Available online at www.centmapress.org

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Proceedings in
System Dynamics and Innovation in Food Networks 2021

DOI: http://dx.doi.org/10.18461/pfsd.2021.2010

Consumer attitudes and value perception for fruit with a lower carbon footprint

Maurizio Canavari, Marco Medici, and Luca Di Noto

Department of Agricultural and Food Sciences, Alma Mater Studiorum - Università di Bologna.
Viale Giuseppe Fanin 50, 40127 Bologna.
maurizio.canavari@unibo.it, m.medici@unibo.it, luca.dinoto@studio.unibo.it

ABSTRACT

This work analyses consumers' attitudes for products characterised by a reduced environmental impact on carbon footprint (CF). Value perception was measured using a contingent valuation approach, asking consumers to state their willingness to accept (WTA) monetary compensation for a product exchange offer. Consumers were hypothetically endowed with a punnet of fruit produced with innovative, low CF farming methods and was offered to exchange it with a punnet of regular fruit. Results showed that demographics affect the value associated with fruit with a lower CF and that consumers' preference for lower CF products is associated with fruit consumption habits and environmental concern. At the same time, a positive relationship with CF levels needs further investigation.

Keywords: carbon footprint; willingness-to-accept; fruit; stated preference

1 Introduction

Consumers are getting more aware of environmental challenges and reflect purchase decisions from value systems more oriented to sustainability issues. During the last years, a number of high-value attributes and claims have been used to promote the added value of food products in terms of sustainability, such as carbon footprint (CF) labels.

A CF is the total greenhouse gas (GHG) emissions associated with a product or a service's fruition. It is widely used to describe climate change as an environmental impact category, and it is measured in terms of the mass of carbon dioxide equivalent (e.g., gCO2).

Other studies have analysed sustainable food choices and consumer preferences, and willingness to pay (WTP) for sustainability attributes concerning the different type of food: coffee (Van Loo et al., 2015), dairy products (De-Magistris & Gracia, 2016), meat (Burnier et al., 2021), milk and bread (Echeverría et al., 2014) to name but a few, showing a positive attitude towards the CF concept. This study's main contribution was in the selected product, fruit, that was not previously considered in a similar context. Also, rather than a typical WTP design, a willingness to accept (WTA) setting was used to more precisely measure the aversion towards products without the sustainability attribute. This study aims to determine the monetary compensation consumers would ask to trade fruit characterised by a higher CF in place of fruit characterised by a lower CF.

Lastly, another contribution of the design was in having explained to participants that the fruit with lower CF was grown with the support of precision agriculture (PA): integrating PA approach and concepts, the goal was to strengthen the CF attribute, identifying the reasons behind the actual CF reduction and making participants more aware of the sustainability attribute. A second objective was to investigate consumers' behaviour and attitudes for food characterised by a reduced environmental impact in CF and to judge factors affecting their perceived value. To this end, consumers' habits related to food consumption, attitudes towards food expenditure, and concerns regarding the environment were examined to highlight and explain possible correlations with the WTA to downgrade to a high CF food.

The study was conducted at two diverse locations and six different types of fruit (apricots, nectarines, plums, apples, pears and kiwifruits) to best capture potential differences in attitudes and habits across various portions of the population and during different seasons.

2 Methods

Field surveys were conducted at different locations in Bologna between August and December 2019, generating a total sample of 220 participants. Surveys lasted several weeks to help capture various opinions regarding different varieties of fruits with different seasonality. The locations were two supermarkets, one in the city centre and the other in the immediate periphery area. These locations were chosen as a good representation of the general population, being frequented from young people to elder people, and both of them permitted us to submit surveys at the entrance. Several participants were having breaks from work and came from the surrounding office buildings. Even if young students were not targeted in the surveys, the supermarket in the city centre was also frequented by many students, whose widespread presence is a typical characteristic of Bologna.

