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Japanese kiwifruit consumer consumption behaviours and product preferences: A Latent Class Analysis of New Zealand kiwifruit

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Research Report No. 378
August 2022

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Key Points

- The Agribusiness and Economics Research Unit (AERU) at Lincoln University with the support of research partners under the *Unlocking Export Prosperity from the Agri-food Values of Aotearoa New Zealand* research programme has estimated willingness-to-pay (WTP) values for selected credence attributes of kiwifruit by Japanese consumers, with a focus on identifying preferences for attributes considered *distinctively New Zealand.*
- Preferences for many of the credence attributes considered here are not readily observable from market prices and so the non-market valuation method of Discrete Choice Experiments was used. This involved an online survey of Japanese residents in August 2021, using a research panel.
- As well as WTP values, this survey reports on:
    - Purchase frequency by kiwifruit type, and by country-of-origin
    - Prices paid by kiwifruit type
    - Country-of-origin quality ranking
    - Brand purchase frequency
    - Kiwifruit attribute importance
    - Use of digital media and smart technologies
- Green is the most often purchased kiwifruit, and consumers pay on average about ¥100 per small Green kiwifruit. This represents the lowest cost alternative to consumers and the highest prices usually paid are for Organic varieties. Almost a third of consumers are usually paying between ¥150 and ¥175 per kiwifruit.
- Zespri is the most recognised kiwifruit brand and New Zealand kiwifruit was by far the most purchased country-of-origin with 62 per cent frequently purchasing, compared with Japan as the next most purchased country-of-origin at 32 per cent. New Zealand was ranked the highest of the countries included for quality by 60 per cent of respondents, compared to 22 per cent for Japanese kiwifruit. 94 per cent of consumers ranked NZ kiwifruit in their top three from a set of twelve countries available in-market.
- Almost half of consumers use mobile devices to search for information about kiwifruit, and a third use them to make purchases. A range of smart technologies are used with smart phones with a quarter of consumer making purchases using QR codes, and searching for product information via a QR code. Current use of mobile apps in relation to kiwifruit is relatively low, apps for accessing discounts showed the highest at 13 per cent of consumers. However, strong indications of potential interest are found across a range of app uses, with the most interest coming from access to discounts at 61 per cent.
- The survey included a Discrete Choice Experiment to assess the willingness-to-pay by consumers for different attributes associated with kiwifruit. Using a Latent Class Modelling approach the consumers were segmented into three classes each with different characteristics and preferences.

- The results demonstrate significant preference differences between consumer segments. The first segment is the largest of the three and these consumers preferences focus on personal and environmental health attributes. They have the highest values for increased fibre, carbon neutrality, and biodiversity enhancement of the three segments. These consumers are more likely to have higher usual spend on kiwifruit, believe that minimising harm to the environment is an important purchasing factor, and try to improve their own personal health.
- The second consumer segment comprises one in four consumers and while these consumers have the broadest set of preferences of the three segments, their kiwifruit choices are primarily influenced by taste profile. They have the highest WTP for sweet and balanced taste profiles of the three segments. These consumers are more likely to be older, have higher purchase frequency overall and purchase Zespri kiwifruit more often. The third segment is the smallest and these consumers prioritise enhanced food safety above other claims. They also prefer kiwifruit with enhanced nutrition and environmental claims and are the only segment to prefer an acidic taste profile. These consumers are more likely to female and have a relatively lower purchase frequency overall.
- The average respondent's willingness-to-pay across the three consumer segments is presented in the following table.

Kiwifruit Attributes	Segment 1 60% of consumers	Segment 2 25% of consumers	Segment 3 15% of consumers
Increased Fibre	116% (70%, 163%)	16% (7%, 24%)	33% (22%, 43%)
Increased Vitamin C	33% (23%, 42%)	12% (6%, 18%)	27% (19%, 36%)
Acidic Taste		27% (15%, 38%)	31% (19%, 43%)
Sweet Taste	19% (5%, 35%)	77% (67%, 87%)	
Balance of Acidic and Sweet		70% (62%, 78%)	
Organic	7% (1%, 13%)	13% (7%, 18%)	25% (19%, 32%)
Enhanced Food Safety	39% (29%, 49%)	13% (7%, 20%)	39% (30%, 47%)
Carbon Neutral	87% (63%, 110%)	27% (17%, 36%)	19% (8%, 30%)
Biodiversity Enhancement	77% (54%, 101%)	16% (7%, 26%)	
Water Quality Protection		14% (7%, 21%)	
Social Responsibility	28% (20%, 36%)	14% (9%, 19%)	

Average WTP per single kiwifruit. 95% Confidence Interval in brackets.

Chapter 1
Introduction

This study is part of a research programme entitled *Unlocking Export Prosperity from the Agri-food Values of Aotearoa New Zealand*. It is funded by the Ministry of Business, Innovation and Employment (MBIE) Endeavour Fund for science research programmes. Information on this research programme including reports of other surveys is available from the AERU website https://www.aeru.co.nz/projects/uep.

The research aims to provide new knowledge on how local enterprises can achieve higher returns by ensuring global consumers understand the distinctive qualities of the physical, credence and cultural attributes of agri-food products that are "Made in New Zealand".

Agricultural exports are an important contributor to the New Zealand (NZ) economy. While NZ historically relied on key markets such as the United Kingdom for export trade, NZ has more recently significantly expanded its export markets and Japan has become established as an important kiwifruit destination. It is critically important for NZ exporters to understand export markets and the different cultures and preferences of those consumers to safeguard market access, and for realising potential premiums.

This report describes the application of a survey of Japanese kiwifruit consumers that is designed to examine consumption behaviour and consumer Willingness-to-Pay (WTP) for credence attributes. While *search attributes* such as price or colour can be observed directly, and *experience attributes* such as flavour or texture can be assessed when consumed, *credence attributes* such as environmental sustainability cannot be immediately seen or experienced at the point of sale. For products promoting credence attributes, the role of verification including labelling is of significant importance.

Our approach is to apply a Discrete Choice Experiment economic valuation method, analysed using a statistical approach called Latent Class Modelling that describes profiles for different consumer segments identified in the data and provides estimates of attribute WTP across these segments.

Chapter 2
Kiwifruit Survey Method

To understand how consumers' value NZ credence attributes this study used a structured self-administered online survey that included the Choice Experiment, conducted in Japan in August 2021. The survey was administered through Qualtrics™, a web-based survey system, and focused on kiwifruit consumers with purchase frequency of at least monthly.

The survey was developed by the research team drawing from a literature review on consumer trends for fruit products, results from previous surveys examining consumer attitudes in overseas markets including Japan, and consultation with industry partners and stakeholders, especially those on the AERU advisory board.

Sampling involved recruiting participants from an online consumer panel database provided by an international market research company (dynata.com). Panel members are recruited by online marketing across a range of channels and panels are profiled to ensure adequate representativeness. Panels are frequently refreshed, with the participation history of members reviewed regularly. Respondents for each survey were compensated with a retail voucher for completing a survey.

2.1 Using Choice Experiments to examine consumer preferences

Discrete Choice Experiments are a survey-based valuation approach that have been widely used to value consumer preferences for food product attributes. They are particularly useful for examining the role of new attributes, and attributes that that are not easily observable in market prices, such as the attributes explored in the current report. The ability of this method to identify which individual attributes are more important in consumer choices, and to estimate consumers WTP for these, has seen this approach to valuation become increasingly favoured by researchers.

Designing a Discrete Choice Experiment survey involves deciding which product attributes are of interest, combining these into different product offerings, and asking consumers to pick which offering they prefer from a range of alternatives. In this study, alternative kiwifruit products are described by taste, nutrition, production practices, and price (Table 2-1). Attribute selection was primarily informed by previous surveys, including scoping surveys that used a combination of open text and structured questions to identify which attributes Japanese consumers considered distinctive of NZ kiwifruit.

Table 2-1 Kiwifruit attribute descriptions used in the choice experiment

Kiwifruit attributes	Attribute descriptions
Organic Production	The kiwifruit may be labelled as being grown 100% organically which is GE free and without using synthetic fertilisers or pesticides.
Environmental Sustainability	The kiwifruit may be labeled as being certified by an Environmental Agency who guarantees that the production of the kiwifruit employs a management system that is either Carbon Neutral, Enhances Biodiversity, or Protects Water Quality.
Nutritional Content	Kiwifruit is a good source of nutritional value such as vitamins and fibre. There are natural ways to grow and distribute kiwifruit that is high in vitamins, such as selecting varieties that have higher levels of vitamins or reducing loss during storage.
Taste	The taste of kiwifruit is described as being either sweeter, more acidic, or having balanced sweetness and acidity.
Social Responsibility	The kiwifruit may be labeled as being produced by growers that are socially responsible and actively include public interest into their decision making.
Enhanced Food Safety	The kiwifruit may be labelled as being certified by a Food Safety Agency who guarantees that the production of this kiwifruit employs a management system that is of a higher safety standard than the minimum required.
Price ¥/kiwifruit	Price per individual kiwifruit

Changes in kiwifruit attributes are described using the levels in (Table 2-2). Price levels were determined by market prices, and from what scoping survey respondents said that they usually paid.

Table 2-2 Kiwifruit attribute levels used in the choice experiment

Kiwifruit attributes	Attribute levels			
Enhanced Food Safety	No Label	Certified		
Social Responsibility	No Label	Certified		
Organic Production	No Label	Certified		
Nutritional Content	No change	Increased Fibre	Increased Vitamin C	
Taste	No Label	More acidic than sweet	More sweet than acidic	Balance of sweet and acidic
Environmental Sustainability	No Label	Carbon Neutral	Biodiversity Enhancement	Water Quality Protection
Price ¥ per kiwifruit	¥60	¥100	¥160	¥220

An example of alternative product offerings presented to respondents is shown in Figure 2-1. Each set of offerings comprises three options, of which respondents chose their preferred one. Two options present alternative kiwifruit, while the third is a 'none of these' option. Each respondent answered ten choice sets. Product choices are statistically analysed using Latent Class Models to identify consumers preferences for each product attribute and to estimate consumers' WTP for each attribute. A more detailed description of the theoretical foundation and statistical procedure of Discrete Choice Experiments can be found in Appendix A.

