CONSUMER ACCEPTANCE OF GENE EDITED FOODS:

A nationwide survey on US consumer beliefs, knowledge, understanding, and willingness to pay for gene-edited foods under different information treatments.

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SURVEY CONTENTS

EXECUTIVE SUMMARY

The purpose of this project was to determine market potential and consumers' beliefs, knowledge, understanding, and acceptance of gene-editing technology and gene-edited foods with the ultimate goal of providing valuable information to producers, retailers, consumers, and policy makers.

To achieve the project objectives, a nationwide consumer survey was developed. The survey was designed and programmed into an online accessible format by the director in August 2019 and administered to 4,487 U.S. food shoppers in September 2019. Different treatments were set up which varied the food product, whether the product was fresh or processed, and the information provided about gene-editing. Respondents were randomly grouped into the treatments. In each case, respondents completed simulated purchasing scenarios where they chose between products labeled to be organic, non-GMO, bioengineered, conventional, or gene-edited at varied price levels[1]. The core findings are as follows.

- Regardless of food product, presence of processing, or information, mean willingness-to-pay for organic labels was higher than the other food labels/claims. Respondents considered organic food to be healthier, safer, and more beneficial for animal welfare, but also anticipated organic being more expensive.
- Willingness-to-pay for gene-edited products tended to be lower than that for conventional and bioengineered ones. However, willingness-to-pay significantly increased with the provision of information; particularly information about the benefits of gene-editing technology. This evidence suggests that willingness-to-pay is not much changed by merely providing respondents with information about gene-editing technology, but rather it is necessary to supplement this information with specific benefit messages if the technology is to be more widely accepted. Benefits to the environment and consumers show an overall stronger impact than benefits to the farmers.
- Consumers have a very low level of awareness and knowledge about gene-edited products when compared to the mediocre knowledge and high awareness of GMOs. About half of the respondents indicated they had never heard of gene-editing.
- Respondents completed open-ended word association tasks, which revealed fear associated with the unknown. Negatively connoted words dominated mentions in relation to "gene-editing." Furthermore, these mentions closely resembled those given for genetically modified products.
- Despite the positive perception of the organic products, respondents mostly purchase conventionally produced food products. Even though respondents have higher willingness-to-pay for organic food, it is also higher priced. When directly asked about primary purchase motivations, respondents typically rank price and taste first, while production methods usually fell somewhere in the middle of a list of possible motivations.

[1] See Figure 3 for a definition of the terms.

- The cluster analysis resulted in three distinct risk preference segments, risk loving, risk averse, and risk neutral. A closer look at the segments by treatment reveals that when provided with basic information the share of respondents in the risk averse group increases and the risk loving group decreases. This effect reverses when information on the environmental benefits are provided.
- The willingness-to-pay for gene-editing varies across type of products and levels of processing. As for the former, consumers are willing to pay relatively more for fresh gene-edited vegetables (tomatoes and spinach) compared to fresh meat when information is provided to them. For fresh plant products, the willingness-to-pay is higher compared to their processed counterpart. On the other hand, the willingness-to-pay for gene-edited meat is higher for bacon than for pork chops.
- Despite somewhat negative opinions about gene-edited food, some consumers value having the option to buy them. When consumers are informed of the benefits of gene-editing, the market share for gene-edited products (when pitted against organic, non-GMO, conventional, and bioengineered) exceeds 15%. Consumer willingness-to-pay to have gene-edited foods available range from $0.00 to $0.23 per choice.

Results of this study reveal consumers generally think about gene-editing in a negative light. However, over half of the respondents indicate having never heard of the technology. Simply informing consumers about the technology has trivial effects on willingness-to-pay, but specific information about the benefits of gene-editing can significantly improve consumer acceptance of gene-editing.