Approximately every participant spent about seven minutes on the survey. Potential participants were approached and asked if they would be willing to participate in a short study on environmental-friendly fruit. The requirements to join the survey were that they ate the fruit, were responsible for food purchase in their family and were over 24 years old. The survey was submitted with a tablet, and participants could see text and figures displayed on the screen. The questionnaire was divided into four sections: participant attitude towards fruit consumption, WTA conventional fruit in place of fruit with a lower CF, participant concern towards the environment, and socio-economic and personal factors.

Participants agreeing to join the survey were first asked the weekly frequency of fruit consumption. Then, before investigating participants' WTA, general information about PA and its ability to reduce the environmental impact was provided, in order to inform the participant about agronomic approaches underlying the fruticulture characterised by a lower impact on the environment, with the following:

"Precision agriculture allows a better distribution of agricultural inputs, being able to apply the right thing, in the right place, at the right time, and with the right amount. PA takes advantage of the use of practices and technologies, like sensors monitoring soils and crops and measuring the amount of nutrients, the water content, and the possible presence of crop diseases. It makes available very accurate information leading to a limitation in agricultural input applied to crops and fields, and overall can mitigate the environmental impact characterised by conventional agriculture, by reducing greenhouse gases emissions."

Participant's WTA was elicited using a contingent valuation, in-person survey. This method was selected since it was suitable for the specific field settings. The participants were first hypothetically endowed with a 1-kg punnet of fruit produced with innovative farming methods, thus characterised by a lower CF. Then they were asked their minimum compensation necessary for trading the fruit with a kilogram of the same fruit but grown conventionally, thus characterised by a higher value of CF and an average market price, based on prices that consumers could find in the supermarkets. Table 1 reports prices and CFs for each type of fruit. CFs were preliminarily assessed, with final estimates reported in Medici et al. (2020).

Table 1.
Fruit attributes (values per kilogram of fruit)

Type of fruit	Low CF fruit (gCO_{2e})	High CF fruit (gCO2e)	CF increase (%)	Price – High CF fruit[1] (€)
Apricots	68.5	74.1	+8.2%	4.4
Nectarines	41.1	64.4	+56.7%	1.8
Plums	75.4	108.5	+43.9%	4.0
Apples	98	150.4	+53.5%	1.5
Pears	72.2	105.3	+45.8%	3.2

Kiwifruits	**111.8**	**155.8**	**+39.4%**	**4.0**

[1]Source: Preliminary assessment based on LCA, the method, the refined values are available in Medici et al. (2020)

The following steps were followed to determine the participant's WTA. The participant was asked to imagine being endowed with a kilogram of fruit grown with PA techniques and characterised by a certain CF level. Then, the participant was told the following:

"Imagine that you are given for free a kilogram of fruit grown with the support of PA and characterised by a reduced environmental impact. Then you were offered the possibility to trade this fruit with another kilogram fruit grown with conventional agricultural practices and characterised by a higher CF."

The participant was hence recommended to reflect on the characteristics of the two products and the fact that the product in his possession was characterised by a lower environmental impact than the product he could trade. Then he was asked:

"How much is the minimum amount that you would be willing to accept as compensation to forgo the product with a lower CF owned by trading it for the higher CF product? If the trade were made, you would get the fruit with the higher CF, plus the monetary compensation you requested. Please remember that compensation of € 0 would indicate the two products have the same value, whereas a very high compensation would indicate high aversion, thereby no willingness to accept the higher CF fruit in place of the lower CF fruit."

Participants stated compensation requests using the tablet screen. Then, participants were asked questions aimed at measuring their attitude towards safeguarding the environment using a Likert scale based on 6 items evaluating the so-called green consumption values (GCV):

1. It is important to me that the products I use do not harm the environment.
2. I consider the potential environmental impact of my actions when making many of my decisions.
3. My purchase habits are affected by my concern for our environment.
4. I am concerned about wasting the resources of our planet.
5. I would describe myself as environmentally responsible
6. I am willing to be inconvenienced in order to take actions that are more environmentally friendly

Participants entered values in the range 1-7 for each GCV randomised item on the tablet screen.