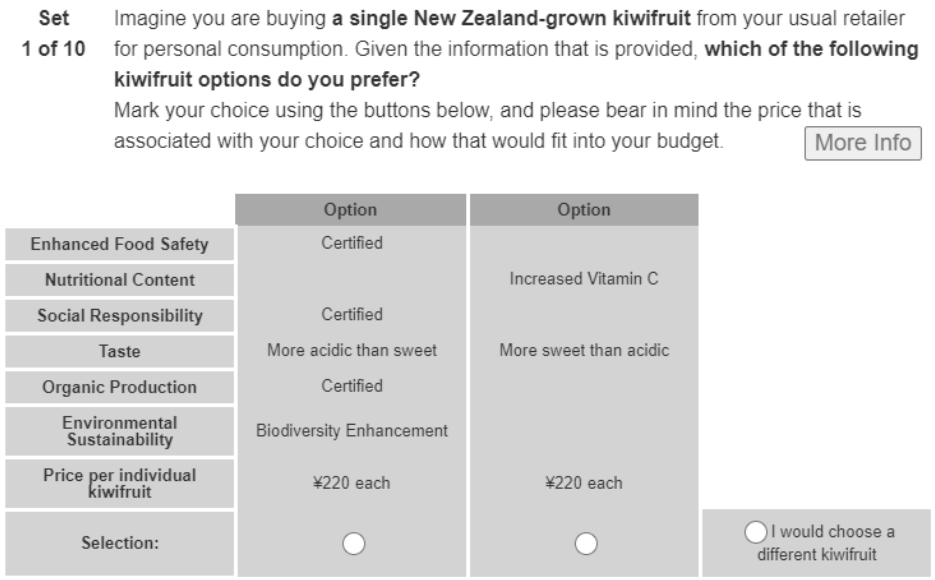
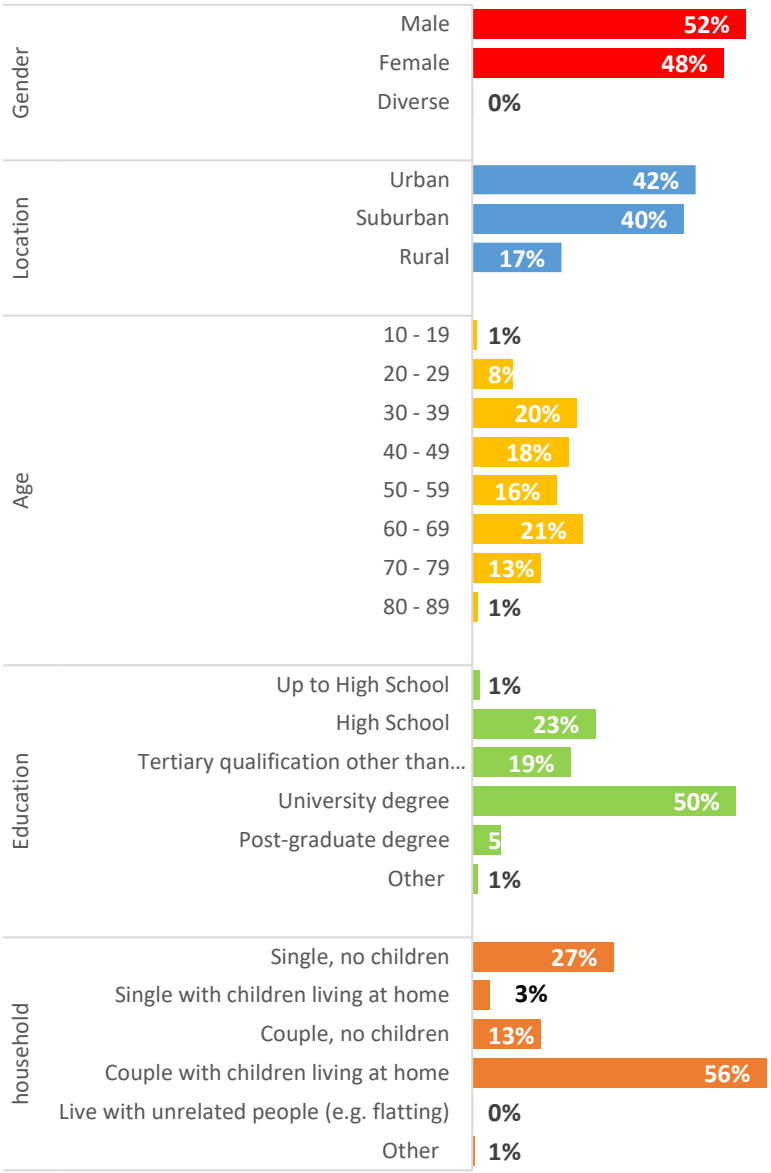


Figure 2-1 Example of a choice experiment question shown to respondents

Chapter 3
Survey Results

3.1 Sample demographic description

- The sample comprised a wide range of demographics, which is important to ensure that the sampling process has broadly canvased the relevant population (Figure 3-1).
- It is important to note that we are not attempting to represent the overall Japanese population, but rather those that purchase kiwifruit at least monthly.



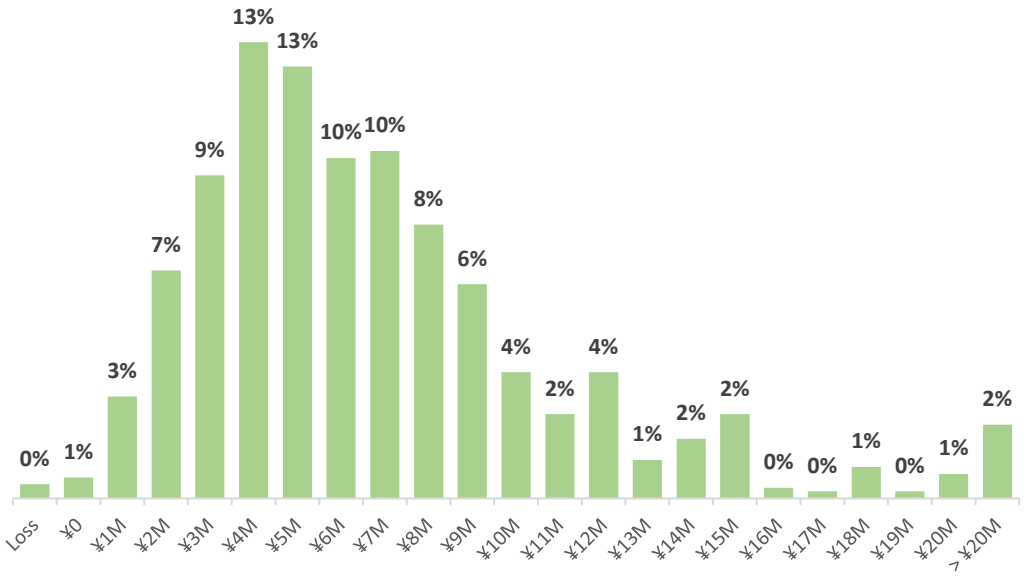


Figure 3-1 Sample demographics

3.2 Purchase and consumption behaviours

3.2.1 Purchase frequency by variety

- Looking at how often consumers purchase kiwifruit overall we can see that 45 per cent of the sample purchase kiwifruit at least weekly (Figure 3-2).

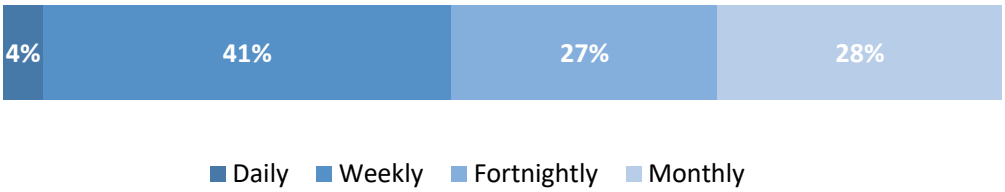


Figure 3-2 Kiwifruit purchase frequency

- Focusing on variety and size reveals that Green is the most frequently purchased variety, while the Kiwiberry and Red varieties were the least frequently purchased (Figure 3-3).

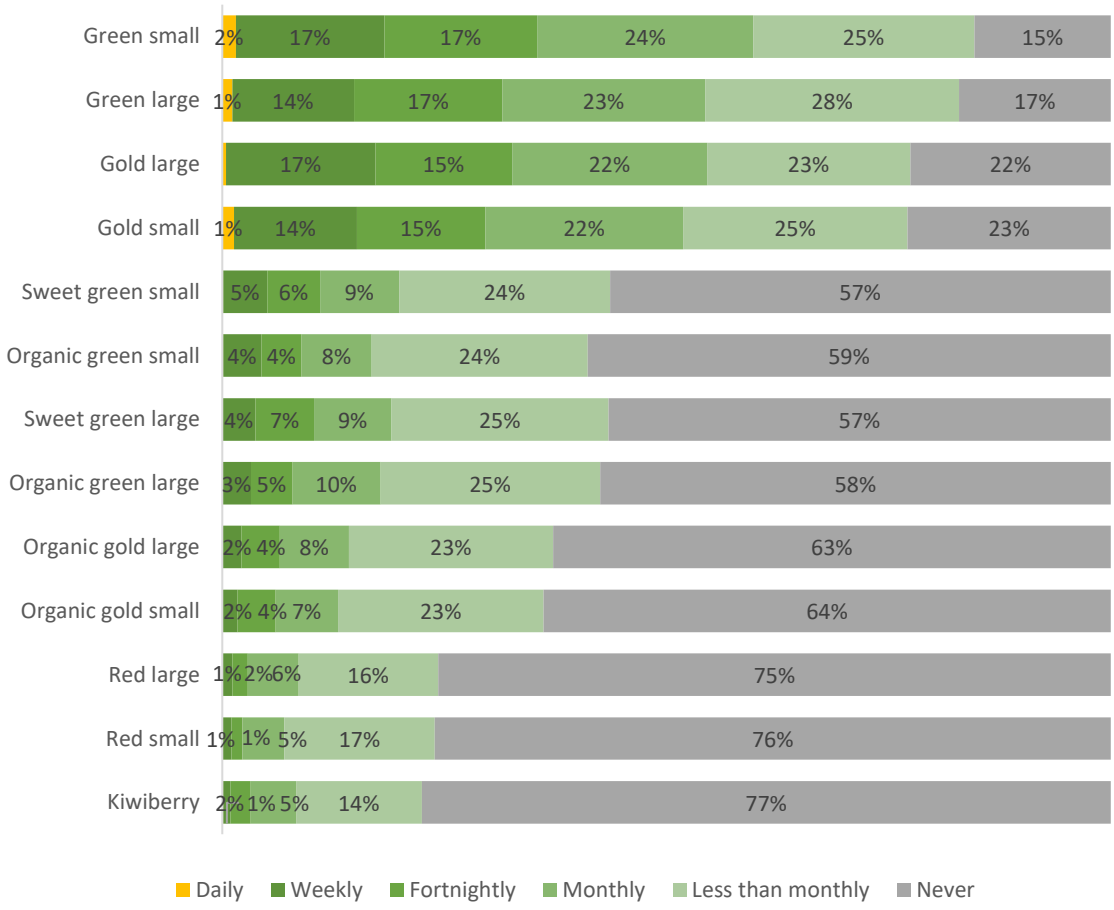


Figure 3-3 Purchase frequency by kiwifruit variety

3.2.2 Usual prices paid for kiwifruit varieties

- Considering the price per kiwifruit that respondents usually paid, 61 per cent of consumers pay between ¥75 and ¥150/kiwifruit (Figure 3-4).
- Looking at how prices paid vary over the different varieties and sizes (Figure 3-5) shows that the highest average prices were paid for large Gold Organic, with the lowest for small Green.

