

Article

Canadian Consumers' Perceptions of Sustainability of Food Innovations

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Abstract: Educated consumer food choices not only enhance personal health but can also contribute to environmental, economic, and social well-being, as well as food sustainability. This exploratory study examines Canadian consumers' perceptions of sustainable and innovative food, along with their sources of information. It uses nationwide survey data and statistical tests (chi-square and Kruskal–Wallis tests) to test differences between different demographic groups. Results show that consumers refer mostly to the ecological aspect of food sustainability in their perceptions and food-buying behavior. Web-based information was a widely consulted source of information about food-related sustainability and innovation, although it ranked low among consumers in terms of trust level. The most trusted sources of information about food sustainability and innovation were mainly institutional—medical professionals and university scientists. Survey results also demonstrate that perceptions of sustainability and trust in sources of information varied in different socio-demographic segments. The current insights can be used to guide policymakers in making informed guidelines and recommendations to inform Canadian consumers about sustainable food-consumption practices.

Keywords: biotechnology; consumer behaviour; dietary identity; environment; food price; gene editing; plant-based proteins; trust



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1. Introduction

The shift towards more sustainable diets and food systems has led to evolving consumption habits, changing food-business practices, and increased academic research. This reform movement is a core policy goal as reflected in both national and global strategies. The Canadian federal government set “Supporting a healthier and more sustainable food system” as the second goal of its Sustainable Development Strategy for 2022–2026 [1]. The United Nations set “Ensuring sustainable consumption and production patterns” as the 12th goal of its 2030 Agenda for Sustainable Development [2]. Consumers have exhibited interest in sustainable agrifood products as reflected by changes in eating patterns, such as integrating plant-based proteins, locally sourced products, organic food, natural food, etc., into their diets. Furthermore, there is a trend to reduce the consumption of red meat and highly processed foods and food waste. Other incentives include reusable bags in grocery stores. Those trends are deeply influenced by the increased awareness of environmental issues [3,4]. Kovacs and Keresztes [5] posit that food-sustainability concerns are increasingly highlighted due to the sustainability goals related to climate change, the effects of which have caused more health and social dilemmas. As such, consumers play a key role in reducing the burden on the environment through their food choices, while enhancing their personal health. Indeed, the consumer's decision-making process is not only about satisfying needs from an economic perspective, but it also involves psychological, sociological/personal-related, and cultural/environmental aspects [6,7].

Sustainability is also a multi-dimensional concept as captured in the Food and Agriculture Organization's definition: "sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources" ([8], p. 7). As to a sustainable food system, it is defined as "a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised" ([9], p. 1). Both definitions highlight that the concept of sustainability is complex, as it considers different, yet interdependent, aspects, namely: environmental/ecological, economic/financial, and social/ethical. Sustainable food products contribute—through their attributes and consequences—to these three goals. The economic aspect has to do with a fair price for the agricultural producers and affordable consumer prices. The ecological component refers to sustainability in the strict sense of preserving the environment and sustainable use and management of natural resources—for instance through reductions in pesticide and water usages. The social component concerns an integration of agriculture in the priorities and needs of the citizens and an appreciation and support for the agri-food sector from the society, as well as from the government [10]. While the economic and social aspects are important indicators of sustainability, they are largely ignored compared with the environmental sustainability that has been prioritized in research and practice [11,12].

Sustainability requires major transformations in the modes of innovation. In fact, "the world can only meet its future food needs by harnessing scientific agriculture innovation" ([13], p. 1). Consumers' acceptance of new and emerging food production technologies is tied to their understanding of the costs and benefits of the outcomes. Advances in agrifood biotechnology not only provide direct benefits to consumers (e.g., nutrition), but also potential environmental benefits. Improved consumer understanding of the benefits of innovative agrifood products can aid in the adoption process. Thanks to brands such as Beyond Meat and Impossible Foods, animal-free burgers are commonplace innovative foods on the market. The popularity of these products is driven by concerns over climate change, global food security, the ethics of farming and health trends. Another example of food innovation is gene-editing technology that has been leading advancements in crops and animal breeding within the last decade owing to its technical simplicity and potential socio-economic and environmental benefits [14,15].

In the Canadian context, research evaluating consumers' perceptions of sustainably produced food is scant. In their systematic review on consumers' perceptions on food-related sustainability in high-income countries, Bussell et al. (2022) found only one Canadian study by Simpson and Radford (2012). Much of the existing research has narrowly focused on particular attributes of sustainability such as organic (e.g., [16–21]), local (e.g., [22–25]), environmentally friendly (e.g., [26]), animal-friendly (e.g., [27,28]), ecolabels (e.g., [29]), and single-use plastic packaging (e.g., [30]). While organic and local foods might be perceived as sustainable choices, they deal with specific aspects of sustainability—a broad, multi-dimensional concept. That is, organic is not a synonym of sustainable. On the other hand, organic food production is not necessarily more sustainable than conventional consumption, as organic food production uses more resources, including land and energy [31]. This study investigates food-related sustainability following a holistic approach that takes into account the three pillars of sustainability: environmental, economic, and social. Due to the growing interest among consumers and various stakeholders regarding issues of sustainability and the limited research in the Canadian context evaluating consumer behaviors and perceptions associated with sustainably produced foods, this study is designed to contribute to a growing body of knowledge addressing this topic. This study is unique as it links sustainability with food innovation and related sources of information and trust.

This exploratory analysis aims to understand how Canadian consumers interpret sustainability in relation to agriculture and food products. The main objectives are to

identify important food attributes in consumer purchase decisions, key factors influencing purchases of sustainable food, familiarity with food innovation trends, where consumers access information about sustainable and innovative foods, and how strongly they trust the sources they consult. A national survey was utilized asking Canadian consumers about their food perceptions with respect to sustainability attributes and innovative food, along with their sources of information. Associations between socio-demographic characteristics and consumers' perceptions were also explored. The current results offer some insights into consumers' possible future decision making toward incorporating novel foods such as gene-edited products into their diets. They also help public and private decision-makers in closing the commercialization gap of sustainable and innovative agricultural and food products.

1.1. Emerging Sustainable Innovations in the Agrifood Sector

Climate change, population growth, the pandemic's outbreak, and ongoing conflicts are shaking the environmental, societal, and economics ecosystems. Those global challenges pose a threat for food security; thus, there is an urgent need for innovative solutions and technologies to render the agrifood system more sustainable and resilient [32]. Two food-related megatrends have emerged in recent years in response to these global dilemmas: the shift in eating habits—with the emergence of vegan, vegetarian, and flexitarian diets, and the digitalization of farming and food transformation (the latter is beyond the scope of this article). Among the food trends that have emerged are novel or different food sources (e.g., plant-based proteins, algae, fungi) and advanced biotechnologies such as gene editing in plant breeding and cell-cultured foods that have been associated with more sustainable food systems and enhanced nutritional qualities, including safety [32].

Evidence shows that the environmental impacts of animal products exceed those of vegetable substitutes. To illustrate, meat, aquaculture, eggs, and dairy use about 83% of the world's farmland and contribute 56 to 58% of food's different emissions (greenhouse gas—GHG, acidifying, and eutrophying emissions), despite providing only 37% of our proteins and 18% of our calories [33]. On the other hand, a diet that excludes animal products and includes new vegetable proteins has the potential to “reduce food's land use by 3.1 billion ha (a 76% reduction), food's GHG emissions by 6.6 billion metric tons of carbon dioxide equivalents (a 49% reduction); acidification by 50%; eutrophication by 49%; and scarcity-weighted freshwater withdrawals by 19% for a 2010 reference year” ([33], p1). That is why plant-based burgers are considered better for the environment than meat burgers, as livestock production is a heavy emitter of GHG, and thus a large contributor to climate change [34,35]. In addition to reducing ecological degradation, cutting meat consumption and integrating more plant-based proteins is promoted as a healthy diet that can reduce several diseases, including cancer, obesity, and cardiovascular illnesses [36,37]. However, an assessment of plant-based meats in the United Kingdom found them to have significantly higher levels of sodium, which contributes to higher levels of high blood pressure, strokes, and heart disease, as well as having lower levels of minerals and vitamins than meat from livestock [38]. In addition, plant-based food still faces several challenges, notably consumer acceptance of the sensory properties (e.g., flavor, texture, color) of ingredients. In Canada, dietary guidance and the Food Guide encourages the increased consumption of plant-based foods as a source of dietary protein.

Allowing for targeted improvement in an organism's genetic material, gene editing has revolutionized plant breeding, aquaculture, and livestock. Clustered Regularly Interspaced Short Palindromic Repeats, or CRISPR, dominates the field of gene editing, as it is considered the most efficient, targeted, and affordable tool [13,39,40]. Gene editing in plant breeding has the potential to achieve sustainability by reducing inputs such as fertilizers and pesticides, controlling diseases, increasing yields, improving nutrition, and developing climate-resilient crops [13–15]. Similarly, CRISPR applications in livestock can improve production traits, enhance animal welfare through adaptation and resilience, confer resistance to infectious and transmissible diseases, and control pests and invasive species that

threaten animals [14,41]. Unlike plant-based products, most gene-editing-based solutions for crops and animals are still proof-of-concept, with hopes of release in the near future.