CHAPTER 1: INTRODUCTION

The discovery of Crispr DNA sequences in the mid-1990s heralded a new era for genetic engineering of agricultural products through the introduction of gene-editing. Unlike the first generation of genetic engineering, which uses random insertions of DNA segments into the genome of a new species (usually referred to as genetic modifications), gene-editing technologies make precise changes at specific locations in the DNA. Moreover, gene-editing does not necessarily require the insertion of foreign DNA. As such, gene-editing technologies represent an evolution of traditional breeding and have the potential to revolutionize the food industry. In light of this, gene-editing is showing significant prospects for many different agricultural sectors as research has been applied to a wide variety of agricultural products. These products include animal-based products such as cattle, chicken, carp, catfish, goat, pig, salmon, sheep, and trout (see Tait-Burkard et al., 2018 for an overview), as well as numerous crops such as corn, soybean, and cotton (see Zhang et al., 2018 for an overview). With the wide array of applications of the technology, gene-editing has the potential to become more common in the agricultural sector. Benefits generated by gene-editing include increased disease and pest resistance (e.g. Whitworth et al., 2016; Shukla et al., 2009; Wang et al., 2016), environmental benefits (Patra and Andrew, 2015) and improved food product quality, including health and nutritional enhancements (e.g. Voytas and Gao, 2014; Shan et al., 2015; Waltz, 2016). As a more efficient breeding method than genetic modification (Haspel, 2018), gene-editing also holds the potential to create cheaper products of higher quality.

Although gene-edited products have begun to be commercially available (Choi, 2019), there are still a number of unanswered questions regarding gene-edited foods and their success in food markets. For example, do consumers recognize gene-editing as distinct from first-generation genetically modified foods- also known as GMO foods? If so, does this distinction translate into different attitudes, beliefs, and acceptance of gene-edited foods when compared to GMO foods? Are consumer preferences for gene-edited food products dependent? Does information on the benefits implied by gene-editing positively influence consumer valuation for gene-edited foods? Furthermore, can people with different knowledge, attitudes, beliefs, and preferences of gene-edited foods be segmented into different groups based on socio-demographic factors? The answer to these questions is crucial to better understand the potential market of these nascent products. Companies and producers involved in the research and development of the products need to determine if there is a viable market for gene-edited services and products. Farmers need to decide whether to switch to these new varieties. Intermediaries and retailers in the supply chain need to learn what price to charge. Consumers need to choose whether they will purchase and eat gene-edited foods. Finally, policymakers need to decide if and how gene-edited foods should be regulated and if this varies from the regulation of GMOs. To help address these questions, more information is needed about consumer perceptions and preferences for these new technologies.

Prior studies on gene-edited food products and their acceptance by consumers are few and limited in their scope (Shew et al., 2018; Yunes et al., 2019; Muringai et al., 2019). Both Shew et al. (2018) and Muringai et al. (2019) included a comparison with GMO products in their analysis and found a higher acceptance of gene-edited products compared to GMO foods. In addition, Shew et al. (2018) found a positive impact of providing information on consumer acceptance. However, while the study differentiates between a short and long information treatment, it does not look at different types of information such as the explanation of labels and claims or the direct description of benefits. In addition, the studies mentioned only focus on a singular food product and ignore the degree of processing. Lastly, while Yunes et al. (2019) (the only study looking at gene-edited meat products) examines consumers' general acceptance of meat products, they do not derive consumers' willingness-to pay (WTP)- which is vital to derive the product's market potential.

This research aims to address this gap in literature by using a comprehensive online consumer survey to determine U.S. consumers' 1) knowledge and understanding of gene-editing technologies; 2) beliefs about production methods including gene-editing, retail prices, environmental impacts, and the tradeoffs among these issues given different claims/labels; 3) preferences and WTP for three different meat and plant-based gene-edited agricultural products with different degrees of processing in relation to GMO, organic, conventional, and GMO-free foods; and 4) changes in consumer preferences and WTP for gene-edited foods under different information regimes.

The report is organized as follows: The next section summarizes the project objectives. After the objectives, Chapter 2 elaborates on the experimental procedures. Chapters 3 and 4 focus on the data analysis and results, respectively. Chapter 5 concludes by presenting the implications of this research.

1.1 PROJECT OBJECTIVES

The overall goal of this project is to advance consumer food choice and decision-making research and apply this research to generate more realistic consumer insights for the U.S. food industry. To accomplish this overall goal, and in accordance to the RFP, the project is organized around four main objectives:

(1) Determine the level of consumers' beliefs, knowledge, and understanding regarding gene-editing technology and gene-edited foods;

(2) Determine consumer acceptance of gene-edited food by examining how consumers value gene-edited foods over conventional foods, GMO foods, non-GMO labeled foods, and organic foods;

(3) Determine whether and how different information reported in labels influences consumer preferences and WTP for gene-edited foods;

(4) Determine whether external and behavioral factors play a deciding role in consumers' perception of gene-edited food

These specific objectives will be accomplished by conducting a novel consumer new-food-technology survey. The following section describes the methods that will be followed to achieve the specific objectives.