In the section part of the survey, socio-demographic information was collected.

3 Sample data

Table 2 shows the descriptive statistics for the 220 participants who completed the survey.

Table 2.
Statistics for participants' WTA for 1 kg of fruit with a higher CF

Fruit species	Obs	Min (€)	Min%	Max (€)	Max%	Median (€)	Mean (€)	Std dev (€)
Apricots	**38**	**0.0**	**2.6%**	**3.0**	**5.3%**	**1.0**	**1.07**	**0.70**
Nectarines	**39**	**0.2**	**12.8%**	**2.0**	**5.1%**	**0.7**	**0.78**	**0.49**
Plums	**20**	**0.0**	**5.0%**	**3.0**	**5.0%**	**1.0**	**1.02**	**0.64**
Apples	**50**	**0.0**	**16.0%**	**2.5**	**4.0%**	**0.5**	**0.75**	**0.75**
Pears	**23**	**0.0**	**4.3%**	**3.0**	**4.3%**	**1.0**	**1.05**	**0.64**
Kiwifruits	**50**	**0.0**	**6.0%**	**2.5**	**4.0%**	**1.0**	**1.12**	**0.71**

Overall	**220**	**0.0**	**8.2%**	**3.0**	**4.5%**	**1.0**	**0.95**	**0.68**

Source: Author's calculations on the survey data.

All participants have attributed a non-negative value to the fruit with lower CF, with an overall median value equal to 1€. About 6% of the overall sample did request a compensation equal to 0, meaning that they were willing to attribute the same value to the fruit characterised by a higher CF, with the only exception of nectarines, for which participants requested a minimum compensation equal to 0.2€. Figure 1 displays WTA variation by fruit species.

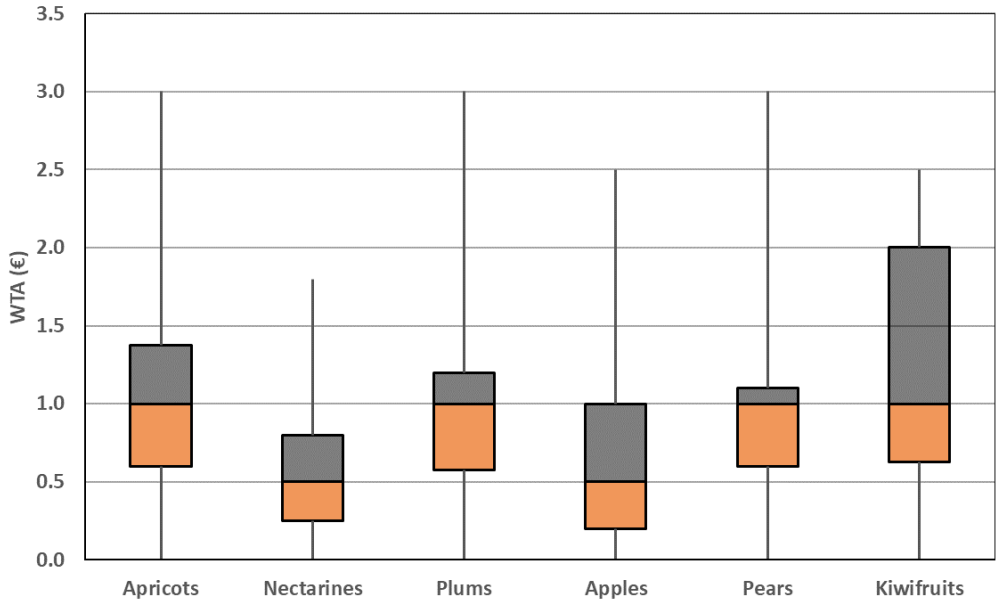

Figure 1 – Distribution of the stated WTA by fruit species

Even with differences between fruits, most of the 220 subjects' WTA offers requested compensation between 0.5 € and 1.5 €. Considering WTA median values and conventional prices, participants attributed on average the following additional monetary value to lower CF fruit compared to higher CF fruit: 22.7% for apricots, 38.9% for nectarines, 25.0% for plums, 33.3% for apples, 31.3% for pears, and 25.0% for kiwifruits.