1.2. Review on Canadian Consumers' Perceptions of Sustainable Food

In addition to the innovation trends previously highlighted, and parallel to the role of producers as a vital part of the solution, consumers—through their diet—also have a responsibility in contributing to the environmental, economic, and social goals of sustainability. As advanced in the introduction, research studying sustainability as a tripartite concept is lacking in the Canadian context, thus this section briefly reviews Canadian consumers' perceptions of certain aspects (i.e., organic, local, packaging) of food-related sustainability.

Several studies have investigated attributes related to production methods and related quality claims. Using a discrete choice survey instrument, Uzea et al. [27] found a significant diversity of consumer attitudes for animal welfare attributes and the source of verification. While a group of consumers were strongly motivated to purchase meat coming from welfare-enhanced production systems, others were indifferent between these products and conventional versions. Innes and Hobbs [26] found that one-third of Canadian participants valued bread containing grains produced using environmentally sustainable and/or pesticide-free methods. The authors also observed that those consumers placed similar amounts of trust in the government, third parties, and farmers to provide accurate information about farming methods, while food processors and supermarkets were less trusted. When examining consumer perceptions of ecolabels, Guntzburger et al. [29] found that participants lack knowledge about the difference between organic, local, and genetically modified organisms (GMO)-free claims. The importance of these claims was found to be influenced by health risk perceptions and motivations and vary in different socio-demographic segments. Similarly, Campbell et al. [22] asserted that consumers, in general, know the key concepts of local and organic production; however, many are confused about less-advertised practices, and perceptions are heterogeneous with respect to some demographics. Hamzaoui Essoussi and Zahaf [16] identified health, the environment, and support of local farmers as being the principal values explaining organic food consumption among participants based on Ottawa. In their Canada-wide study on sustainable food-packaging alternatives, Walker et al. [30] observed that most participants (94%) were motivated to reduce their consumption of single-use plastic food packaging, but were less willing to pay for sustainable alternatives. This motivation was also shown to vary across regions and income groups. In their meta-analysis of consumers' willingness to pay (WTP) for sustainable food products, Li and Kallas [42] highlighted that gender, region, sustainable attributes, and food categories influence the WTP estimate, and that there are significant differences between global regions. They found that consumer WTP is lower in North America compared with Asia and Europe.

Based on these insights, consumers' heterogeneity in their perceptions of sustainability and related food choices is expected, along with differences in trust levels toward various sources for accurate information about sustainability and innovation in the agriculture and food sectors. Canadian consumers' perceptions of sustainability and trust in information sources are proposed to vary in different socio-demographic segments.

2. Methodology

2.1. Data Collection

This study used an online survey instrument that was approved by the University of Dalhousie Social Sciences & Humanities Research Ethics Board (REB#2022–6418) in November 2022. Angus Reid Group, a Canadian market research firm, was commissioned to administer the questionnaire across Canada and recruit respondents using its own-operated consumer-survey panels. The survey was hosted by Qualtrics, an online survey platform, where quotas on region, gender, age, and education were set to be representative of the Canadian population. The survey was available 6–8 December 2022 in English and

French. Once a pre-test (soft launch) of 79 complete responses determined the survey instrument was sound, the survey was administered (full launch) at a larger scale targeting randomly selected Canadians. The survey took an average of 12 min to complete, and the final data set comprised 1005 responses used for the analysis.

2.2. Survey Design

The survey included multiple choice, Likert scale, and yes/no questions (Supplementary Materials). Likert-scale statements measure both agreement (denoted by “Strongly agree” and “Agree”) and uncertainty (denoted by “Neither agree nor disagree”) with respect to sustainability and innovation topics. The survey was divided into four parts. First, the survey probed respondents on whether their food choices were based on sustainability attributes. Second, a series of questions on agrifood innovation were asked. Third, sources of information and trust about sustainability and innovation were queried. The socio-economic determinants of respondents including dietary identity (omnivore, vegetarian, etc.), gender, age, education, household income, and employment status were collected at the end.

2.3. Data Analysis

In the data analysis conducted, the Statistical Package for the Social Sciences (SPSS, version 28.0) was used, and graphical representations were created in MS Excel. Consumers’ socio-demographics are commonly used variables to help explain their effects on decision making. The effects of these variables on consumer decision making regarding sustainably produced and innovative food was tested. For binary-independent variables such as gender, a Chi-square statistic test (χ^2) of homogeneity was used to test their effects. A larger value of χ^2 indicates larger differences between the groups being compared. A calculated χ^2 *p*-value lower than the critical value of 0.05 demonstrates that the independent variable (e.g., gender) has an effect on the independent variable (null hypothesis rejected). For ordinal data (with more than two independent groups), Kruskal-Wallis (H) tests [43]—ranked-based nonparametric tests—were used to determine differences (in medians) between groups by age, region, income, and education. *p*-values > 0.05 indicate that differences are not statistically significant among groups. When a Kruskal-Wallis test was rejected (null hypothesis: the mean rank of the groups are the same—i.e., distribution of scores is similar for all groups), a Dunn [44] test—the appropriate nonparametric pairwise multiple-comparison procedure—with Bonferroni adjustment was performed as a post hoc analysis [45]. All reported pairwise comparisons were run at 95% confidence intervals, and *p*-values were Bonferroni-adjusted.

3. Result Analysis and Discussion

3.1. Sample Socio-Demographic Profile

Sample characteristics are presented side by side with data from the most recent Canadian census in Table 1. The sample was closely representative of the Canadian population in terms of gender, age (15% of the Canadian population younger than 18 years is excluded from the sample as this group was not eligible to participate in the survey), and region (set as a quota variable during data collection). Slightly over half of the sample were females (53%). Regional distribution shows that most participants reside in Ontario (38%) or Quebec (23%), followed by the Prairies (Alberta, Saskatchewan, and Manitoba) (19%), British Columbia (13%), and the Atlantic provinces (7%). The sample was dominated by Baby Boomers—aged 55–75 (36%), generation X—aged 33–54 (33%), followed by generations Y and Z—aged 18–34 (26%). The majority of respondents had earned either an undergraduate degree (59%) or a graduate degree (17%), and the majority were in the workforce (59%). A sample skewed toward highly educated people is expected with an online survey. About one-quarter of the sample had children.

Table 1. Sample socio-demographic characteristics ($n = 1005$).

Demographic Variable	Percent Respondents ^a (%)	2021 Census of Population ^b (%)
Gender		
Male	47	49.27 ^b
Female	53	51.73
Age		
18–24 (Gen. Z, iGen, Centennials)	7	14.07 ^b
25–34 (Gen. Y, Millennials)	19	13.35
35–44 (Gen. X)	16	13.28
45–54 (Gen. X)	17	12.63
55–64 (Baby Boomers)	17	14.11
65–75 (Baby Boomers)	19	10.16
Over 75 (the Silent Gen., Traditionalists)	5	7.23
Location		
Alberta	12	11.74 ^c
British Columbia	13	13.65
Manitoba	4	3.61
New Brunswick	1	2.09
Newfoundland and Labrador	2	1.34
Nova Scotia	4	2.63
Quebec	23	22.24
Ontario	38	38.85
Prince Edward Island	0	0.44
Saskatchewan	3	3.07
North (Northwest Territories, Nunavut, Yukon)	0	0.33
Children		
Yes	26	29.3
No	73	
Prefer not to say	1	
Education		
Elementary school	1	16.2
Secondary (high) school	21	26.7
Technical/College/University	59	49.8
Graduate studies	17	7.3
Prefer not to say	2	
Employment status		
Working full time	46	57 Employed
Working part time	7	
Self employed	6	
Unemployed	3	6.56
A student	5	36 Not in the labor force
Retired	27	
Homemaker	4	
Other	1	
Prefer not to say	1	
Community		
Rural	27	17.8 ^d
Urban	72	82.2
Prefer not to say	1	

Table 1. Cont.

Demographic Variable	Percent Respondents ^a (%)	2021 Census of Population ^b (%)
Income		
Under \$29,999 (Lower class)	9	36
\$30,000–\$49,999 (Lower-middle class)	13	24
\$50,000–\$69,999 (Middle class)	11	16.3
\$70,000–\$89,999 (Middle class)	11	9.6
\$90,000–\$109,999 (Middle class)	12	10.5
\$110,000–\$129,999 (Upper-middle class)	9	(\$100,000 to
\$130,000–\$149,999 (Upper-middle class)	6	\$149,000)
More than \$150,000 (Upper-middle/Upper class)	14	3.6
Prefer not to say	15	

^a Percentages rounded to the nearest whole number reported for surveyed consumers for each demographic variable. Sources: ^b Statistics Canada [46], ^c Statistics Canada [47], ^d Statistics Canada [48].