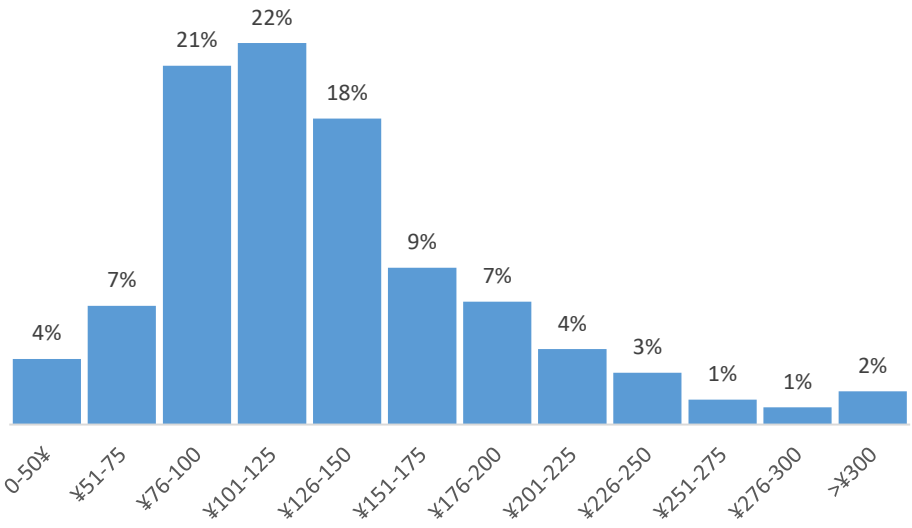


Figure 3-4 Range of prices usually paid

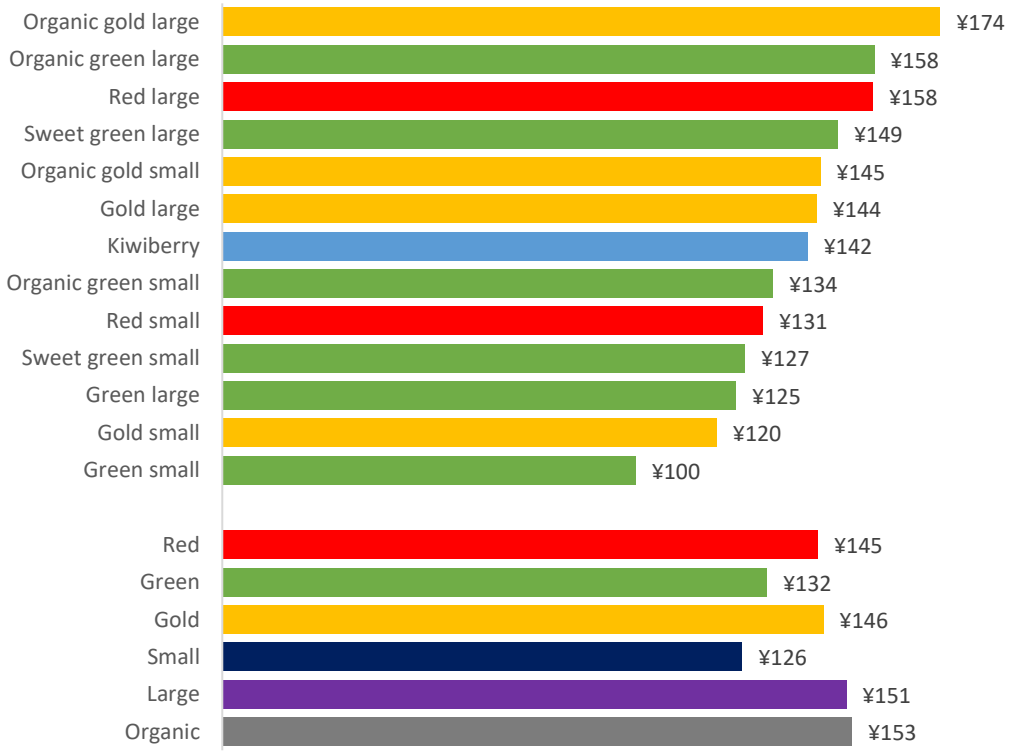


Figure 3-5 Average price usually paid by variety

3.2.3 Brand and country-of-origin purchase frequency

- Looking at brand purchase frequency shows that Zespri is the most frequently purchased kiwifruit brand, with just 10 per cent of respondents having never purchased Zespri kiwifruit (Figure 3-6).

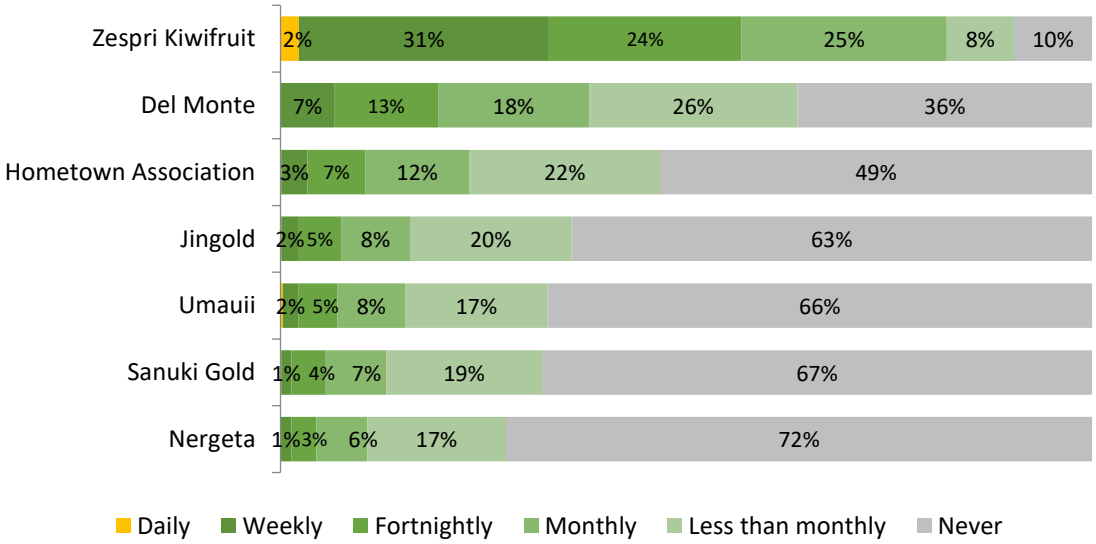


Figure 3-6 Kiwifruit brand purchase frequency

- Consistent with brand purchase frequency, NZ has the highest country-of-origin purchase frequency of all kiwifruit (Figure 3-7).

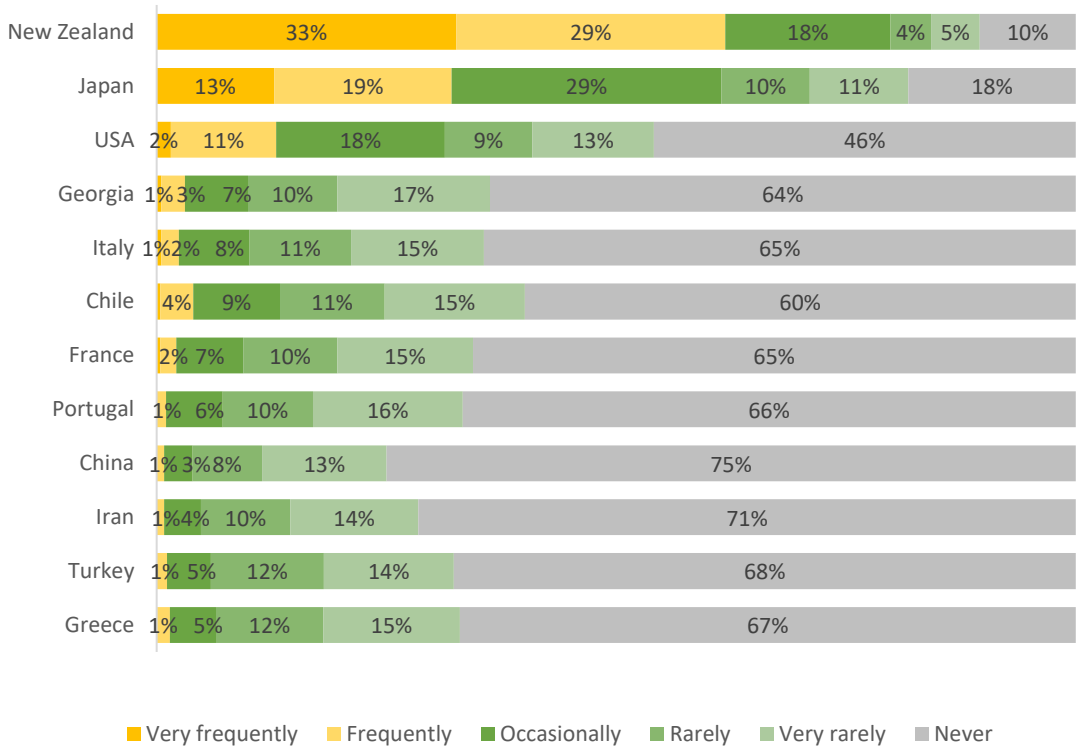


Figure 3-7 Country-of-origin purchase frequency

3.3 Perceptions of kiwifruit quality, and important purchase characteristics

3.3.1 Country-of-origin quality ranking

- Consumers were asked to rank the quality of kiwifruit produced by country-of-origin (Figure 3-8). We see that NZ is ranked first by 60 per cent of consumers, while Chinese and Iranian kiwifruit are more often ranked last than other countries.