Table 3 shows the statistics for all variables considered. Most respondents ate fruit quite often, at least nearly every day (91%). Opinions regarding GCV showed a clear concern for environmental problems and the overall participants' determination in engaging environmentally friendly behaviours. The majority of the subjects reported medium to high levels of GCV. Overall, with 85.9% reporting a GCV equal to or higher than 5, environment protection was considered an important component of respondents' behaviour. Only 9.9% of the respondents showed almost indifference, while about 4.2% of respondents showed a negative approach toward environmental protection (GCV 1-3). Results are quite uniformly distributed between the six GCV items. Overall, the most negative items were GCV 2 and 3, with 7.2% and 8.6% of the respondents scaled within 1-3. The six GCV items showed a Cronbach's α equal to 0.8333, indicating a good internal consistency level.

Cost concerns regarding food expenditure characterised most respondents, from moderate caution applied (60%) to significant attention in food expenditure (34%). The job situation reflected a very diverse sample composition compared with the Emilia-Romagna region's employment situation, suggesting the sampling procedure performed well. Also, sample demographics were consistent with regional demographics, given most women and the measured average age.

Table 3.
Variables and descriptive statistics

Variable	Description	Mean	Std Dev
Fruit consumption habits - Frequency	1 if 'Everyday'; 0 otherwise	0.41	-
	1 if 'Nearly every day'; 0 otherwise	0.50	-
	1 if 'Less than twice a week'; 0 otherwise	0.09	-
Green consumer values - GCV (mean)	1 = totally not agree to 7 = totally agree	5.78	1.27
GCV/1	1 = totally not agree to 7 = totally agree	6.13	1.09
GCV/2	1 = totally not agree to 7 = totally agree	5.41	1.38
GCV/3	1 = totally not agree to 7 = totally agree	5.25	1.40
GCV/4	1 = totally not agree to 7 = totally agree	6.37	1.10
GCV/5	1 = totally not agree to 7 = totally agree	5.78	1.03
GCV/6	1 = totally not agree to 7 = totally agree	5.77	1.23
Socio-economic factors - Job situation	1 if 'Stable or retired'; 0 otherwise	0.84	-
	1 if 'Occasional work'; 0 otherwise	0.07	-
	1 if 'Unemployed'; 0 otherwise	0.10	-
Socio-economic factors - Food expenditure	'No financial problems'	0.06	-
	'Moderate care'	0.60	-
	'Very careful'	0.34	-
Demographics – Male	1 if subject is male; 0 otherwise	0.39	0.49
Demographics – Age	Age, in years	47.7	15.84
Demographics – Education	Number of years of schooling	15.4	3.23
Demographics - Household composition	Partner	0.55	-
	Parents in the household	0.07	0.34

	Children in the household	0.48	0.85
	Number of household members	2.37	1.17

Source: Author's calculations on the survey data.

4 Regression model

A linear regression model was applied to investigate determinants of consumers' WTA conventional fruit in place of fruit with a lower CF:

$$y_i = \boldsymbol{x}\boldsymbol{\beta} + \varepsilon_i \quad (1)$$

where y_i represents subject *i*-th compensation for trading the lower CF fruit with the higher CF fruit, $\boldsymbol{x}$ is the vector of independent variables, $\boldsymbol{\beta}$ is the vector of regression parameters, and ε_i is the linear regression error, with zero mean and constant variance. The model consisted of the variables listed in Table 3 and the increased CF characterising the higher CF fruit compared to the low CF fruit, as reported in Table 1. It was expected that frequent fruit consumers with higher levels of GCV requested a higher compensation to accept high CF fruit, while those less concerned with environmental issues would request less. The same goes for the higher frequency of fruit consumption, stable work position, and unconstrained food expenditure, based on past studies and intuition.