In terms of household income, there is an under-representation of the lower-income group relative to its share of the population, which is to be expected with an online survey. Only 22% of respondents reported their income as under \$50,000 (lower and lower-middle classes), compared with 60% in the population. There is also an over-representation of the high-income group (upper-middle and upper classes), as 29% of respondents in the sample reported an income of \$110,000 and over, whereas in the general population this group accounts for less than 15%. Most respondents (72%) live in urban communities, and 93% claimed that they neither studied nor worked in the agri-food field. Only 11% of the sample claimed they are involved with, a member of, or follow an environmental organization/movement (87%: No, 2%: Do not know). At 66%, the sample is dominated by omnivore consumers whose diets include both animal- and plant-based foods, 19% indicated that they are meat reducers whose diet includes fewer meat products, and 14% are vegetarian or vegan (3% preferred not to answer).

3.2. Important Food-Product Attributes in Consumers' Purchase Decisions

To understand what influences food-buying practices, participants were asked what product attributes determine their purchase decisions of foods in a grocery store. A list of factors provided in the survey for respondents to choose from is presented in Figure 1, in descending order of their importance. Results show some heterogeneity in consumer food-buying behaviour where egoistic motivations (e.g., health reasons) are more important than altruistic motivations (e.g., production methods). In fact, the majority of respondents claimed that price (83%), nutrition (76%), and natural ingredients (49%) matter the most, followed by locally grown or raised (44%) and hormone/antibiotic free. Phrases used were “Price is the number one factor for food choices for my family and I right now”, “Price is currently the prime consideration”, or “Price and taste are the most important things for me in food choices”. Our results support several other Canadian studies that found that price and nutrition are the main drivers for food-buying choices (e.g., [27,49–52]).

Tied at 39%, consumers viewed “sustainability produced” and “free of GM” as the seventh decision factors in their food purchases. Seemingly, sustainability does not—yet—influence Canadian food choices compared with the urgency of the climate change threat as it pertains to agriculture, biodiversity, and human society. On the other hand, vegan-/vegetarian-friendly (76%), certified organic (64%), produced using renewable energy (57%), and ecologically responsible/eco-labels (46%) are the least important considerations. Lacking knowledge about or misunderstanding the complex nature of food sustainability could be one explanation for this relatively low consideration of associated cues (ecolabels, fair trade). For instance, food products sold with fair trade attributes are relatively new or unknown, with limited products sold under this label; hence, it has little impact on consumers' buying behaviour [53,54]. Given that nutrition and product naturalness are the two popular (non-financial) determinants of food choices,

marketers can use individual health as an important aspect to promote the consumption of sustainable foods.

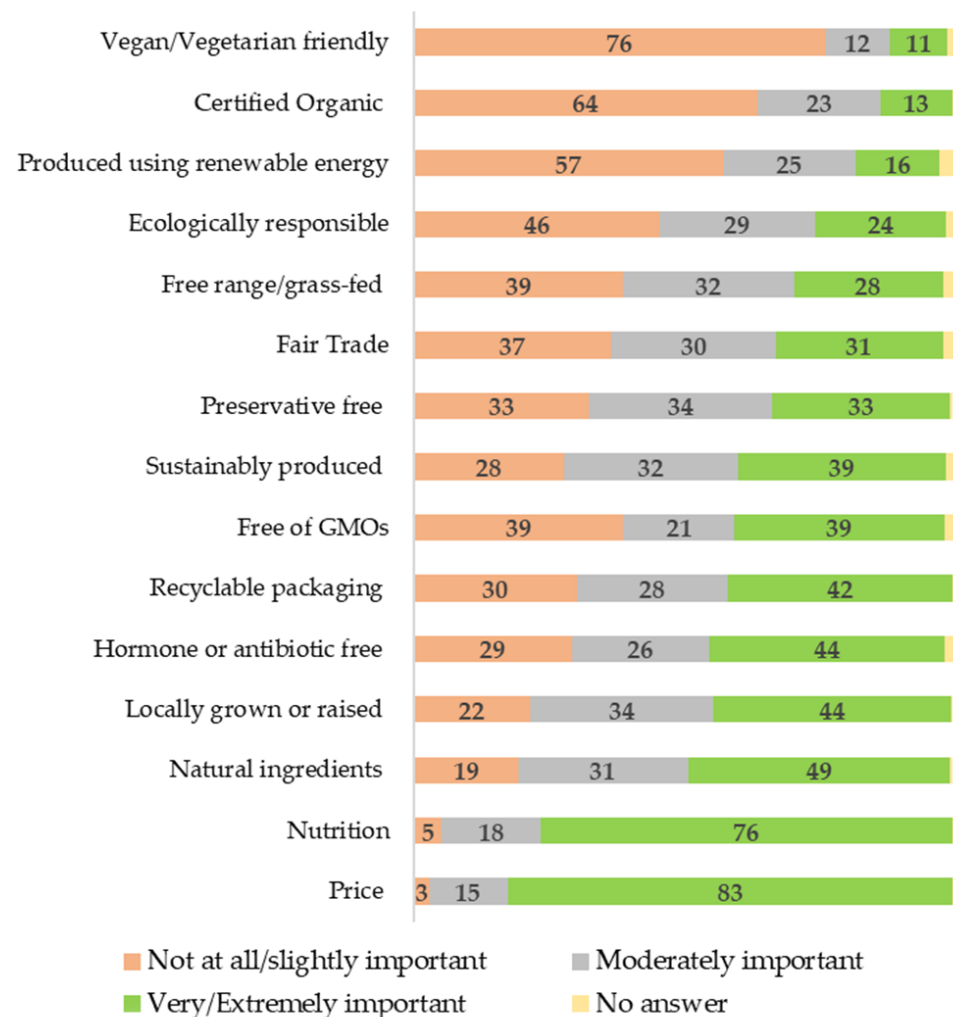


Figure 1. Factors influencing food-purchase decisions (% responses). Note: The scale options ‘Not at important’ and ‘Slightly important’ were grouped together to increase the cell count. The same applies for ‘Very important’ and ‘Extremely important’. The recoding did not alter the result interpretation.

The cross tabulation shows a significant statistical gender difference ($\chi^2 = 20.28$, $p < 0.001$) at a 0.05 level of significance with respect to the “sustainable produced” attribute. That is, the importance of the trait is not consistent among males and females: the trait was ‘Not at all/Slightly important’ for 16% of male respondents compared with 12% of female respondents. On the other hand, 24% of females considered the trait “Very/Extremely important”, compared with 16% males. Given that the sample is dominated by omnivore (66%), all other diet types were merged under “non-omnivore” to increase the cell count and run tests. Dietary identity (omnivore versus non-omnivore) is also statistically significant ($\chi^2 = 41.949$, $p < 0.001$) as proportions of omnivore respondents were nearly equally distributed among the importance levels (22%: not at all/slightly, 23%: moderately, and 21%: very/extremely important) of the “sustainable produced” feature, while half (16% out of 32%) of the non-omnivore respondents indicated that sustainably produced food was “Very/Extremely important” in their purchase decisions.

The Kruskal–Wallis H test demonstrates no age effect on the purchase decisions of sustainably produced food ($H = 4.774$, $p = 0.573$), as the different age groups (Gens. Z and Y, Gen. X, Baby Boomers) exhibited consistent opinions. For example, the majority in each segment considered the trait “Very/Extremely important”. Similarly, there is no significant

statistical regional difference ($H = 7.433$, $p = 0.1151$) among residents in Ontario, Quebec, the Prairies, British Columbia, and the Atlantic provinces. Neither are there significant differences among the income ($H = 10.437$, $p = 0.165$) nor education groups ($H = 2.286$, $p = 0.319$). In sum, only gender and diet type have an effect on the purchase decisions of sustainably produced food in a grocery store among surveyed Canadian consumers.

3.3. What Is Sustainable Food?

When asked about the meaning of sustainable food, most respondents (80%) associated the concept to its “green” dimension, by which sustainable food protects the nature, including the diversity of both plants and animals, and avoids damaging or wasting natural resources. This is not surprising given that sustainable products are often marketed as a proxy for “environmentally appropriate” without considering other dimensions, which may have caused a misconception that sustainability is a one-dimensional concept [12]. About one-third of the sample defined sustainable food as food that is good quality, safe, and healthy (social dimension) (34%) or believed that sustainable food contributes to thriving local economies, for instance through lower production costs for producers (32%). Only 3% claimed that they did not know what sustainable food means. These results imply that one-third of the surveyed Canadians have a complete picture or a holistic view of food sustainability with integrated environmental, social, and economic aspects. Yet, the majority lack adequate knowledge of sustainability as they do not seem to be able to interpret it as a tripartite concept; rather they hold a narrow understanding limited to the environmental dimension. The unbalanced view of food sustainability (i.e., limited to its ecological goal) appears to be true not only in Canada but also in many other high-income countries [4]. The credence nature of sustainability as a set of socio-environmental attributes (e.g., eco-friendly, health, product origin, production conditions, social benefits, fair trade) could explain the consumers’ lack of knowledge about it. As defined by Darby and Karni [55], credence attributes are intangible qualities of a product that cannot be directly verified by consumers either before purchase or after consumption, and which include environmental, social, and ethical features of the product. Therefore, it is highly important to use clear, verified, and consistent terms to communicate sustainability-related information to consumers.

