritious, and better tasting than conventional methods. Also, organic egg production was seen as being more sensitive to animal welfare and ethical issues. Table A78 below shows the results for the WTP of egg attributes.

Table A78: WTP (₺) of Turkish consumers' for egg attributes

Attribute	WTP (Turkish Lira ₺)
Price	-
Egg type: Conventional	-
Egg type: enriched	0.04
Egg type: free-range	0.76
Egg type: organic	0.76
Brand: unbranded	-
Brand: local	1.02
Brand: big	0.81
Colour: white	-
Colour: brown	0.04

Source: Guney and Giraldo (2020)

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 A79 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 A79: 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 A80 show that respondents, on average, were willing to pay the most ($1.16/12oz, or 16% premium) for USDA certified coffee, and up to a 19 per cent premium for *'sustainability and price conscious'* consumers, which included most of the sample. The results also showed that visual attention to attributes is related to preferences for attributes whereby taking more time and fixating more attention on a particular attribute related to higher WTP. Significant interactions with participants' attention included USDA organic, Fair Trade and price attributes. Hence this study illustrated that *sustainability-motivated* consumers are also likely to seek information about sustainability credentials.

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

Table A80: 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, RNAi, 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 A81 shows, consumers on average preferred chicken with a lower food safety risk and improved animal welfare, regardless of the presence of nanotechnology. WTP values were found to be higher for the "welfare-improved" consumers compared with "conventional" consumers. It also appeared that the presence of nanotechnology could increase WTP for food safety and chicken welfare. A choice debriefing question revealed that around half of the respondents considered the inclusion of such

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

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

Table A81: 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 A82, 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 A82: 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 A83). 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 A83: 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)

Britton and Tonsor (2019) investigated consumers' WTP to pay for beef products derived from RNA interference technology. This is a new technology that is not currently used in the meat sector, but has been successfully used in fruits and vegetables. Ribonucleic acid interference (RNAi) is a process in which small interfering RNA is introduced into an organism's cells and disrupts protein synthesis to alter traits such as muscle development, sex ratios and physiological changes in livestock. This technology has the potential to reduce the level of hormones and antibiotics used in the industry – something that consumers have been demanding. To investigate this further, the researchers adopted a choice experiment methodology and collected responses from an online survey of 3000 U.S. individuals. There were four choice experiment designs and respondents received one of these with an even spread across the sample (n=750). The three non-price beef steak attributes used in the study

were *antibiotic use* (used, free, no claim), *RNAi use* (used, free, no claim), and *USDA grade* (choice and select).

The results showed a negative association between price and the use of RNAi technology in beef steaks. This suggests that consumers will require a discount for beef products produced using RNAi, with specific magnitudes varying substantially based on the label wording faced by consumers. Further, when other controversial attributes are present on the labelling of these products, such as antibiotic or hormone use, there is a potential market share to be gained for products using RNAi technology as an alternative. as opposed to antibiotics. This is important for the future use of the technology and its potential market viability.

A1.7 Summary

In conclusion, this review included 83 international CE and other WTP studies regarding food and beverage choices and associated credence attributes from 2010 to 2021. 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 (38), following by wine (12), fruit and vegetable (11) and dairy products (8). Another 14 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.

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Appendix B: Survey Instrument

Our Land and Water Science Challenge - Survey

Our Land and Water Science Challenge

The Drivers Project

Welcome to Our Land and Water Science Challenge survey.

We welcome your opinion on the international and domestic issues that have the potential to influence land use change/practice in New Zealand. The results will help Our Land and Water understand how New Zealanders prioritise the issues facing the primary sector, and provide market intelligence and foresight into consumer trends.

This survey takes about 10 minutes to complete. You have the right to decline answering any question or stop the survey at any time. If you do stop the survey before the end, the information you have provided will not be used. This survey is being conducted by the Agribusiness and Economics Research Unit (AERU) at Lincoln University in New Zealand.

The lead researcher is Professor 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, click on the >> button below.