CHAPTER 2: EXPERIMENTAL PROCEDURES

Summary:

The following sections present an overview about the survey design. They explain both the rationale behind the methods and questions chosen as well as the procedure followed. We begin by providing a general overview of the survey, which also details the characteristics of the sample. We then follow the overview with an explanation of the choice experiment design and the between-subject treatments- which form the centerpiece of the experiment conducted. Next, we discuss the knowledge and beliefs questions asked in the survey. These questions contribute to understanding consumers underlying reasoning and motivations. In line with this understanding, we next discuss the risk preference questions.

Furthermore, the appendix reports in more detail all the survey questions, food experiments, and treatments.

2.1 SURVEY OVERVIEW AND SAMPLE CHARACTERISTICS

A nationwide survey was conducted in September 2019. The survey was designed by Professor Vincenzina Caputo with the help of feedback from Dr. Jayson Lusk and implemented in Qualtrics (https://www.qualtrics.com) with the assistance of Valerie Kilders, graduate student at Michigan State University. Dynata (https://www.dynata.com/), which is a world leading provider of survey samples, delivered the survey to their online panel and managed the data collection.

The survey included various questions and food choice experiments designed to achieve each of the research objectives of the project. To qualify for the survey, respondents had to answer several screening questions to ensure that they were a decision-making entity for food purchasing in their household. We required respondents to:

- be above 18 years old
- buy at least half of their household's groceries
- have bought and consumed at least one of the selected food products in the last three months.

In addition to the initial screening questions related to the above stated requirements, we further eliminated those respondents who provided nonsensical answers to open ended questions (e.g. sjdfg). Lastly, accordance with U.S. Census data was achieved through the implementation of various quotas. These blocked the partaking of potential respondents if sufficient participation of their specific demographic had been reached but was not held too strictly to avoid a low participation overall.

Resulting from these constraints, we obtained 4,487 completed responses in total. These responses were distributed over six products and 22 different treatments (see section 2.3). The characteristics of the overall sample and for the individual products are reported in Graph 1.

Overall, the full sample approximately matched the U.S. population aside from gender, income, and education. A higher share of females (~60%) is appropriate given our restriction that the majority of grocery shopping had to be done by the respondent and is also in line with other studies in this field (e.g. Grebitus et al., 2013, Lusk, 2011, Nocella et al., 2010). With regards to income, we sampled slightly more middle-income respondents than the U.S. average and slightly less high-income respondents. However, when looking at the median and average of the variables, they are in accordance with the census data. Lastly, we have a higher share of respondents with at least a college degree in our sample than the U.S. Census. This as well is in line with other food studies (e.g. van Loo et al., 2011; de Marchi et al., 2016) and reflects the generally higher participation of better educated respondents in surveys (Singer et al., 2000). The overall results are also reflected in the sub-samples for the six different products, which generally conform with the full sample. One exception is the comparatively higher share of males in the Bacon category, which can be explained by men more frequently eating processed meats (Beardsworth et al., 2002) leading to a higher assignment of men to this group.

Table 1. Socio-demographic Characteristics of the whole Sample and across Treatments