3.4. What Motivate and Stifles the Purchase of Sustainable Food?

About two-thirds of the sample indicated they do not deliberately seek out sustainable food products in a grocery store, compared with 28% who do so and 7% claimed that they do not know. A possible explanation of this result is that due to the fact that most consumers do not yet consider sustainability as a major driver for their food choices, they may be considering it as a secondary effect of a healthy diet and thus, they do not feel the need to seek out those products or change their diet patterns.

A chi-square test shows statistically significant differences in deliberately seeking sustainable products between males and females ($\chi^2 = 8.277$, $p < 0.016$) and between omnivorous and non-omnivorous consumers ($\chi^2 = 81.308$, $p < 0.001$). More females (17%) claimed that they intentionally look for sustainable food products than males (11%). The majority of omnivore participants (49% out of 66%) selected a negative response, whereas non-omnivore respondents were equally split between Yes (15%) and No (15%) answers. Score distributions are not statistically different between groups of age ($H = 9.389$, $p = 0.153$), region ($H = 2.697$, $p = 0.610$), education ($H = 1.000$, $p = 0.606$), and income ($H = 10.299$, $p = 0.172$).

As to the frequency of buying or consuming sustainable food products, 11% indicated never or rarely, 46% sometimes, and 21% often (3%: always, 18% do not know). Respondents choose to buy or consume sustainable food products because they want to support local producers (53%), they care for the environment (51%), or they find those products healthy (33%) or more natural (taste better) (25%). Less than one-quarter of the sample claimed that they are motivated to purchase/consume sustainable products as they are fresher (22%) and safer (16%) than conventional counterparts. Among the comments were

those that stated: “I don’t want to consume foods that are GMO, synthetic, or full of pesticides”, “I will never try fake food”, or “I won’t consume artificial food”. On the other hand, respondents choose not to buy or consume sustainable food products because they find them too expensive (56%) or not available (28%). Regarding the price, a subset of consumers stated that they: “Would choose more local, higher quality nutrition if finances allowed”, “While I wish I could choose the food I want and purchase more sustainable options than I already do, the truth is that the price of food and financial situation plays a huge role in my food purchases”, or “I would buy sustainable food for health and environmental reasons if it were less expensive”. For availability, terms used were, “I can’t identify them”, “I never see anything market sustainable”, “I have never noticed this labelling”, or “I would love to eat more local foods without running around the countryside to find them”. Our results are consistent with findings by van Bussel et al. [4]. In their systematic review on consumers’ perceptions of food-related sustainability in high-income countries, the authors noted that consumers believed that sustainable foods were hard to find, inconvenient in use, and more expensive. Overall, those results show that at least one-quarter of surveyed Canadian consumers express an interest in seeking and purchasing food produced in a sustainable manner.

The results of the χ^2 test show both gender ($\chi^2 = 12.543$, $p < 0.001$) and diet type ($\chi^2 = 31.887$, $p < 0.001$) effects of the environmental motivation to buy/consume sustainable food. There are more females (30%) than males (21%) and more non-omnivore (21% out of 32%) than omnivore (31% out of 68%) participants who care for the environment. Score distributions of “I care for the environment” are statistically different among the age ($H = 10.396$, $p = 0.015$) and education ($H = 13.550$, $p = 0.001$) segments. Pairwise comparisons reveal statistically significant differences in the distribution of the youngest group (i.e., Gen. Z and Y) and Baby Boomers ($p = 0.001$) and in the distribution of respondents with secondary school education or less and those with a higher education level. Respondents with technical-/college-/university-level education and those with graduate studies care more about the environment than those with a lower education level. The score distributions are similar across regions ($H = 8.413$, $p = 0.078$) and income groups ($H = 2.373$, $p = 0.499$).

As to the benefits of sustainable agrifood products (Figure 2), over half of the sample recognize the environmental benefits, including diversity preservation (64%), soil health improvement (64%), less chemical/pesticide use (57%), and the promotion of animal welfare (56%). Addressing climate change (55%) and food insecurity (51%) and improving producer welfare (47%) are among the perceived socio-economic benefits. While 45% of participants agreed that sustainable products have a better overall quality than conventional counterparts, 57% disagreed that they are more affordable. Participants (45%) also opposed that the cost of producing sustainable food products is cheaper than producing conventional versions.

3.5. Innovative Food: Familiarity, Motives, and Perceived Benefits

Innovation in the agrifood sector refers to the use of science and technology to improve and/or develop new ways of producing, processing, or packaging food. The sample was provided with a list of innovation trends in the agrifood sector and asked about its familiarity with them (Figure 3). Most participants were moderately or very familiar with plant-based meat alternatives (e.g., veggie burger, Beyond burger) (58%) and GM products (49%). They were not at all or slightly familiar with nutraceuticals (83%), biofortified food products (82%), cellular agriculture (e.g., cell-cultured meat), gene editing including CRISPR (77%), and biofuels (62%). A significant knowledge gap about gene editing has been underlined in recent studies on Canadian consumer perceptions of the technology [56–59].

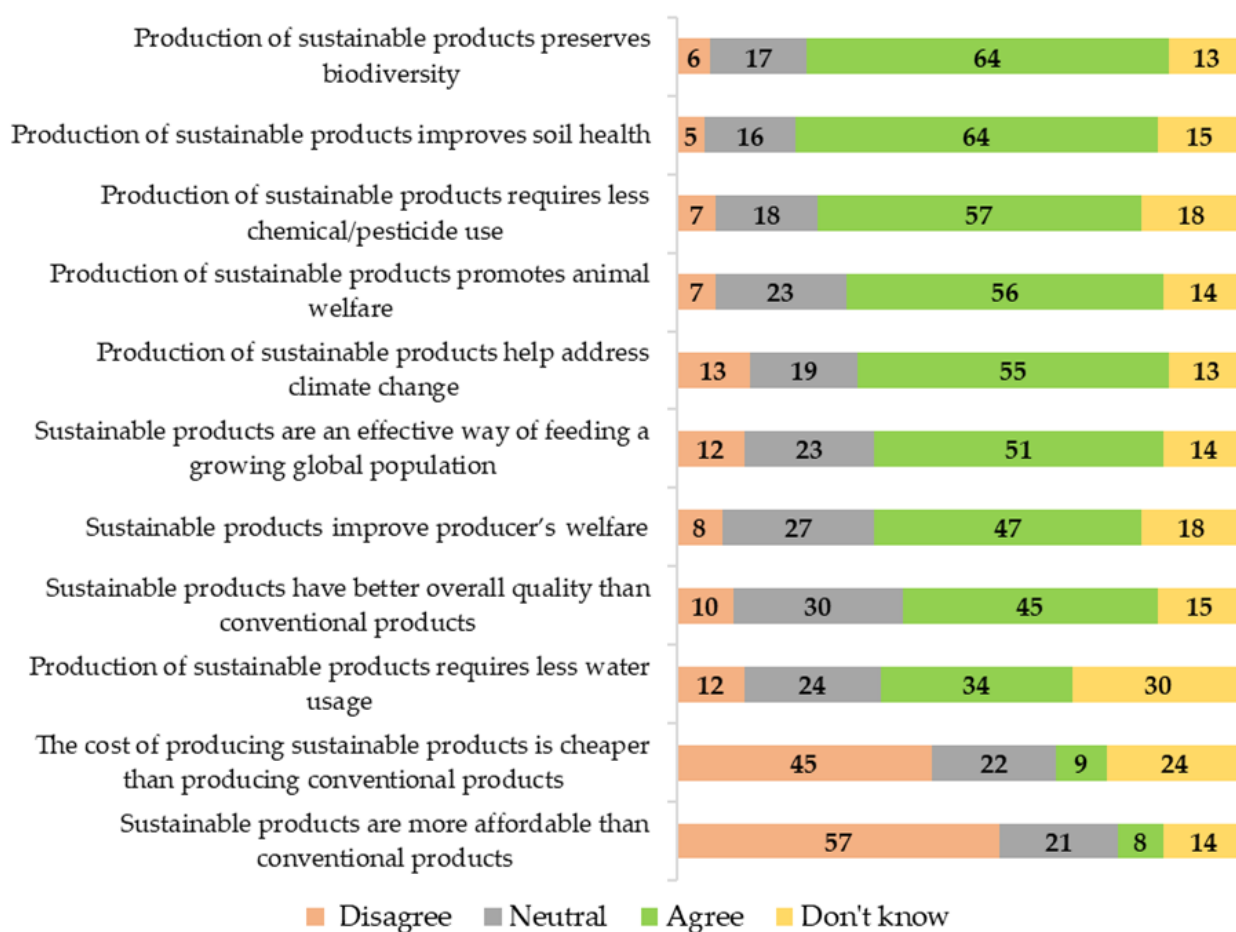


Figure 2. Perceived benefits of sustainable agricultural and food products (% responses). Note: The scale options 'Strongly agree' and 'Agree' were grouped together to increase the cell count. The same applies for 'Strongly disagree' and 'Disagree'. The recoding did not alter the result interpretation.