Kind regards,

Caroline Saunders

Page Break

Q1 **Key Issues**: What do you see as the three most critical ***international*** issues that have the potential to influence **New Zealand land use change/practice**?

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

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

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

Page Break

Q3: **International Issues**

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

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

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

	High (1)	Medium (2)	Low (3)	Don't know (4)
Māori values (25)	❍	❍	❍	❍
Organic production (26)	❍	❍	❍	❍
Pasture-based production (27)	❍	❍	❍	❍
Product quality (28)	❍	❍	❍	❍
Public health (29)	❍	❍	❍	❍
Religion (30)	❍	❍	❍	❍
Social responsibility (31)	❍	❍	❍	❍
Soil quality (32)	❍	❍	❍	❍
Sustainable supply (33)	❍	❍	❍	❍
Trade agreements (34)	❍	❍	❍	❍
Trade policy (35)	❍	❍	❍	❍
Waste and recycling (36)	❍	❍	❍	❍
Water footprinting and use (37)	❍	❍	❍	❍
Water quality (38)	❍	❍	❍	❍

Page Break

Q7: **Domestic Issues**

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** 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)	❍	❍	❍	❍
Cultural values (11)	❍	❍	❍	❍
Demographics (12)	❍	❍	❍	❍
Digital communications systems (13)	❍	❍	❍	❍
Emissions trading (14)	❍	❍	❍	❍
Extreme weather events (15)	❍	❍	❍	❍
Family and community values (16)	❍	❍	❍	❍

Food safety (17)	❍	❍	❍	❍
Functional food (18)	❍	❍	❍	❍
GM and nanotechnology (19)	❍	❍	❍	❍
Greenhouse gas emissions (20)	❍	❍	❍	❍
Health and safety (21)	❍	❍	❍	❍
Innovative products and services (22)	❍	❍	❍	❍
Local foods/food miles (23)	❍	❍	❍	❍
Māori values (24)	❍	❍	❍	❍
Organic production (25)	❍	❍	❍	❍
Product quality (26)	❍	❍	❍	❍
Public health (27)	❍	❍	❍	❍
Religion (28)	❍	❍	❍	❍
Social responsibility (29)	❍	❍	❍	❍
Soil quality (30)	❍	❍	❍	❍
Sustainable supply (31)	❍	❍	❍	❍
Waste and recycling (32)	❍	❍	❍	❍
Water footprinting and use (33)	❍	❍	❍	❍
Water quality (34)	❍	❍	❍	❍

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Q5: Which 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)

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Q6: How **important** do you consider the following product attributes in achieving **higher product value** from lower volume for New Zealand agricultural products?

	Very important (1)	Important (2)	Neutral (3)	Unimportant (4)	Very unimportant (5)	Don't know (6)
Animal welfare credentials (1)	❍	❍	❍	❍	❍	❍
Low carbon footprint (2)	❍	❍	❍	❍	❍	❍
Lower environmental impact of production (3)	❍	❍	❍	❍	❍	❍
Food safety (4)	❍	❍	❍	❍	❍	❍
Free range (5)	❍	❍	❍	❍	❍	❍
GM-free (6)	❍	❍	❍	❍	❍	❍
High quality (7)	❍	❍	❍	❍	❍	❍
Low level of processing (8)	❍	❍	❍	❍	❍	❍
Low price (9)	❍	❍	❍	❍	❍	❍
Made in New Zealand (10)	❍	❍	❍	❍	❍	❍