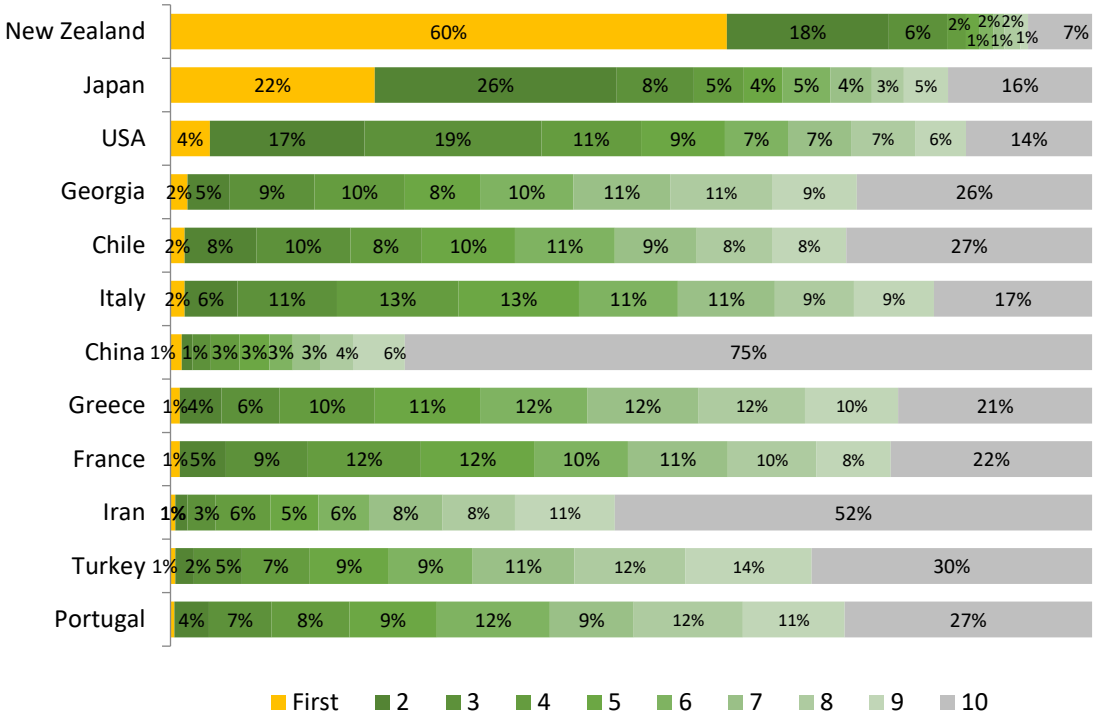


Figure 3-8 Country-of-origin quality ranking

- We can summarise the country-of-origin rankings above by the number of times each country is ranked in the top three by each consumer. This shows that 84 per cent of respondents ranked New Zealand within the top three (Figure 3-9).

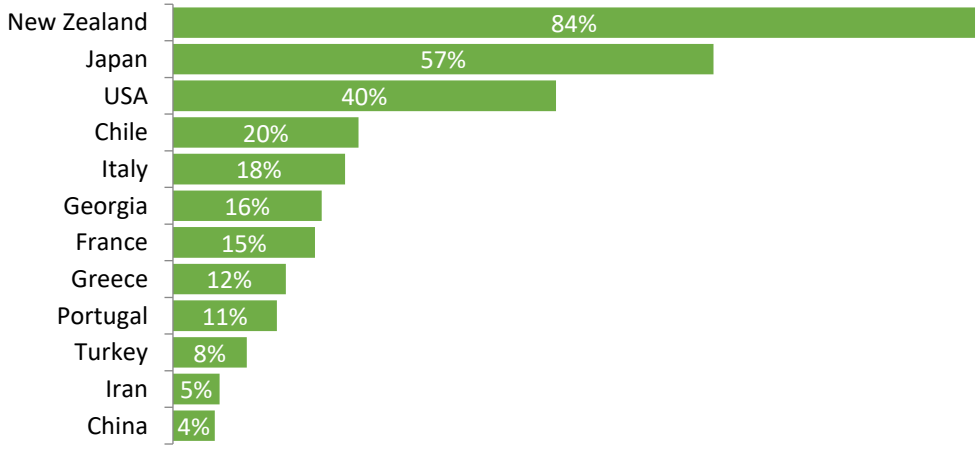


Figure 3-9 Top three country-of-origin quality ranking

3.3.2 Important of kiwifruit characteristics in purchase decisions

- Consumers were asked to rate the importance of a set of kiwifruit characteristics in their purchase decisions (Figure 3-10). Overall, it is most important to consumers that kiwifruit taste good, are fresh, are safe to eat, and affordable.

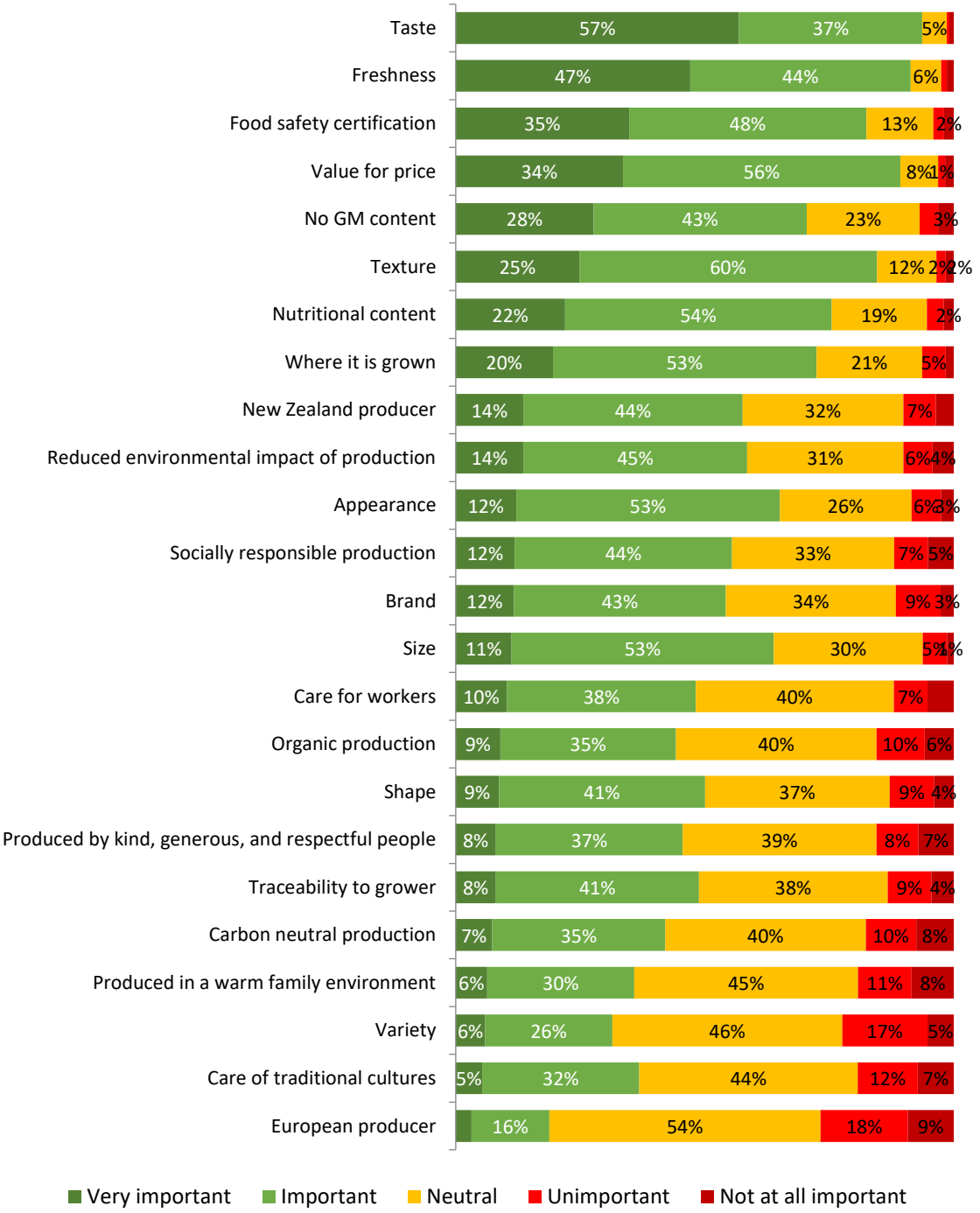


Figure 3-10 Importance of kiwifruit product attributes when purchasing

3.4 Use of smart technology and digital media for kiwifruit shopping

3.4.1 Internet access by device and use

- Use of mobile devices to access the internet exceeds that of home computers with 70 per cent of respondents accessing the internet daily using their mobile device (Figure 3-11).

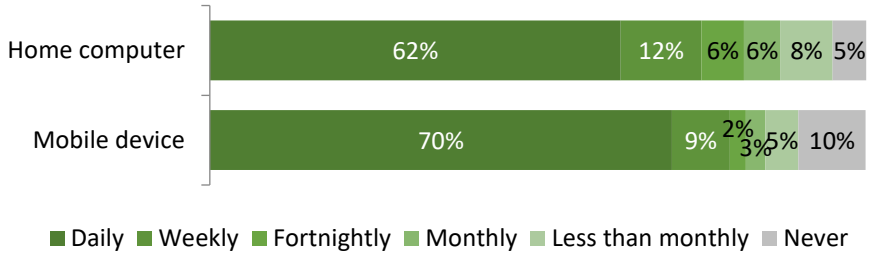


Figure 3-11 Frequency of internet access

- Consumers were then asked how often they used the internet to help decide which kiwifruit to buy. Use was consistent across home computers and mobile devices (Figure 3-12).

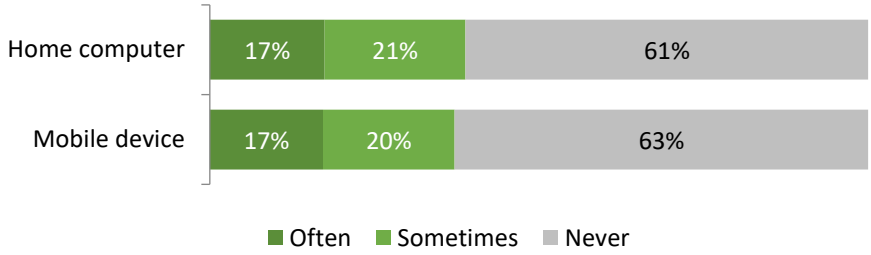


Figure 3-12 Use of internet to help with kiwifruit purchase decision

- Focusing on mobile device use, nearly half of respondents stated that they use mobile devices to search for information about kiwifruit, and a third use them to make purchases (Figure 3-13).