5 Results

Results of the linear regression are reported in Table 5. The multiple R^2 was calculated as 0.1258, indicating a good fit. All significant variables were within 5%.

Table 1.
Linear regression results of WTA the higher CF fruit. Fruit attribute: CF increase

Parameter	Estimate	p-Value	Significance
Intercept	0.9441	<2e-16	***
Fruit consumption - Not Everyday	0.2474	0.0177	**
Environmental protection - GCV	0.1159	0.0229	**
Demographics - Age	-0.0074	0.0126	**
Demographics - No. of Children in the Household	-0.1234	0.0243	**
Fruit attributes - CF increase	-0.6722	0.0123	**

Source: Author's calculations on the survey data.

Fruit consumption habit was found to be significant, particularly the highest fruit consumption (*Everyday*), which was the regression baseline, and the lowest one (*Less than twice a week*), have found to be respectively positively and negatively correlated. As expected, the more frequently subjects consumed fruit, the more willing they requested to accept the higher CF fruit, and vice versa. Consumers who are more familiar with fruit care more about fruit attributes.

Turning to consumers' attitude towards environmental protection, subjects showing higher GCV asked for more compensation, representing an additional validation of GCV proposed by Haws et al. (2014).

In terms of demographics, subject age was negatively correlated with the WTA higher CF fruit. Elder consumers seemed to pay less attention to fruit/food attributes, while younger consumers showed higher compensation to accept the higher CF fruit. Surprisingly, subjects who lived with children were more

accepting of the higher CF fruit, indicating that they do not necessarily want their children to be trying environmentally friendly food.

The remaining demographics, *Male, Education, Partner in family, Parents in family*, and *Number of family members*, and the employment situation and the attitude toward food expenditure were found to be not significant.

Lastly, the CF increase associated with lower CF fruit trade with the higher CF one was found to be significant. As expected, consumers declared a relatively high compensation to accept the exchange with fruit with a higher CF. This result suggests that consumers pay attention to a certain attribute concerning the respect of the environment in food purchase decisions. Nevertheless, the relationship between the WTA higher CF fruit and the CF increment shows an intrinsic limitation. Indeed, this association may not be only due to the increased CO_2 value since it may also be influenced by fruit species and price displayed to participants. In particular, the size of the CF increase (in percentage from the measure of the low-impact fruit) and the price for the higher CF fruit showed a relatively high correlation (-0.79). Anyhow, the linear regression analysis with the variable price instead of CF increase (Table 6) indicated reasonable goodness of fit as well (R^2 = 0.134). The same variables were significant compared to the results with the former regression, with a slight difference in significance for three variables: *Age* and *Price - High CF fruit*.

Table 6.
Linear regression results of WTA the higher CF fruit. Fruit attribute: price of the high CF fruit

Parameter	Estimate	p-Value	Significance
Intercept	0.9564	<2e-16	***
Fruit consumption - Not Everyday	0.1884	0.0719	*
Environmental protection - GCV	0.1059	0.0358	**
Demographics - Age	-0.0076	0.0095	***
Demographics - No. of Children in the Household	-0.1134	0.0376	**
Fruit attributes - Price of High CF fruit	0.1083	0.0035	***

Source: Author's calculations on the survey data.

6 Discussion

The results suggest interesting aspects of the food industry, marketers, and future research.