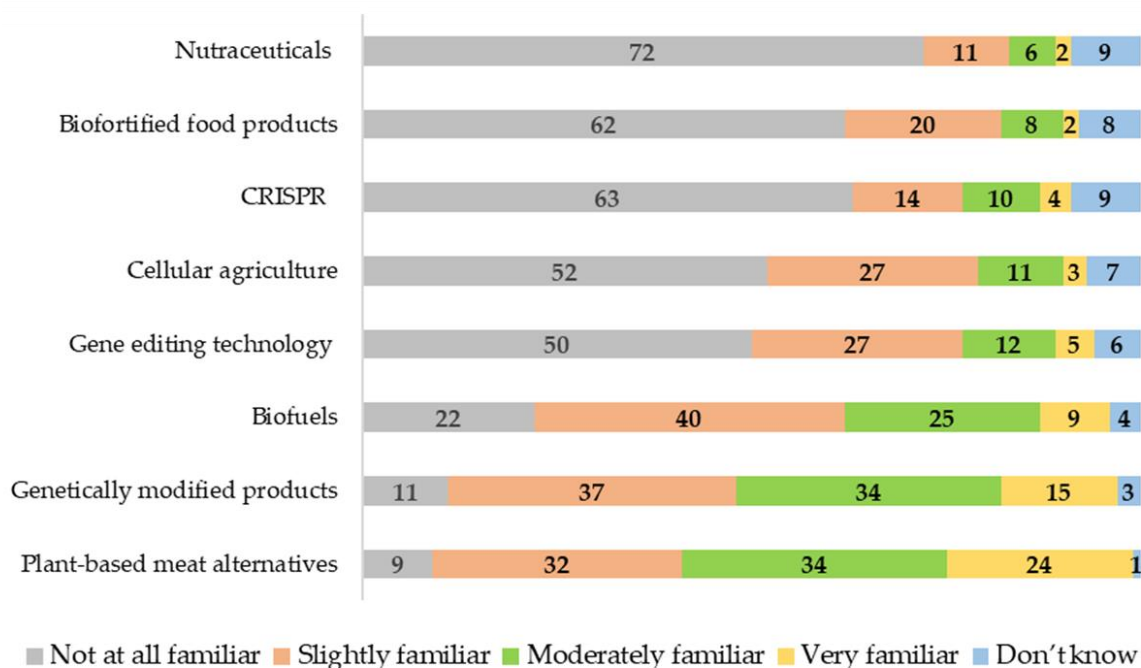


Figure 3. Sample familiarity with food innovation trends (% responses).

Crosstabs demonstrate an effect of dietary identity ($\chi^2 = 21.679, p < .001$) on familiarity with plant-based alternatives, but no gender effect ($\chi^2 = 5.643, p = 0.227$). There are more non-omnivore consumers who were moderately/very familiar (21% out of 32%) with those innovations than the omnivore group (38% out of 68%). The Chi-square test also shows a gender effect ($\chi^2 = 5.643, p = 0.227$) on familiarity with biofuels, as more males (22% out of 47%) were moderately/very familiar with them than females (13% out of 53%), and also on familiarity with cellular agriculture ($\chi^2 = 9.968, p = 0.041$). While there is no gender effect ($\chi^2 = 7.808, p = 0.099$) on familiarity with gene editing, there is a gender effect on familiarity with CRISPR technology ($\chi^2 = 23.444, p < 0.001$).

Kruskal–Wallis tests demonstrate that familiarity with food innovations including plant-based alternatives ($H = 48.305, p < 0.001$; $H = 16.428, p < 0.001$), biofuels ($H = 12.0715, p = 0.007$; $H = 14.224, p < 0.001$), biofortified food products ($H = 11.922, p = 0.008$; $H = 11.510, p = 0.003$), GM products ($H = 11.922, p < 0.001$; $H = 22.041, p < 0.001$), cellular agriculture ($H = 41.944, p < 0.001$; $H = 28.758, p < 0.001$), gene editing ($H = 27.849, p < 0.001$; $H = 18.162, p < 0.001$), and CRISPR ($H = 34.472, p < 0.001$; $H = 10.023, p = 0.007$) varies across age and education groups, respectively. There is also evidence for a regional effect on familiarity with all listed innovations except for biofuels and cellular agriculture. An income effect exists only on familiarity with biofuels and nutraceuticals.

Results show that price affordability (77%) and availability in stores (52%) are the key factors that might influence respondents to try innovative food and agricultural products, followed by concerns about the environmental impact (49%) and health considerations (48%). Concerns about animal welfare (39%), weight management (24%), and allergies/food sensitivities (23%) have a lower impact on trying new products among participants.

To investigate more in-depth consumer perceptions about innovations, their views about gene editing and its role in contributing to sustainable food and agricultural production are explored. The following definition was provided in the questionnaire: “Gene editing involves making precise small changes to a cell’s gene structure and does not necessarily involve mixing DNA from different species of plants or animals. Those changes could happen through traditional breeding but would have taken much longer.”, and participants were asked about the benefits of gene editing. As displayed in Figure 4, most participants agreed that using gene-editing technology in agriculture has various benefits. Reduced pesticide use (73%), water conservation (72%), and breeding crops resistant to severe weather conditions (e.g., droughts) (68%) are among the top environmental advantages reported. Tied at 65%, yield improvement, breeding crops with better resistances to diseases/pests/insects, and the reduced use of fertilizer are among the other identified advantages. Animal welfare benefits comprising improved livestock health (65%) and eliminating the threat of diseases (63%) are also recognized. Less than half of the sample believed that gene-editing technology offers health benefits such as removing allergens (45%) and reducing saturated and trans fats in crops and commodities (48%).

3.6. Where Canadians Obtain Their Information about Food Sustainability?

One of the central objectives of this study is to better understand where Canadians’ perceptions about sustainable and innovative agrifood products may originate from in terms of where information is sourced and how much the indicated sources are trusted. A list of information sources provided in the survey for respondents to choose from is presented in Figure 5, in ascending order of their popularity among participants. The survey results show that food labels (51%) and the internet (websites and web browsers such as Google) (50%) are the two most commonly utilized sources of information that respondents use to learn about sustainable agrifood products. As a direct shopping tool, labels are not only product features but also a communication channel that signals quality to consumers; thus, they can aid making informed buying decisions and increase consumer awareness and responsibility [60–62]. The Government of Canada (e.g., Health Canada) came in third place, followed by friends/family members. Less than a quarter of the sample indicated that they gather information from social media platforms (e.g., Instagram,

Facebook, Twitter), television/radio, or newspapers/magazines/books. Only 15% and 18% indicated that they obtain information about sustainability-related food from health experts and educational institutions, respectively. This highlights an issue in accessing information, as the public has greater and easier access to web-based information than they do from face-to-face consultations with experts such as medical professionals. In the same vein, van Bussel et al. [4] found that Canadian consumers admitted a lack of available information on sustainability. Food companies are the least popular source of information among surveyed consumers.