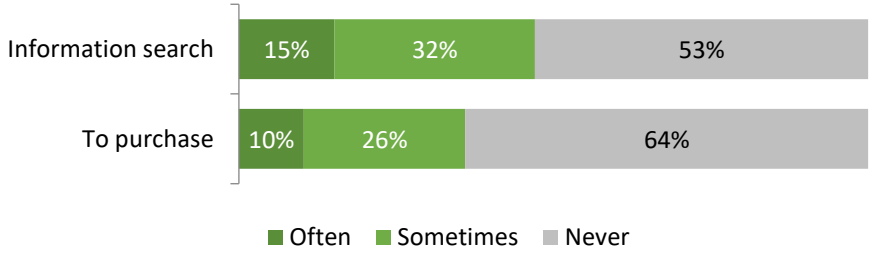


Figure 3-13 Use of mobile device for kiwifruit info and purchases

3.4.2 Use of mobile device smart technologies and apps in relation to kiwifruit

- The types of smart technologies used with a mobile device were fairly consistent between purchasing and information searching (Figure 3-14). With about one in five kiwifruit consumers using QR codes, with these being the most popular use of smart technology.

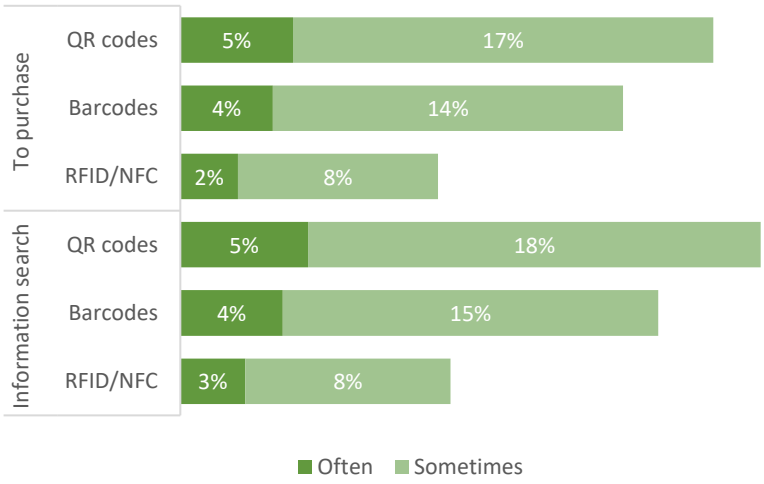


Figure 3-14 Use of mobile device smart technologies in relation to kiwifruit

- While current use of mobile apps is relatively low (Figure 3-15), there is an indication of strong interest across a variety of uses. Discounts/coupons and dietary information are currently the most popular reason for respondents using mobile apps for kiwifruit.

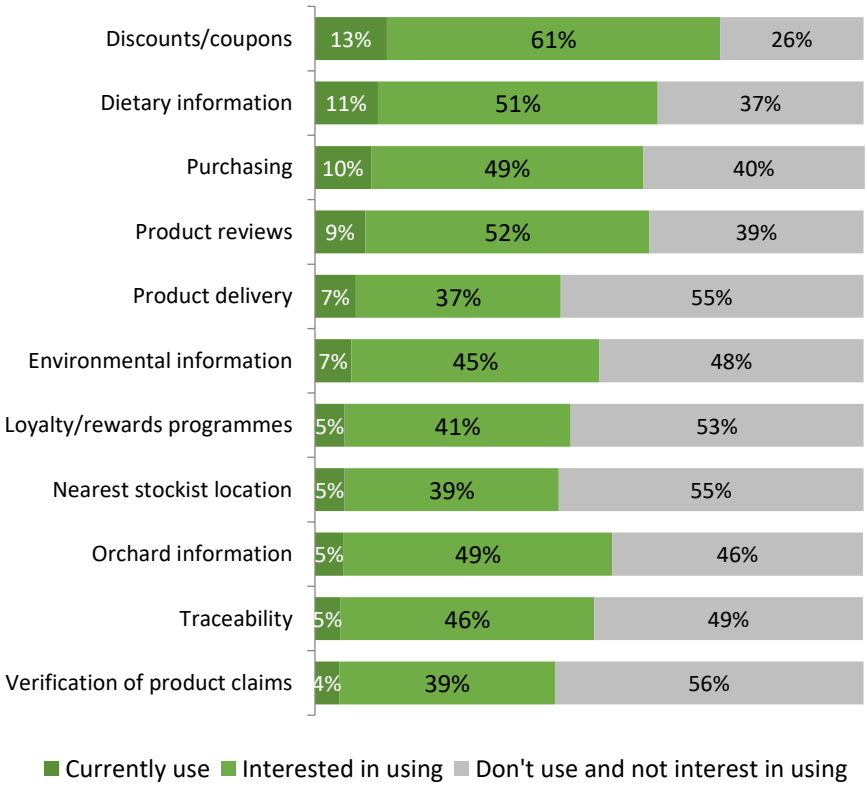


Figure 3-15 Reasons for using mobile apps for in relation to kiwifruit

3.4.3 Kiwifruit expenditure by purchase channel

- Respondents were asked to allocate their **kiwifruit expenditure according to their usual purchase channels** (Figure 3-16). The graph below shows the average expenditure by channel.
- Almost two thirds of expenditure occurs at Supermarkets making this the most popular retail channel for kiwifruit purchases.

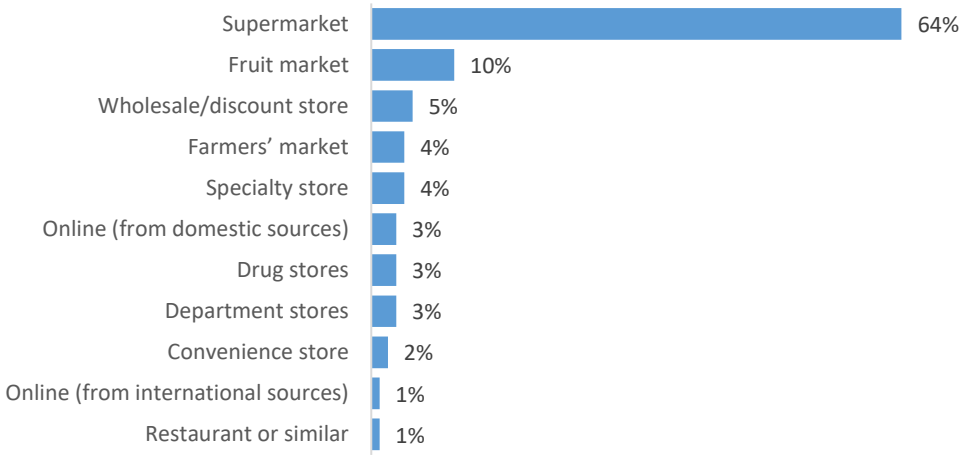


Figure 3-16 Percentage of kiwifruit expenditure by retail channel

- 22 per cent of consumers purchased kiwifruit online. The two main benefits of online shopping were greater avoiding having to go in store, and access to international products (Figure 3-17).

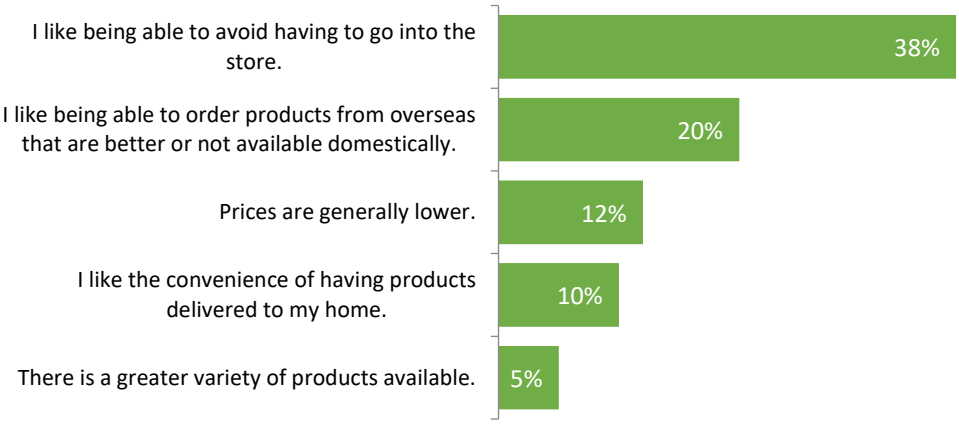


Figure 3-17 Main benefit of shopping online for kiwifruit

3.5 Discrete Choice Experiment analysis of kiwifruit choices

In this section, we present findings of the Discrete Choice Experiment. Our aim is to identify which kiwifruit attributes drive kiwifruit choice, by how much, and by who. We do this by segmenting the sample of consumers into groups based on which product offerings they preferred using a Latent Class Modelling method (Appendix B). Discrete Choice Experiments can be somewhat more difficult to answer compared with the usual question formats that people have typically seen before, so it is important to check whether respondents have been able to complete the exercise reliably. Overall, task and attribute understanding were relatively high, and most respondents felt certain that their responses reflected real-world choices if these kiwifruits were available (Figure 3-18).