The presence of the attribute CF has demonstrated to be significant, and its presence of food labels is strongly recommended to support the market differentiation strategy. Consumers seem to be somehow sensible to the reduction of CF compared to the conventional product, even if this attitude would require additional research to consider possible confounding effect with the product's price. Indeed, fruit species, price and CF increase are strongly associated because each fruit species was characterised by unique attributes (price for the high CF fruit and CF increase). Certainly, it is possible to argue that the low CF fruit had on average a relevant value as expressed by the intercept, but there is not sufficient evidence about how much carbon emissions saved affected this value. On the other hand, a useful finding was that the GCV scale could predict consumer preference even for food characterised by lower CF as part of the environmentally friendly products. This aspect highlights that positive attitudes towards the environment tend to increase the product's perceived value with lower CF.

These results highlight that there is an environmental impact mitigation potential pulled from the food demand side. This finding may have interesting policy implications, embracing consumers and producers. As suggested by Canavari & Coderoni (2019), the diffusion of CF labels can inform consumers about the

environmental impact associated with food production and the environmental label's potential in reducing it while helping food producers in cost-effectively reducing carbon emissions.

Also, the higher compensation requested by consumers to trade low CF fruit with high CF fruit may enter cost-benefit analysis in the form of additional revenues gained thanks to the low CF food attribute, and this may favour the adoption of practices and technologies aimed to reduce the environmental impact associated to food production as highlighted by (Medici et al., 2020).

Nevertheless, this study has several limitations. The contingent valuation method adopted is a stated preference approach, based on a hypothetical setting, and affected by hypothetical bias due to non-actual purchase decisions. A hypothetical bias means that people tend to request a monetary amount significantly different from what they actually would do in a real transaction. Addressing this point, supermarkets' choice as the survey location was also performed to limit participants' strategic behaviour and response bias. Personal interviews limited the shortcomings of surveying through a simple questionnaire, providing detailed information on the product attributes and the farming method used to grow it, i.e. PA. Also, the use of WTA instead of WTP may have limited participants' bias, even though it may have created some misunderstanding since it is a less intuitive measure of value. Results suggested a good relationship between the monetary value attributed to the lower CF fruit and the level of CF itself. However, because of the particular survey settings, it was impossible to limit possible bias associated with the other product attributes of fruit species and price.

7 Conclusions

This study's results have described consumers' behaviour and attitudes for products characterised by a reduced environmental impact in terms of CF and constitute a contribution to the literature in the fields of consumer science and sustainable supply chain management. Findings support the use of CF labels for fruit, helping to orient consumers towards buying products less harming the environment and thus addressing the agriculture and food sector to an increasing limitation of its contribution to global warming.

Acknowledgements

This research was funded by the Emilia-Romagna Region, Italy, within the RDP program 2014-2020, Measure 16.2.01.

References

Burnier, P. C., Spers, E. E., Barcellos, M. D. de. (2021). Role of sustainability attributes and occasion matters in determining consumers' beef choice. *Food Quality and Preference* **88**: 104075.

Canavari, M., Coderoni, S. (2019). Green marketing strategies in the dairy sector: Consumer-stated preferences for carbon footprint labels. *Strategic Change* **28** (4): 233–240.

De-Magistris, T., Gracia, A. (2016). Consumers' willingness to pay for light, organic and PDO cheese. *British Food Journal* **118** (3): 560–571.

Echeverría, R., Hugo Moreira, V., Sepúlveda, C., Wittwer, C. (2014). Willingness to pay for carbon footprint on foods. *British Food Journal* **116** (2): 186–196.

Haws, K. L., Winterich, K. P., & Naylor, R. W. (2014). Seeing the world through GREEN-tinted glasses: Green consumption values and responses to environmentally friendly products. *Journal of Consumer Psychology*, **24** (3): 336–354.

Medici, M., Canavari, M., & Toselli, M. (2020). Interpreting Environmental Impacts Resulting from Fruit Cultivation in a Business Innovation Perspective. *Sustainability*, **12**(23): 9793.

Van Loo, E. J., Caputo, V., Nayga, R. M., Seo, H.-S., Zhang, B., & Verbeke, W. (2015). Sustainability labels on coffee: Consumer preferences, willingness-to-pay and visual attention to attributes. *Ecological Economics* **118**: 215–225.