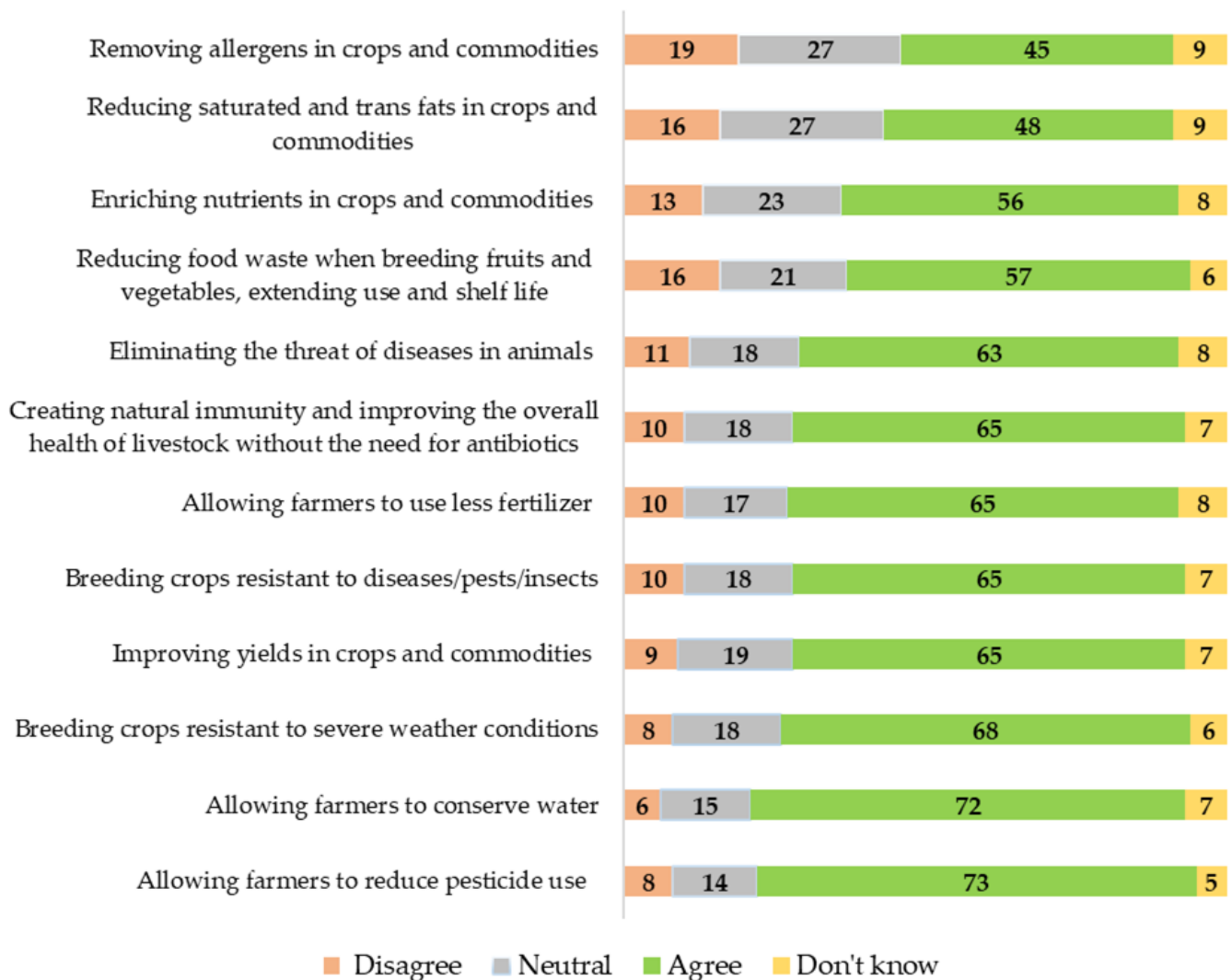


Figure 4. Perceived benefits of gene editing (% responses). Note: The scale options ‘Strongly agree’ and ‘Agree’ were grouped together to increase the cell count. The same applies for ‘Strongly disagree’ and ‘Disagree’. The recoding did not alter the result interpretation.

While Canadian consumers acquire information from various sources (crowdsourcing) to make informed food-buying decisions with respect to sustainability, online information comprises a massive source as information is available and easily accessible on the internet. Such information is circulated intentionally or unintentionally without necessarily a factual basis and sufficient evidence. This largely reduces the role of experts such as healthcare professionals in evaluating the quality of information to determine its veracity. On the other hand, the spread of misinformation on social networks has become a widespread concern among scholars [63]. It is generally recognized that online information comprises a large amount of misinformation that often misleads the public into making the wrong

decisions, stimulates negative public emotions, and even poses serious threat to public safety and social order [63,64].

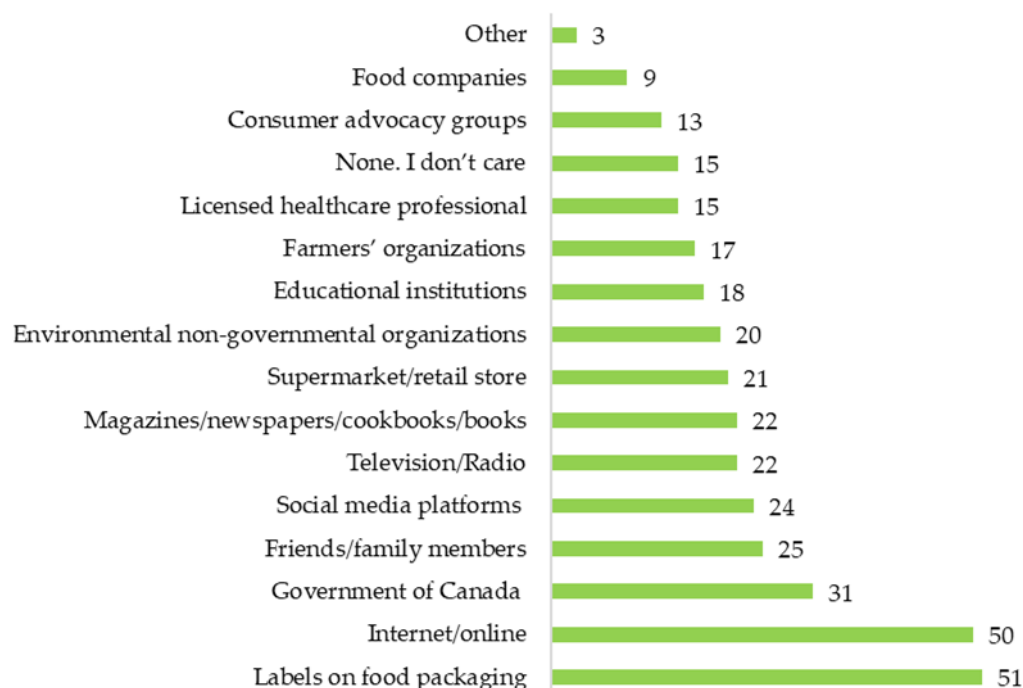


Figure 5. Information sources participants consult to obtain information on sustainable food and agricultural products (% responses).

To test whether the use of the top three popular sources of information consulted depends on consumer characteristics, a test of homogeneity was performed. Results demonstrate an effect of dietary identity on the use of labels on food packaging ($\chi^2 = 5.580$, $p = 0.018$), of internet ($\chi^2 = 4.631$, $p = 0.031$), and of the federal government websites ($\chi^2 = 4.389$, $p = 0.036$), to obtain information on sustainable agrifood products. There is a gender effect on the use of labels on food packaging ($\chi^2 = 8.819$, $p = 0.003$), but not on the use of internet ($\chi^2 = 3.459$, $p = 0.063$), nor the federal government websites ($\chi^2 = 0.960$, $p = 0.327$).

The post hoc analysis reveals statistically significant differences in the use of the internet ($H = 10.244$, $p = 0.017$) as a source of information among age groups. Indeed, the sample distributions between Baby Boomers and Gen Z and –Y and between Baby Boomers and Gen X were not alike. A similar effect is found among education groups ($H = 10.636$, $p = 0.005$), as the sample distribution of those with a secondary school-level education or less is different from those with a technical/college/university degree on their use of the internet as a source of information. No region or income effects on the use of labels, the internet, or government websites were detected.

3.7. Information Sources Canadians Trust about Sustainability and Innovation

After knowing the primary sources of information participants use when searching for information about sustainability and understanding some of the origins of consumers' decision making, the extent of trust consumers place in the sources of information they consult is examined. Most participants indicated that they mainly trust licensed healthcare professionals for accurate information about food-related sustainability (Figure 6) and innovation (Figure 7), followed by the federal government (e.g., Health Canada) and farmers' organizations (Figure 6). Social media platforms (e.g., Facebook, Twitter), food companies, internet, television, and magazines/newspapers are the least-trusted sources of information about both sustainability and innovation. Within the globalized food system, links of trust and direct relations with producers have vanished [65]. One consumer

commented “Veggie meats are highly processed. I want real food . . . not manufactured food with greenwashing.” Greenwashing refers to deceptive marketing practices that overinflate the company’s commitment to environmental, social, and economic concerns.