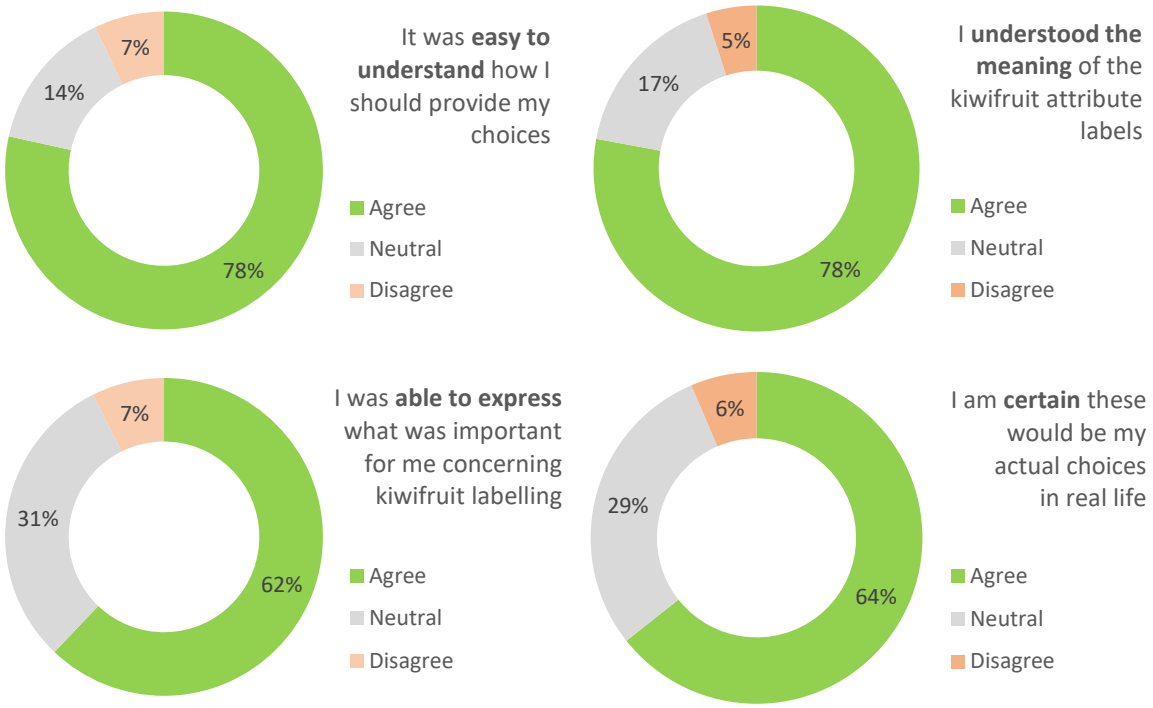


Figure 3-18 Choice experiment debriefing questions: task understanding, attribute understanding, ability to express preferences, certainty of choices made

3.5.1 Consumer willingness-to-pay values

Estimates of WTP tell us how much more the average consumer is willing to pay for a kiwifruit with a particular attribute, over a kiwifruit that does not have this attribute (Table 3-1, Figure 3-19). For example, consumers in the first segment are willing to pay, on average, ¥45 more for a kiwifruit with increased vitamin C over one that does not have this claim. There is some uncertainty in WTP estimates, and the Confidence Intervals reported in Table 3.1 indicate that we can be 95 per cent sure that the true WTP falls within this interval, in this case between ¥35 and ¥57.

We can see that three distinct consumer groups have been identified. The first has an estimated size of 60 per cent, the second group's size is 25 per cent and the third is 15 per cent. These segment sizes tell us the probability that a randomly selected Japanese kiwifruit purchaser belongs to that consumer group.

Table 3-1 Japan Kiwifruit willingness-to-pay by consumer segment

Kiwifruit Attribute	Segment 1 60% of consumers	Segment 2 25% of consumers	Segment 3 15% of consumers
Increased Fibre	¥157*** (94, 220)	¥21*** (10, 32)	¥44*** (30, 58)
Increased Vitamin C	¥45*** (31, 57)	¥16*** (8, 24)	¥37*** (25, 48)
Acidic Taste		¥36*** (20, 51)	¥42*** (26, 58)
Sweet Taste	¥26*** (7, 47)	¥104*** (91, 117)	
Balance of Acidic and Sweet		¥95*** (84, 105)	
Organic	¥9** (1, 17)	¥17*** (10, 24)	¥34*** (25, 43)
Enhanced Food Safety	¥53*** (39, 66)	¥18*** (9, 27)	¥52*** (40, 64)
Carbon Neutral	¥117*** (85, 149)	¥36*** (23, 48)	¥26*** (11, 41)
Biodiversity Enhancement	104*** (73, 136)	¥22*** (10, 35)	
Water Quality Protection		¥19*** (9, 29)	
Social Responsibility	¥38*** (27, 49)	¥19*** (12, 26)	

Average WTP ¥2021 per single kiwifruit (95% Confidence Interval)
***, **, * indicates statistical significance at 1%, 5%, 10% level.

Japanese Consumer Willingness-to-pay Segments

1. Healthy Me - Healthy Environment — 60% of consumers

This segment is the largest of the three consumer groups. These consumers preferences focus on personal and environmental health attributes. They have the highest WYP for increased fibre of the three segments.

Consumers in this segment are more likely to:

- Have higher usual spend on kiwifruit
- Minimise environmental harm
- Improve their personal health

2. Broad Considerations-Taste Driven — 25% of consumers

While these consumers have the broadest set of preferences of the three segments, their kiwifruit choices are primarily influenced by taste profile. They have the highest WTP for sweet and balanced taste profiles of the three segments.

Consumers in this segment are more likely to:

- Older
- Purchase kiwifruit more often
- Purchase Zespri more often

3. Safety Focused — 15% of consumers

These consumers value enhanced food safety the most. They also prefer kiwifruit with enhanced nutrition and environmental claims. They are the only segment to prefer an acidic taste profile.

Consumers in this segment are more likely to:

- Be female
- Have lower purchase frequency

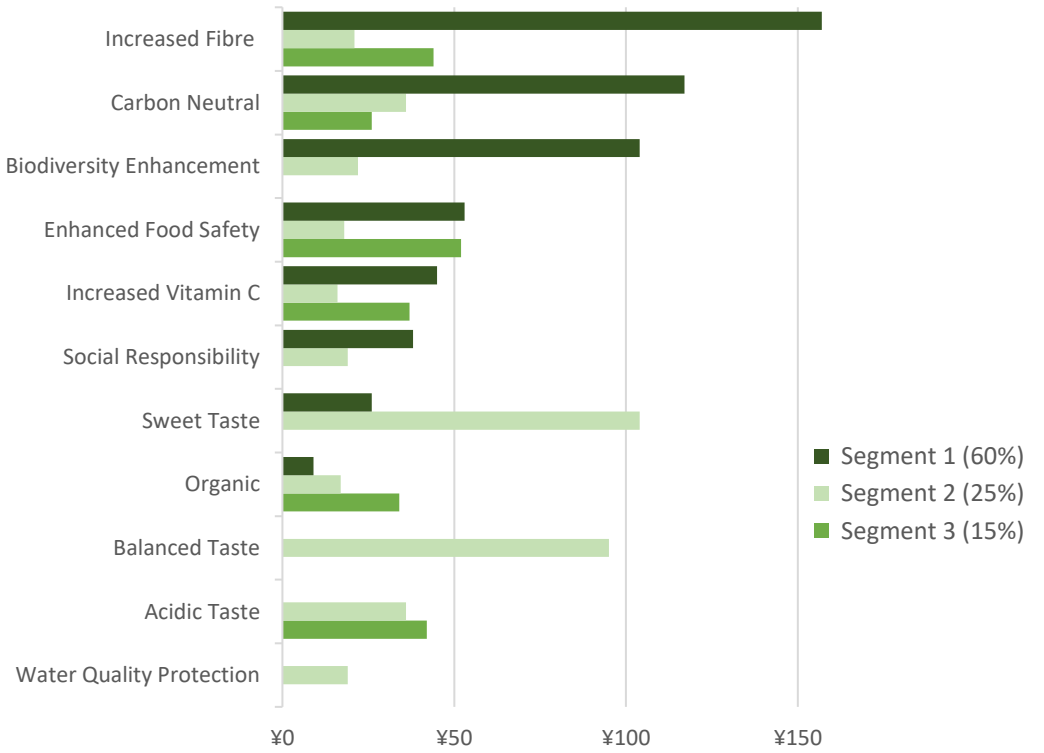


Figure 3-19 Japanese consumer willingness-to-pay for kiwifruit attributes

To provide an indication of overall willingness-to-pay values, the individual segment values presented above are combined to form a weighted aggregate value (Figure 3-20**Error! Reference source not found.**). These estimates are formed by weighting each willingness-to-pay value for each class, by their class size and summing across segments. In this case, the attribute with the greatest willingness-to-pay is for increased fibre, followed by carbon neutral production.

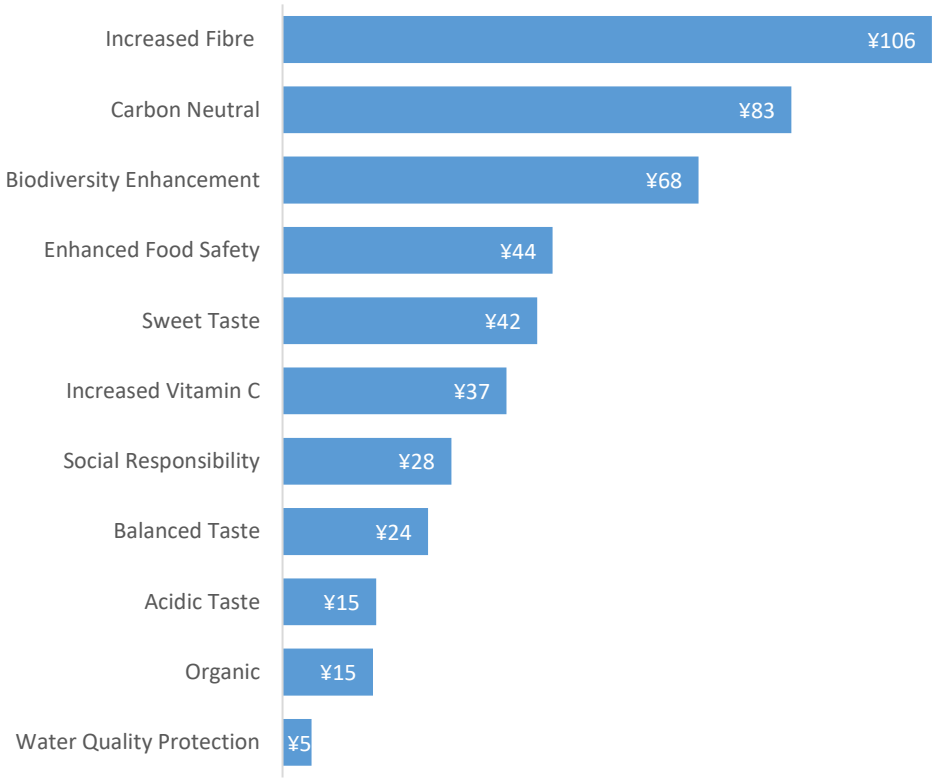


Figure 3-20 Weighted aggregate willingness-to-pay

Chapter 4
Conclusions

This report presents the findings of a structured online survey of Japanese kiwifruit consumers. The surveys objective was to provide insights into consumers' purchase and consumption behaviours. The information gathered included examining perceptions of important drivers of product characteristics, the role of digital media and smart technologies, and consumer preferences for distinctively New Zealand credence attributes.