	Very important (1)	Important (2)	Neutral (3)	Unimportant (4)	Very unimportant (5)	Don't know (6)
No additives (11)	❍	❍	❍	❍	❍	❍
Organic production (12)	❍	❍	❍	❍	❍	❍
Personal health-enhancing (13)	❍	❍	❍	❍	❍	❍
Reduced water use (14)	❍	❍	❍	❍	❍	❍
Reduced energy use (15)	❍	❍	❍	❍	❍	❍
Regenerative farming (16)	❍	❍	❍	❍	❍	❍
Glysphosate-free (17)	❍	❍	❍	❍	❍	❍
Freshness (18)	❍	❍	❍	❍	❍	❍
Good reputation of producer/grower (19)	❍	❍	❍	❍	❍	❍
Produced by kind, generous people (20)	❍	❍	❍	❍	❍	❍
Produced by a family enterprise (21)	❍	❍	❍	❍	❍	❍
Produced by a Māori enterprise (22)	❍	❍	❍	❍	❍	❍
Reduced chemical residues (23)	❍	❍	❍	❍	❍	❍
Socially responsible production (24)	❍	❍	❍	❍	❍	❍
Taste (25)	❍	❍	❍	❍	❍	❍
Traceability to farm (26)	❍	❍	❍	❍	❍	❍
Seasonal availability (27)	❍	❍	❍	❍	❍	❍
Care for workers (28)	❍	❍	❍	❍	❍	❍
Care for traditional cultures (29)	❍	❍	❍	❍	❍	❍

	Very important (1)	Important (2)	Neutral (3)	Unimportant (4)	Very unimportant (5)	Don't know (6)
Brand (30)	❍	❍	❍	❍	❍	❍
Nutritional content (31)	❍	❍	❍	❍	❍	❍
Pasture-raised rather than housed indoors (32)	❍	❍	❍	❍	❍	❍
100% grass fed (33)	❍	❍	❍	❍	❍	❍
Other, please specify: (34)	❍	❍	❍	❍	❍	❍

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Q7: Agribusinesses can belong to or participate in many schemes for quality assurance, marketing, certification or other purposes. For the next few questions, we are calling all of these ***'agribusiness schemes'***. Examples of agribusiness schemes include programmes such as New Zealand Farm Assurance Programme (NZFAP) and GlobalGAP.

Are you currently participating in an ***agribusiness scheme***?

- ○ Yes
- ○ No

[If 'No' selected, skip to Q11]

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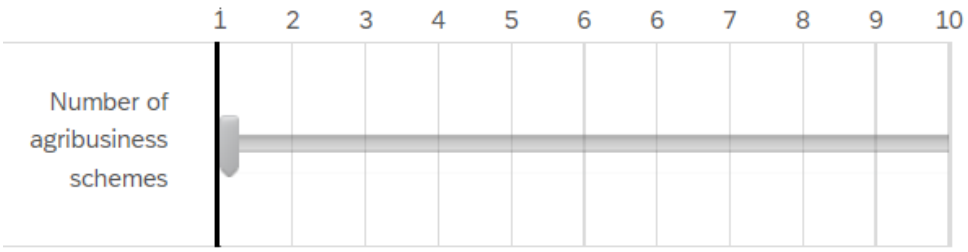
Q8: **How many** agribusiness schemes are you currently participating in?



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Q9: Does the agribusiness scheme(s) that you are participating in account for **environmental**, **social**, **economic**, and/or **cultural** dimension(s)?

	Is this dimension included in the evaluation criteria for the agribusiness scheme(s) that you participate in?		How many criteria are used to assess this dimension under the agribusiness scheme(s) that you participate in?	How often are you audited/assessed for your compliance with your agribusiness scheme(s) requirements for this dimension?			
	Yes	*No*	*Number of criteria*	*Monthly*	*Quarterly*	*Annually*	*Less than annually*
Environmental	○	○		○	○	○	○
Social	○	○		○	○	○	○
Economic	○	○		○	○	○	○
Cultural	○	○		○	○	○	○

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Q10: How much does your agribusiness scheme(s) affect the **prices** that you get for what you sell?

- ○ Large increase in prices received
- ○ Moderate increase in prices received
- ○ Small increase in prices received
- ○ No increase or decrease in prices
- ○ Small decrease in prices received
- ○ Moderate decrease in prices received
- ○ Large decrease in prices received

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Q11: 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)	❍	❍	❍	❍	❍

Q12: 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)	❍	❍	❍	❍	❍

Q13:

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

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