Characteristic	All samples	Grape Tomatoes	Pasta Sauce	Fresh Spinach	Frozen Spinach	Pork Chop	Bacon	U.S. Census Data
Region								
Northeast Census Region	21.4%	18.7%	19.1%	18.8%	22.7%	13.7%	16.1%	17.2%
Midwest Census Region	18.3%	21.7%	21.7%	21.3%	17.3%	23.7%	22.0%	20.9%
South Census Region	37.8%	33.6%	37.8%	37.0%	42.5%	40.4%	38.4%	38.1%
West Census Region	22.5%	25.9%	21.5%	22.8%	17.5%	22.2%	23.5%	23.8%
Age								
18-24 years old	8.3%	7.5%	8.7%	9.0%	5.3%	8.2%	10.9%	9.3%
25-34 years old	14.5%	13.3%	16.5%	14.5%	12.3%	12.4%	17.2%	14.0%
35-44 years old	14.1%	13.5%	15.3%	14.8%	10.0%	15.4%	14.8%	12.6%
45-54 years old	15.0%	12.3%	17.2%	15.7%	12.2%	14.7%	17.2%	12.7%
55-64 years old	21.4%	22.8%	20.0%	19.0%	14.7%	22.9%	19.8%	12.9%
65-73 years old	18.7%	21.2%	14.4%	19.0%	27.8%	19.5%	12.4%	9.3%
74 years or older	8.1%	9.3%	8.0%	8.0%	7.7%	7.0%	7.7%	6.7%
Gender								
Female	62.3%	64.9%	63.6%	65.0%	67.2%	57.9%	53.5%	51.3%
Male	37.7%	35.1%	36.4%	35.0%	32.8%	42.1%	46.5%	48.7%
Income								
less than $15,000	12.2%	9.1%	15.2%	10.8%	8.0%	14.2%	15.7%	10.6%
$15,000 to $24,999	9.6%	7.8%	10.8%	9.5%	9.3%	10.4%	10.3%	9.0%
$25,000 to $49,999	25.7%	25.1%	28.0%	23.2%	26.7%	24.5%	25.2%	8.9%
$50,000 to $74,999	21.8%	25.2%	20.2%	20.8%	21.3%	20.4%	21.8%	17.4%
$75000 to $94,999	13.5%	13.6%	12.2%	13.8%	15.3%	13.4%	13.4%	12.6%
$100,000 to $149,999	10.8%	12.0%	8.9%	13.2%	12.3%	10.7%	8.8%	15.0%
$150,000 to $199,999	3.8%	4.4%	3.1%	3.5%	3.8%	5.3%	3.0%	6.6%
$200,000 to $249,999	1.1%	1.3%	0.9%	1.8%	1.5%	0.7%	0.8%	7.6%[2]
$250,000 and over	1.4%	1.4%	0.8%	3.3%	1.7%	0.5%	1.2%	
Race/Ethnicity								
White	74.2%	74.9%	74.2%	74.8%	76.2%	75.3%	69.7%	75.4%
Black or African American	9.7%	9.6%	9.3%	7.5%	11.3%	9.0%	11.8%	14.0%

[2] The census brackets combine the last two income brackets used in the survey stating them as >$200,000

Characteristic	All samples	Grape Tomatoes	Pasta Sauce	Fresh Spinach	Frozen Spinach	Pork Chop	Bacon	U.S. Census Data
Hispanic	9.4%	8.6%	11.4%	10.2%	5.5%	7.4%	12.0%	17.8%[3]
Married	46.8%	49.9%	45.2%	48.2%	46.7%	49.6%	40.9%	48.2%
Mean Household Size (# people)	2.4	2.3	2.4	2.3	2.2	2.5	2.5	2.4
College degree	43.1%	48.9%	41.6%	48%	46.5%	36.7%	34.9%	18%

The following sections provide a detailed overview of the survey design based on the research objectives.

[3] In our survey we combined the questions of whether someone was Hispanic and about their race/ethnicity (one answer possible), while the Census separates them into two distinct questions (two answers possible). Hence, the last column sums to more than 100%

2.2 CHOICE EXPERIMENT DESIGN

To elicit consumer preferences and demand for gene-edited foods over conventional, GMO, organic, and non-GMO labeled foods (**Objective 1**), the consumer survey included a number of discrete choice experiments (DCEs) on food selection. DCE is a stated-preference multi-attribute method widely used in many fields of applied economics to elicit individual preferences and has recently become popular in agri-food industry related studies. DCE is a suitable method for this research study for two main reasons. First, it allows us to capture the trade-offs consumers will make among food attributes (e.g., gene-edited, GMO, organic, non-GMO labels/claims, and price). Second, due to its confirmed external validity (Hensher et al., 1998; Swait and Andrews, 2003; Chang et al., 2009; Brooks and Lusk, 2010), results from DCEs can be used to develop pricing models, marketing strategies, and policies. Finally, DCE questions are framed in a manner that resembles actual purchase situations (Caputo et al., 2017), making consumer surveys more realistic. For the DCE, three focal products were selected, each being fresh and processed resulting in a total of six products. The products are tomatoes and pasta sauce, fresh spinach and frozen spinach, as well as pork chops and bacon. This selection is motivated by prior studies (Lusk et al., 2015) showing that consumer valuation for gene-edited food can vary across product types and the stage of processing. Figure 1 summarizes the focal products selected for this study.