Overall, results clearly indicate that New Zealand kiwifruit is held in high regard as a high-quality offering with characteristics that consumers prefer and value. The statistical analysis of consumers' kiwifruit choices using the Discrete Choice Experiment and Latent Class Modelling provides a robust analytical framework to identify consumer segments with differing characteristics and product preferences. Profiling high value consumers informs marketing strategy aimed at engaging consumers with highest willingness-to-pay for the product attributes that New Zealand can deliver.

This survey is the second in the research programme to survey Japanese kiwifruit consumers with the first survey in 2019. The two samples are very similar on demographic measures including income, gender, location, education, age, and household composition. Comparing results found here to the previous survey show that[1]:

- Average prices paid across variates have remained steady between surveys 2019 and 2021, with minor increases in a few varieties such as large Organic Gold of around 5 per cent.
- Zespri remains the most purchased brand, followed by Del Monte. Purchases from consumers Hometown Association have increased from 21 per cent at least monthly to 44 per cent.
- Consumers top three country-of-origin quality ranking remains unchanged between surveys, with NZ quality highest ranked, followed by Japan and the USA.
- The most important factors in consumers kiwifruit choices have remained the same: taste, freshness, food safety, value of money, GM-free, texture, nutritional content, and where it is grown.
- Comparing estimates of consumer willingness-to-pay for kiwifruit attributes in the Discrete Choice Experiment reveals some consistencies and changes (Figure 4-1). Consumer preferences are stable for 'Carbon Neutral' production, with this remaining a highly valued attribute by Japanese consumers. Similarly, preferences for increased 'Vitamin C' have been consistently strong across both surveys. And willingness-to-pay for 'Sweet Taste' and 'Social Responsibility' attributes are essentially the same across both surveys, and are at a significant level.

[1] Tait, Peter, Caroline Saunders, Paul Dalziel, Paul Rutherford, Timothy Driver and Meike Guenther (2020). *Japanese kiwifruit consumer consumption behaviours and product preferences: A Latent Class Analysis.* AERU Client Report, prepared for Unlocking Export Prosperity Research Programme. Lincoln University: Agribusiness and Economics Research Unit.

- Kiwifruit attributes that have seen a significant increase in consumer WTP include 'Enhanced Food Safety', 'Increased Fibre', and 'Biodiversity Enhancement'. Consumer preferences that are weaker in the 2021 survey round include 'Water Quality Protection' and 'Organic'.

At the time of the first survey in 2019, the COVID-19 pandemic had not reached Japan. The pandemic officially broke out in Japan in January 2020 when the first confirmed case was recorded. In the months leading up to the second survey conducted in August 2021, there were around 100 deaths per day on average. Covid has affected changes in consumer food and eating behaviours. Food and nutrition now play a greater role in providing health benefits and in strengthening the immune system. Some of the changes in WTP between 2019 and 2021 estimates may be attributable to these factors. Demand for food that provides preventative health has increased, and this can have the effect of lifting overall WTP values across kiwifruit attributes. Most obviously perhaps, the tripling of WTP for 'Enhanced Food Safety' could be attributable to the pandemic affect. And the now significant consumer interest in 'Increased Fibre' may be generated by consumers' focus on generating health benefits in addition to what they have currently available.

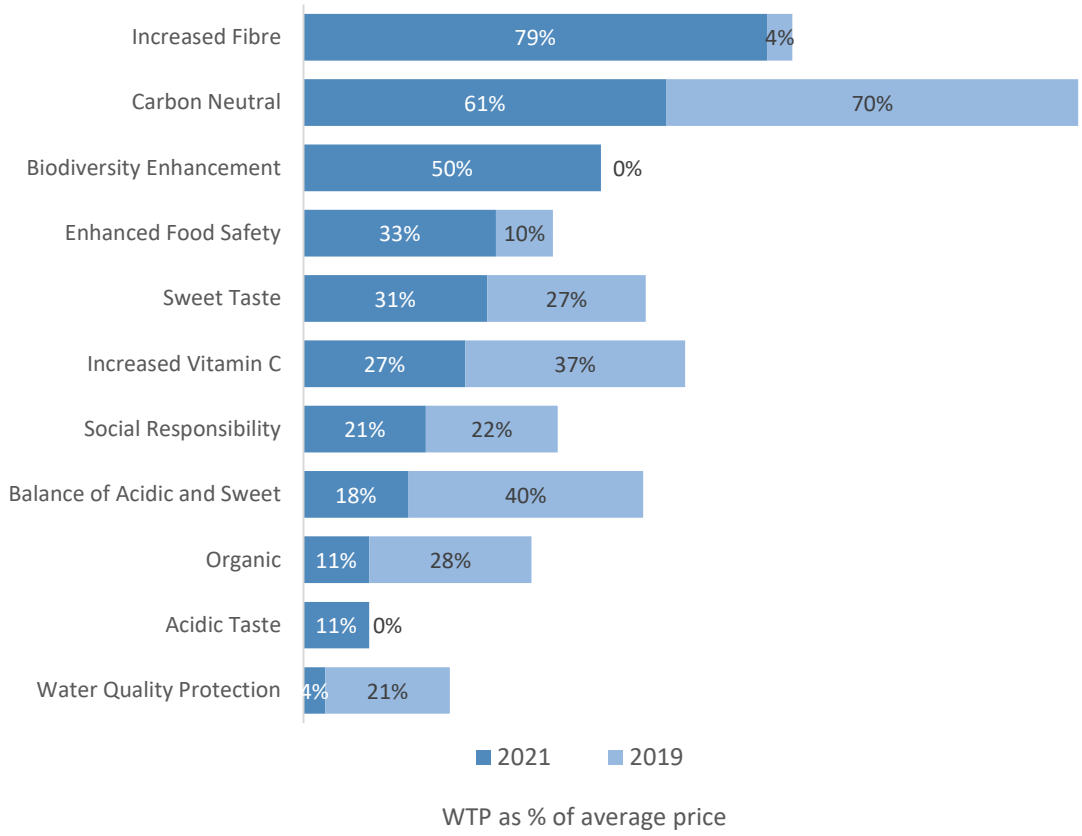


Figure 4-1 Comparing 2021 and 2019 WTP

Appendix A
Statistical Method

This appendix provides technical details of statistical analysis of choice data. The appendix includes a brief description of the theoretical foundations of choice analysis followed by statistical probability estimation approaches, focusing on contemporary models applied in this report. Lastly, the method used in generating monetary estimates is described.

A-1 Conceptual Framework

In Choice Experiments (CEs), researchers are interested of what influences, on average, the survey respondents' decisions to choose one alternative over others. These influences are driven by people's preferences towards the attributes but also the individual circumstances such as their demographics or perceptions of the choice task (e.g., the level of difficulty or understanding) (Hensher et al. 2015).

Each alternative in a choice set is described by attributes that differ in their levels, both across the alternatives and across the choice sets. The levels can be measured either qualitatively (e.g., poor and good) or quantitatively (e.g., kilometres). This concept is based on the characteristics theory of value (Lancaster 1966) stating that these attributes, when combined, provide people a level of utility[2] *U* hence providing a starting point for measuring preferences in CE (Hanley et al. 2013; Hensher et al. 2015). The alternative chosen, by assumption, is the one that maximises people's utility[3] providing the behavioural rule underlying choice analysis:

$$U_j > U_i \tag{0.1}$$

where the individual *n* chooses the alternative *j* if this provides higher utility than alternative *i*. A cornerstone of this framework is Random Utility Theory, dated back to early research on choice making (e.g., Thurstone 1927) and related probability estimation. This theory postulates that utility can be decomposed into systematic (explainable or observed) utility *V* and a stochastic (unobserved) utility ε (Hensher et al. 2015; Lancsar and Savage 2004).

$$U_{nj} = V_{nj} + \varepsilon_{nj} \tag{0.2}$$

where *j* belongs to a set of J alternatives. The importance of this decomposition is the concept of utility only partly being observable to the researcher, and remaining unobserved sources of utility can be treated as random (Hensher et al. 2015). The observed component includes information of the attributes as a linear function of them and their preference weights (coefficient estimates).

$$V_{nsj} = \sum_{k=1}^{K} \beta_k x_{nsjk} \tag{0.3}$$

with *k* attributes in vector x for a choice set s. Essentially, the estimated parameter β shows "the effect on utility of a change in the level of each attribute" (Hanley et al. 2013, p. 65). This change can be specified as linear across the attribute levels, or as non-linear using either dummy coding or effect coding

[2]Related terminology used in psychology discipline is *the level of satisfaction* (Hensher et al. 2015).
[3]In choice analysis, utility is considered as *ordinal utility* where the relative values of utility are measured (Hensher et al. 2015).

approaches. The latter coding approach has a benefit of not confounding with an alternative specific constant (ASC) when included in the model (Hensher et al. 2015).