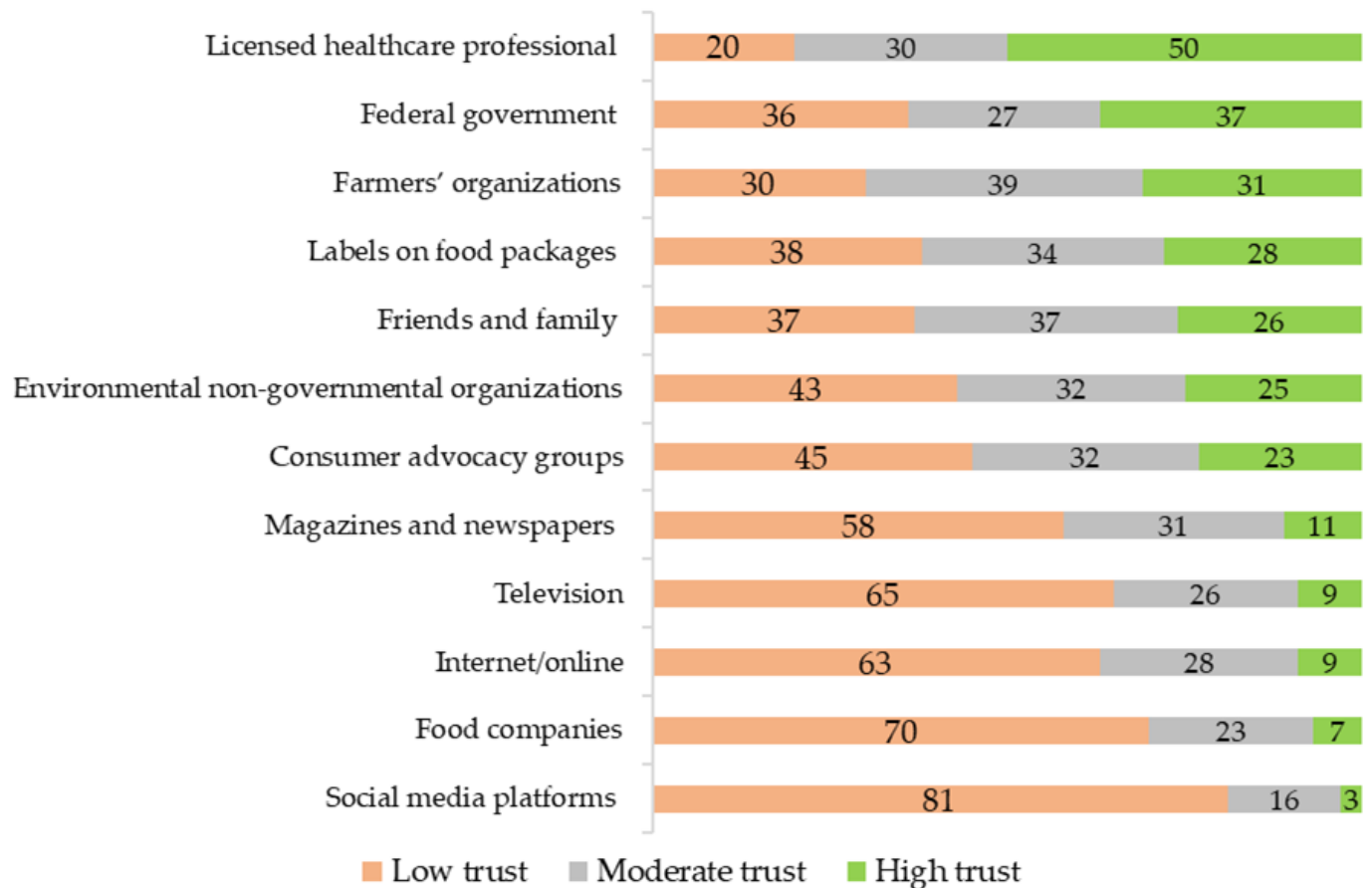


Figure 6. Trust levels in various sources for accurate information about sustainable food and agricultural products. Note: The scale options ‘Do not trust’ and ‘Slightly trust’ were grouped together as “Low trust” to increase the cell count. Similarly, “Mostly trust” and “Completely trust” were grouped into “High trust”. The recoding did not alter the result interpretation.

At least one-quarter of respondents rely on package labels (28%), friends/family members (26%), and non-governmental organizations (25%) as sources of information about sustainable agrifood products. Given that food labels are the most popular source consumers consult to obtain information about food-related sustainability, and that they ranked high in terms of trust (fourth-most trusted source), they can be a useful tool to increase consumers’ awareness of the impact of their food choices. On the other hand, 72% of consumers have a moderate or low trust in labels. It is therefore crucial for policy makers to communicate in a clear and transparent way. A regulated and controlled labelling policy could help drive consumption of sustainable food. Related to this, a participant commented “Whether a particular food product is “sustainably produced” rarely appears on any labelling so I may be using some that are but have no idea. Further, a claim on a food label that it is “sustainably produced” may not be accurate because you do not know what metrics are used by the food co. to give it that label. I am not sure the phrase “sustainably produced” is regulated and so for a consumer it has little meaning. It could mean anything”.

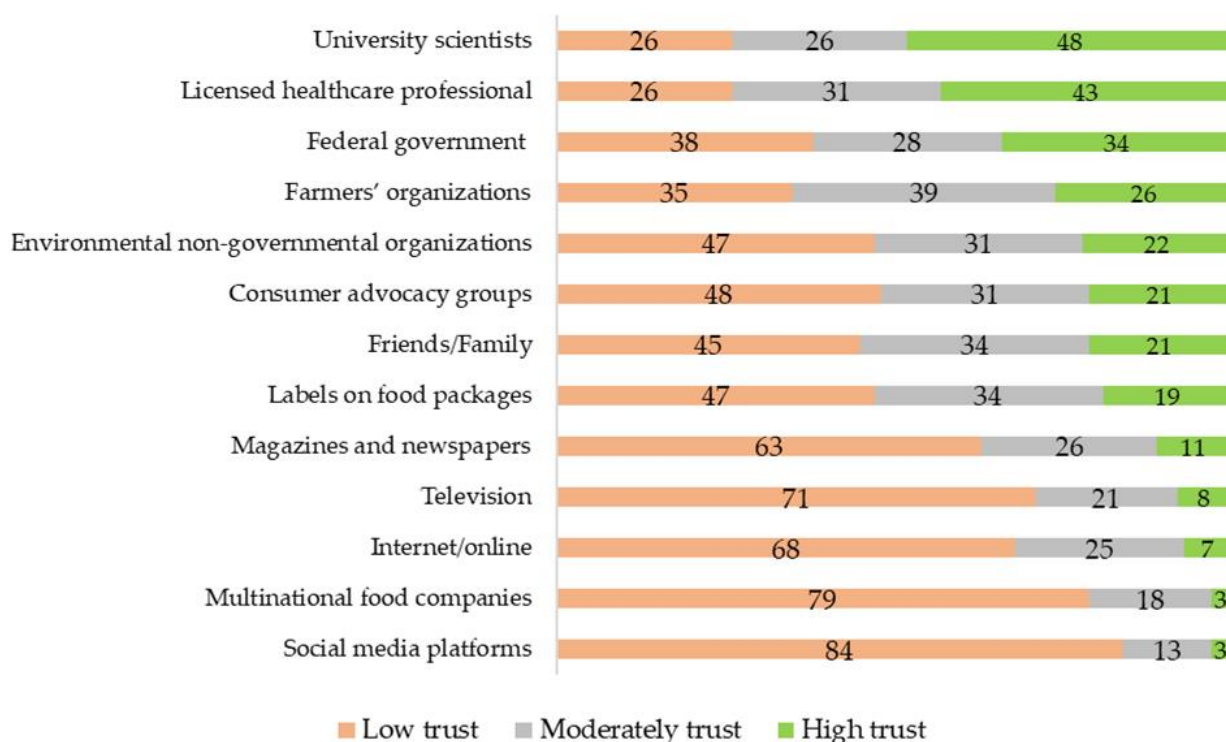


Figure 7. Trust level in various sources for accurate information about innovation in food and agricultural products such as gene editing. Note: The scale options ‘Do not trust’ and ‘Slightly trust’ were grouped together as “Low trust” to increase the cell count. Similarly, “Mostly trust” and “Completely trust” were grouped into “High trust”. The recoding did not alter the result interpretation.

When evaluating the association between gender and the top three sources trusted for accurate information about sustainable agrifood products, the results show a statistically significant difference between males and females ($\chi^2 = 11.880$, $p = 0.018$) on trusting the federal government. Regardless of the diet type, respondents exhibited similar trust levels in the federal government ($\chi^2 = 8.544$, $p = 0.074$) and farmers’ organizations ($\chi^2 = 6.966$, $p = 0.138$). A diet effect was detected for trust in licensed healthcare professionals ($\chi^2 = 11.880$, $p = 0.018$).