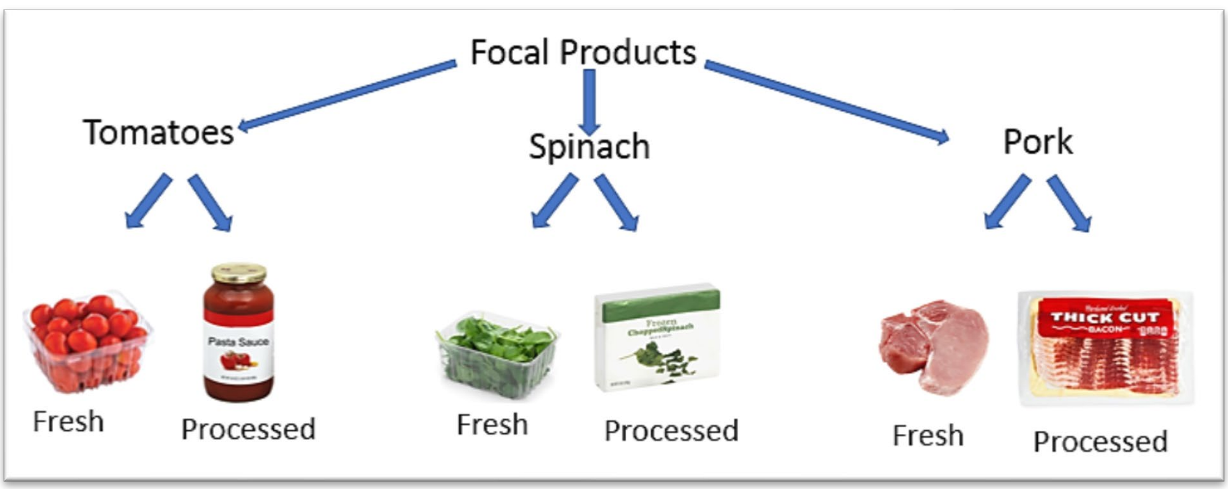


Figure 1: Focal Products

Moreover, to provide an even more realistic impression of actual market conditions found in many U.S. supermarkets, we did not only compare gene-edited products with GMO foods or conventionally produced ones, but also included a comparison with organic and non-GMO products. Hence, we considered five product alternatives (conventional, USDA organic, non-GMO, GMO, gene-edited) offered at different prices. Four price levels were used for each of the six focal products (Table 2). These were selected using pricing information from the U.S. Bureau of Labor Statistics, the U.S. Department of Agriculture (USDA), the Economic Research Service (ERS), and various popular supermarkets and wholesalers. When choosing the price levels, we were mindful of including the price premium common to organic and non-GMO products resulting in slightly higher prices for those attributes.

Table 2. Price levels for the different focal products

Product/Production Method	Gene-Edited, GMO & Conventional	Organic and Non-GMO
Grape Tomatoes (1 pint)	$1.59	$2.59
	$2.59	$3.59
	$3.59	$4.59
	$4.59	$5.59
Pasta Sauce (24oz)	$0.99	$1.99
	$1.99	$2.99
	$2.99	$3.99
	$3.99	$4.99
Fresh Spinach (10oz)	$1.59	$2.59
	$2.59	$3.59
	$3.59	$4.59
	$4.59	$5.59
Frozen Spinach (10oz)	$0.99	$1.99
	$1.99	$2.99
	$2.99	$3.99
	$3.99	$4.99
Pork Chops (1lbs)	$2.59	$4.59
	$3.59	$5.59
	$4.59	$6.59
	$5.59	$7.59
Bacon (1lbs)	$3.99	$5.99
	$4.99	$6.99
	$5.99	$7.99
	$6.99	$8.99

Given the number of alternatives (conventional, organic, GMO, non-GMO, and gene-edited) and price levels within each focal product, a full factorial design would have resulted in 625 (4^5) choice questions. To reduce the number of questions respondents had to answer during the DCE survey, we generated an orthogonal fractional factorial design using Ngene (http://www.choice-metrics.com/features.html). It resulted in 12 choice questions for each of the six focal products. In order to make the choice tasks more realistic and increase external validity, we also allowed respondents to pick a "none" alternative (status quo or no-buy). This alternative means that they can choose not to buy any of the products if the products do not appeal to them at the given prices.