A-2 Statistical Modelling of Choice Probabilities

The statistical analysis aims to explain as much as possible of the observed utility using the data obtained from the CE and other relevant survey data. In order to do so, the behavioural rule (eq. 1.1) and the utility function (eq. 1.2) are combined (Hensher et al. 2015; Lancsar and Savage 2004) to estimate the probability of selecting an alternative *j*:

$$\Pr_{nsj} = \Pr\left(U_{nsj} > U_{nsi}\right) = \Pr\left(V_{nsj} + \varepsilon_{nsj} > V_{nsi} + \varepsilon_{nsi}\right) = \Pr\left(\varepsilon_{nsi} - \varepsilon_{nsj} < V_{nsj} - V_{nsi}\right) \forall j \neq i \quad (0.4)$$

where the probability of selecting alternative *j* states that differences in the random part of utility are smaller than differences in the observed part. A standard approach to estimate this probability is a conditional logit, or multinomial logit (MNL) model (McFadden 1974). This model can be derived from the above equations (1.2 and 1.3) by assuming that the unobserved component is independently and identically distributed (IID) following the Extreme Value type 1 distribution (see e.g. Hensher et al. 2015; Train, 2003). Although the MNL model provides a "workhorse" approach in CE, it includes a range of major limitations (see e.g. Fiebig et al. 2010; Greene and Hensher 2007; Hensher et al. 2015):

- Restrictive assumption of the IID error components
- Systematic, or homogenous, preferences allowing no heterogeneity across the sample
- Restrictive substitution patterns, namely the existence of independence of irrelevant alternatives property where introduction (or reduction) of a new alternative would not impact on the relativity of the other alternatives
- The fixed scale parameter obscures potential source of variation

Some or all of these assumptions are often not realised in collected data. These restrictive limitations can be relaxed in contemporary choice models. In particular, the random parameter logit (RPL) model (aka, the mixed logit model) has emerged in empirical application allowing preference estimates to vary across respondents (Fiebig, et al. 2010; Hensher et al. 2015; Revelt and Train, 1998). This is done by specifying a known distribution of variation to be parameter means. The RPL model probability of choosing alternative *j* can be written as:

$$\Pr_{nsj} = \frac{\exp(\beta_n' x_{nsj})}{\sum_J \exp(\beta_n' x_{nsj})} \quad (0.5)$$

where, in the basic specification, $\beta_n = \beta + \eta_n$ with η being a specific variation around the mean for *k* attributes in vector *x* (Fiebig, et al. 2010; Hensher et al. 2015). Typical distributional assumptions for the random parameters include normal, triangular and lognormal distributions, amongst others. The normal distribution captures both positive and negative preferences (i.e., *utility* and *disutility*) (Revelt and Train, 1998). The lognormal function can be used in cases where the researcher wants to ensure the parameter has a certain sign (positive or negative), a disadvantage is the resultant long tail of estimate distributions (Hensher et al. 2015). The triangular distribution provides an alternative functional form, where the spread can be constrained (i.e., the mean parameter is free whereas spread is fixed equal to mean) to ensure behaviourally plausible signs in estimation (Hensher et al. 2015). Further specifications used in modelling include parameters associated with individual specific characteristics (e.g, income) that can influence the heterogeneity around the mean, or allowing correlation across the random parameters. The

heterogeneity in mean, for example, captures whether individual specific characteristics influence the location of an observation on the random distribution (Hensher et al. 2015). In this study, the frequency of visits to rivers, streams and lakes was used to explain such variance.

Another way to write this probability function (in eq. 1.4) (Hensher et al. 2015) involves an integral of the estimated likelihood over the population:

$$L_{njs} = \int_{\beta} \Pr_{nsj}(\beta) f(\beta|\theta) d\beta \tag{0.6}$$

In this specification, the parameter θ is now the probability density function conditional to the distributional assumption of β. As this integral has no closed form solution, the approximation of the probabilities requires a simulation process (Hensher et al. 2015; Train, 2003). In this process for data *X*, *R* number of draws are taken from the random distributions (i.e. the assumption made by the researcher) followed by averaging probabilities from these draws; furthermore these simulated draws are used to compute the expected likelihood functions:

$$L_{nsj} = E(\Pr_{nsj}) \approx \frac{1}{R} \sum_{R} f(\beta^{(r)}|X) \tag{0.7}$$

where the $E(\Pr_{nsj})$ is maximised through Maximum Likelihood Estimation. This specification (in eq. 1.6) can be found in Hensher et al. (2015). In practice, a popular simulation method is the Halton sequence which is considered a systematic method to draw parameters from distributions compared to for example, pseudo-random type approaches (Hensher et al. 2015).

A-3 Econometric Extensions

Common variations of the RPL model include specification of an additional error component (EC) in the unobserved part of the model. This EC extension captures the unobserved variance that is alternative-specific (Greene and Hensher 2007) hence relating to substitution patterns between the alternatives (Hensher et al. 2015). Empirically, one way to explain significant EC in a model is SQ-bias depicted in the stochastic part of utility if the EC is defined to capture correlation between the non-SQ alternatives (Scarpa et al., 2005).

Another extension which has gained increasing attention in recent CE literature, is the Generalized Mixed Logit (GMXL) model (Czajkowski et al. 2014; Hensher et al. 2015; Juutinen et al. 2012; Kragt 2013; Phillips 2014). This model aims to capture remaining unobserved components in utility as a source of choice variability by allowing estimation of the scale heterogeneity alongside the preference heterogeneity (Fiebig et al. 2010; Hensher et al. 2015). This scale parameter is (inversely) related to the error variance, and in convenient applications such as MNL or RPL, this is normalised to one to allow identification (Fiebig et al. 2010; Louviere and Eagle 2006). However, it is possible that the level of error variance differs between or within individuals, due to reasons such as behavioural outcomes, individual characteristics or contextual factors (Louviere and Eagle 2006).

Recent GMXL application builds on model specifications presented in Fiebig et al. (2010), stating that β_n (in eq. 1.4) becomes:

$$\beta_n = \sigma_n \beta + \gamma \eta_n + (1-\gamma)\sigma_n \eta_n \tag{0.8}$$

where σ is the scale factor (typically = 1) and $\gamma \in \{0,1\}$ is a weighting parameter indicating variance in the residual component. In the case the scale factor equals 1, this reduces to the RPL model. The importance of the weighting parameter is the impact on the scaling effect on the overall utility function (population means) versus the individual preference weights (individual means): when *γ* parameter approaches zero the scale heterogeneity affects both means, whereas when this approaches one the scale heterogeneity affects only the population means (Hensher et al. 2015; Juutinen et al. 2015). Interpretation of these parameters includes

- If *γ* is close to zero, and statistically significant, this supports the model specification with the variance of residual taste heterogeneity increases with scale (Juutinen et al. 2012); and
- If *γ* is not statistically significant from one, this suggests that the unobserved residual taste heterogeneity is independent of the scale effect, that is the individual-level parameter estimates differ in means but not variances around the mean (Kragt, 2013)

The scale factor specification (eq. 1.7) can also be extended to respondent specific characteristics associated with the unobserved scale heterogeneity (Hensher et al. 2015; Juutinen et al. 2015):

$$\sigma_n = \exp\{\bar{\sigma} + \tau\omega_n\} \tag{0.9}$$

where $\bar{\sigma}$ *is* the mean parameter in the error variance; and ω is unobserved scale heterogeneity (normally distributed) captured with coefficient *τ* (Hensher et al. 2015; Juutinen et al. 2015; Kragt, 2013). Juutinen et al. (2012), for example, in context of natural park management found that respondents' education level and the time spent in the park explained the scale heterogeneity ($\tau > 0$, p-value < 0.01). In this study, the respondents indicated levels of choice task understanding and difficulty were used to explain scale heterogeneity.

A-4 Estimation of Monetary Values

Typically the final step of interest in the CE application is the estimation of monetary values of respondent preferences for the attributes considered in utility functions. These are commonly referred to as marginal willingness-to-pay (WTP). WTP estimation is based on the marginal rate of substitution expressed in dollar terms providing a trade-off between some attribute k and the cost involved (Hensher et al. 2015) and is calculated using the ratio of an attribute parameter and the cost parameter. WTP can take into account interaction effects, if statistically significant, such as with the respondent demographics. WTP of attribute *j* by respondent *i* is calculated as the ratio of the estimated model parameters accommodating the influence of the random component (Cicia et al. 2013) as:

$$WTP_i^j = -\left(\frac{\beta_j + \varepsilon_{ij}}{\beta_{price} + \varepsilon_{ip}}\right) \tag{0.10}$$

The estimated mode parameters can also be used to estimate compensating surplus (CS) as a result of policy or quality change in a combination of attributes, using (Hanemann, 1984):

$$\mathbf{CS} = \frac{-1}{\beta cost}\left[\ln\sum_{j=1}^{J}\exp\left\{V_j^0\right\} - \ln\sum_{j=1}^{J}\exp\left\{V_j^1\right\}\right] \tag{0.11}$$

which calculates the difference in utilities before the policy or quality change (V_0) and after the policy or quality change (V_1) (Hanley et al. 2013; Lancsar and Savage 2004). Similar to WTP, the monetary estimation of this change is possible by using the estimate for the monetary attribute $\beta_{cost.}$. Lastly, there are some challenges associated with the empirical estimation of the WTP in the RPL based models. One approach is to use a fixed cost, which simplifies the WTP estimation (Daly et al. 2012) but which may not be as behaviourally a plausible consideration as allowing heterogeneous preferences towards the cost attribute (Bliemer and Rose, 2013; Daziano and Achtnicht, 2014). Conceptually, the estimated cost parameter is a proxy for the marginal utility of income for respondents and economic theory suggests individuals will respondent differently to varying income levels. The use of a random cost parameter however, presents complications in deriving population distribution moments from the ratio of two random parameters.

Appendix B
Latent Class Model of Kiwifruit Choices

Table B-1 Japanese Kiwifruit choice Latent Class model

Utility parameters[1]	Class 1	Class 2	Class 3
Increased Fibre	1.66***(0.28)	0.49***(0.14)	1.22***(0.24)
Increased Vitamin C	0.47***(0.04)	0.38***(0.10)	1.01***(0.17)
Acidic Taste	- 0.50***(0.11)	0.84***(0.21)	1.15***(0.28)
Sweet Taste	0.28***(0.09)	2.42***(0.20)	- 0.14(0.24)
Balanced Taste	0.05(0.07)	2.21***(0.17)	- 0.11(0.28)
Organic	0.10**(0.04)	0.39***(0.90)	0.94***(0.14)
Enhanced Food Safety	0.56**(0.03)	0.43***(0.11)	1.42***(0.17)
Carbon Neutral	1.21***(0.12)	0.84***(0.15)	0.71***(0.21)
Biodiversity Enhancement	1.11***(0.12)	0.53***(0.15)	0.35(0.24)
Water Quality Protection	0.06(0.05)	0.45***(0.13)	0.06(0.22)
Social Responsibility	0.41***(0.03)	0.45***(0.79)	0.11(0.13)
Price/individual kiwifruit	- 0.011***(0.00)	- 0.023***(0.00)	- 0.027***(0.00)
Opt Out	- 0.08***(0.03)	- 0.01(0.07)	- 0.48***(0.12)
Class Membership			
Usual Purchase Price	0.02***(0.01)	0.011**(0.00)	
Environment Important	0.52***(0.00)		
Carbon Reduction Important	1.55***(0.25)	1.19***(0.38)	
Average class probability	0.60	0.25	0.15
Model Fit Statistics			
Log Likelihood function	- 7,510		
Log Likelihood chi^2 stat (48 d.f.)	6,490***		
McFadden Pseudo R^2	0.30		
Number of observations	9,790		
Number of respondents	979		

***, **,* denote statistical significance at the 1%, 5% and 10% levels respectively for the null hypothesis that a parameter estimate is not significantly different from zero.

Standard errors in brackets.

[1] Parameter mean estimates indicates the estimated average value in the model for each different parameter

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