The post hoc analysis reveals no statistically significant differences in trusting licensed healthcare professionals ($\chi^2 = 2.699$, $p = 0.440$), the federal government ($\chi^2 = 2.792$, $p = 0.425$), or farmers’ organizations ($\chi^2 = 5.000$, $p = 0.172$) among age groups. Pairwise comparisons show regional differences between Prairies and Quebec, Atlantic provinces and Quebec, British Columbia and Quebec, and Ontario and Quebec in trusting healthcare experts and the federal government. Indeed, participants from Quebec exhibited higher trust levels in medical experts compared with the rest of Canada. The analysis also demonstrates a statistical regional difference in trusting farmers’ organizations ($p = 0.033$). A Kruskal–Wallis test shows differences in trusting licensed healthcare professionals ($H = 22.800$, $p < 0.001$) and the federal government among education groups ($H = 16.313$, $p < 0.001$), but not in trusting farmers’ organizations ($H = 0.055$, $p = 0.973$). Trust levels in medical experts and the federal government differ among secondary school or less–graduate studies ($p < 0.001$), and technical/college/university–graduate studies ($p = 0.007$). No income effect was found on trusting the top three sources for accurate information about sustainability.

Considering the top three trusted sources of information on innovation, there are significant differences between males and females in trusting the federal government ($\chi^2 = 9.783$, $p = 0.044$) and between omnivore and non-omnivore consumers in trusting medical experts ($\chi^2 = 13.164$, $p = 0.011$). Post hoc analysis reveals significant differences among age groups on trusting university scientists ($H = 18.484$, $p < 0.001$), specifically between Baby Boomers and Gen X ($p = 0.007$) and Baby Boomers and Gen. Z and Y

($p = 0.002$). A region effect was detected in the mean rank of trusting university scientists ($H = 53.563$, $p < 0.001$), the government of Canada ($H = 36.420$, $p < 0.001$), and licensed healthcare professionals ($H = 45.033$, $p < 0.001$). Pairwise comparisons show differences between Prairies and Quebec ($p < 0.001$), British Colombia and Quebec ($p < 0.001$), Ontario and Quebec ($p < 0.001$), and the Atlantic provinces and Quebec ($p < 0.05$) in trusting university scientists and healthcare experts about information on innovation. The analysis also demonstrates differences between Prairies and Quebec ($p < 0.001$), British Colombia and Quebec ($p < 0.001$), and Ontario and Quebec ($p < 0.001$) in mean scores of trusting the federal government.

There are significant differences among education groups on trusting university scientists ($H = 43.724$, $p < 0.001$), the federal government ($H = 16.860$, $p < 0.001$), and licensed healthcare professionals ($H = 16.340$, $p < 0.001$). The sample distribution is different across the three education groups for trust in medical and academic experts, and it is different between secondary school or less and graduate studies and between technical/college/university and graduate studies for trust in the federal government.

In sum, web-based information is the widely consulted source of information about food choices with respect to sustainability, although it ranked lower among consumers in terms of levels of trust. The most trusted sources of information about sustainability and innovation are mainly institutional (i.e., medical professionals, university scientists). This is an important finding to consider when evaluating information sources and consumers' levels of trust in the source's ability to provide correct information. The most widely accessible and available sources may not necessarily be the most widely trusted. This aligns with the results found by Clark and Bogdan [66,67] on trust information related to plant-based food. Table 2 summarizes key results on the effects of socio-demographics characteristics on key variables.

Table 2. Summary of the effect of socio-demographics on selected variables.

	Gender	Diet	Age	Region	Education	Income
Purchase Decision						
Sustainably produced trait	X	X				
Deliberately seek out sustainable food products	X	X				
Caring for the environment	X	X	X	X	X	
Familiarity with innovation trends						
Familiarity with plant-based alternatives		X	X	X	X	
Familiarity with biofuels	X		X		X	X
Familiarity with CRISPR	X		X	X	X	
Familiarity with gene editing			X	X	X	
Familiarity with biofortified food products			X	X	X	
Familiarity with GM products			X	X	X	
Familiarity with cellular agriculture	X		X		X	
Familiarity with nutraceuticals				X		X
Use of sources of information on sustainability						
Food labels	X	X				
Internet		X	X		X	
Federal government		X				
Trust in sources of information on sustainability						
Licensed healthcare professionals		X		X	X	
Federal government	X			X	X	
Farmers' organizations				X		
Trust in sources of information on innovation						
University scientists				X	X	
Licensed healthcare professionals		X		X	X	
Federal government	X			X	X	

X: Significant statistical effect at 0.05 confidence level.

4. Conclusions and Implications

This study presents data on what Canadian consumers are interested in with respect to the food they purchase and consume and how sustainable and innovative food products fit into their dietary choices. The results show that food purchases are primarily driven by self-centered motives—those that consider individual needs (related to health, price, and convenience)—and to some extent by environmental concerns that can be labeled as altruistic motives, as they benefit future generations and the planet in the long term [4,35]. Price affordability is the number one factor driving food choices, and higher prices were perceived as a barrier to a sustainable diet. While interest in sustainable food is more pronounced in younger and higher-educated individuals, it is hampered by the cost—especially with soaring food prices, and particularly for “healthy” options such as vegetables, as reported in Canada’s Food Price Report 2023 [68]. One participant stated that “I want to eat more sustainably, but can’t currently always afford it (especially with the inflation rising the cost of food exponentially).” There is evidence that diets with reduced GHG emissions (i.e., less meat) are affordable regardless of the income group, and healthy and sustainable diets cost less than a conventional western diet [69,70]. Thus, policy makers should remove pricing as a barrier and use it as a catalyst to reach a model of sustainable food consumption. In fact, a healthy diet and access to high quality food—that itself depends on the environment—depend on the affordability.

The results show that Canadian consumers hold an unbalanced view of food sustainability, as the environmental aspect dominates. The social and economic dimensions were not as salient in the analysis as only one-third of the sample understands the multifaceted nature of food sustainability. The importance of the “green” component varied across gender, diet, age, region, and education groups (Table 2). The results also reveal that Canadians are familiar with some innovation trends in the agrifood sector. Familiarity varied across age, region, and education groups, and for some innovation such as CRISPR, biofuels, and cellular agriculture, differences accrued between males and females. This implies that education at the consumer level is essential to increase awareness. These insights can be used to guide policymakers in making informed guidelines and recommendations to improve consumers’ understandings of food innovation and sustainability. This heavily relies on accurate, evidence-based, and trustworthy information.

Regarding information sources, most participants acquire information regarding sustainability from labels, the internet, and the government website. Web-based sources are widely consulted, yet largely untrusted. Institutional sources, mainly medical experts, university scientists, and the federal government, are the top-trusted sources of information, indicating that an important role can be played by these sources in refuting online misinformation and disinformation about safe food and technologies. Thus, they play a key role in consumer education. Governments can initiate this, for instance, through regulated labelling to provide clear guidance to consumers to make more informed sustainable food choices. Stratification of information source usage by key demographic variables indicated some differences among respondents. The study shows that consumers belonging to different dietary groups tend to use information on sustainability available on food labels, the internet, and government websites differently. The use of food labels as a source of information varies by gender, while the use of the internet varies by age and education. As to the level of trust in sources of information for both sustainability and innovation, it varied across regions and education groups. Trusting medical professionals is diet-specific, while trusting the federal government is gender-specific. This is also the case for some sources such as food labels and the internet, the use of which differed among males and females. Those results entail that market segmentation by consumer profiles can further support the alignment of accurate, timely, and accessible information with different consumers’ groups, hence they are an important area of future research.

Finally, how sustainable food products are branded and marketed by stakeholders has significant implications for the future of sustainable agricultural and food products. While Canadian consumers exhibit positive perceptions about the environmental goal of

food sustainability, perhaps accentuating the economic and social aspects, in addition to the health and ecological features of sustainability, might help to promote sustainable and innovative food to become a genuinely mainstream market in Canada. That is, to shift consumers toward more sustainable behaviour in their food choices, consumers need to understand the importance of the three pillars of food-related sustainability. Accelerating action to tackle the challenges around food sustainability and innovation is imperative from all participants in the food system—from the downstream to the upstream levels. While this bit of exploratory research may not be a paradigm-shifting study for sustainable consumption, its data help to better understand how consumers conceive food-related sustainability and related issues, and from them glean important recommendations for food-chain stakeholders in the food system. Future research within the Canadian context can further exploit the complex concept of food sustainability by developing a comprehensive multi-dimensional framework that operationalizes the environmental, social, and economic aspects.

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Author Contributions: Conceptualization, R.L. and S.J.S.; methodology, R.L., S.J.S., J.M. and S.C.; software, R.L.; formal analysis, R.L.; writing—original draft preparation, R.L.; writing—review and editing, S.J.S., J.M. and S.C.; supervision, S.J.S.; funding acquisition, S.J.S. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans, and was approved by the Social Sciences & Humanities Research Ethics Board of Dalhousie University (REB #: 2022-6418, 25 November 2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Consent was granted by all subjects involved in the study by completing the anonymous online questionnaire.

Data Availability Statement: The raw data supporting the conclusions of this manuscript are not publicly available. Survey data is protected and held confidential to ensure responder anonymity. Requests to access the dataset should be directed to Stuart J. Smyth at stuart.smyth@usask.ca.

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