Furthermore, we also included images of the product and displayed the official label for the organic, non-GMO, and GMO products. We provide no additional label or claim for the conventionally produced food and presented the gene-edited product with the claim “gene-edited.” Overall, for each focal product, respondents were asked to answer twelve choice questions. Each choice question included five product alternatives (conventional, USDA organic, non-GMO, GMO, Gene-Edited) offered at different prices and an opt-out option (see Figure 2).

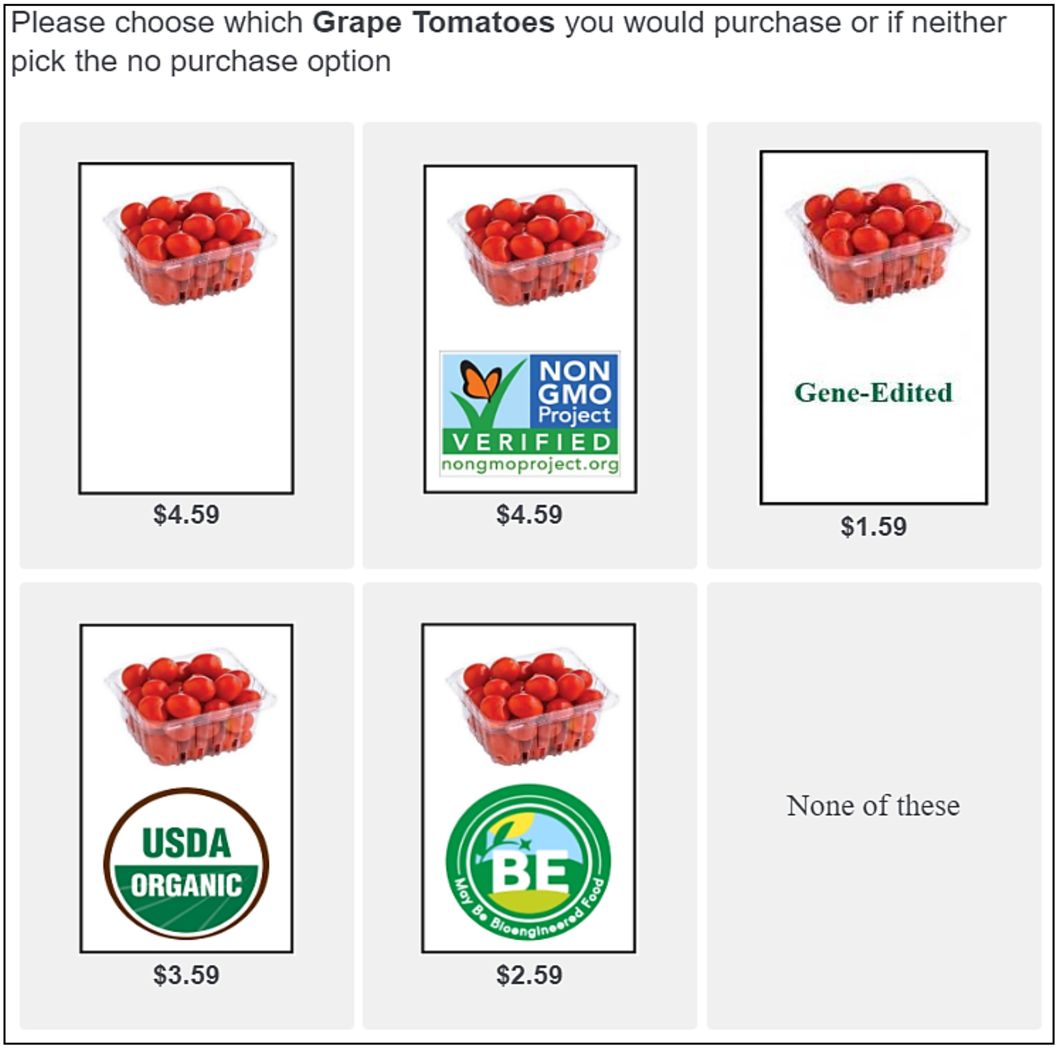


Figure 2: Example of a Choice Question

Before proceeding to answer the twelve choice questions, we provided all respondents with written instructions on how to answer the DCE. After that, respondents were randomly sorted into only one focal product (following a between-subject design approach, see following section) where each respondent only answered the choice questions for one of the six focal products. In order to be assigned to a group the respondent needed to have bought and consumed the specific good at least once in the last three months. If this was not the case for any of the products, the survey was terminated. If this was the case for more than one product, the assignment was random.

2.3 BETWEEN-SUBJECT TREATMENTS

In addition to the food choice questions, the survey also included different information treatments as reported in Table 3. These treatments were designed to explore what information influences consumer preferences and WTP for gene-edited foods the most and thus achieve **Objective 2**. This design is reflected in the different treatments; all of which contain around 200 respondents.

Table 3: Information Treatments Outlines

Products/ Treatments	*Tomatoes*		*Spinach*		*Pork*	
	Fresh	Processed	Fresh	Processed	Fresh	Processed
Control	200	238	200	200	200	251
Basic Information	200	200	200	200	200	200
Benefits to Consumers	200	200			199	200
Benefits to Environment	200	200	200	200		
Benefits to Farmers	199	200				

The set-up, procedure, and phrasing were held consistent throughout all products and treatments to maximize compatibility. In the control treatments, the respondents only received the basic instructions before answering the twelve DCE choice questions. In the basic information treatment, prior to the choice questions, we provided an additional table to the respondents giving a brief explanation of the labels used (USDA organic, non-GMO, bioengineered, unlabeled) and claim (gene-edited) (see Figure 3). The wording of the labels/claims was slightly adjusted depending on if the respondent was presented with a meat or plant-based product.

Category	Meaning
USDA ORGANIC	The USDA organic label indicates that meat, poultry, eggs, and dairy products come from animals which are raised in living conditions accommodating their natural behaviors (like the ability to graze on pasture), fed 100% organic feed and forage, and not administered antibiotics or hormones.
BIOENGINEERED	The bioengineered label indicates that the meat products are from animals that have been genetically modified by adding/inserting foreign genes from other animals or organisms at a random location into the DNA of the animal. The animal can be referred to as a GMO animal. At this point only one product, a genetically modified salmon is available on the market.
NON GMO Project VERIFIED nongmoproject.org	The Non-GMO label indicates that that meat, poultry, eggs, and dairy products come from animals that have not been genetically modified. The label does not prohibit the use of other conventional production methods, such as antibiotics, unrelated to genetic modification.
Gene-Edited	Gene editing is a form of precision breeding that makes small targeted changes, commonly called edits, to an animal genome to bring about desired characteristics.
Unlabeled Bacon	Unlabeled bacon is bacon that has been produced conventionally. Conventional agricultural production often uses a collection of breeding methods that have been developed over time. This includes crossbreeding of related animals, as well as manipulated changes to produce new animal varieties with desirable characteristics. About 95% of animals are produced conventionally.

Figure 3: Example of a Label/Claim description

The benefits treatments contained the same information as the basic information treatment but also added a brief description of the particular benefits gene-editing can provide. To ensure respondents would read the information we integrated a timer, which required a minimum time of 15 seconds to pass for each information set before the respondents could continue with the survey. We focused on benefit message components because research on genetically engineered food has typically shown that those who see more benefits in the technology are willing to pay more for the food (Lusk et al., 2005) and are generally more willing to accept the technology (Siegrist, 2000; Siegrist, 2003). Benefits to the consumers, environment, and farms were considered (as illustrated in Table 4). Contributing to **Objective 2,** this approach of looking at different benefits allows us to compare which benefit resonates the most with consumers. Note that tomatoes were chosen as a baseline for information treatment comparisons, meaning all three benefits (e.g. consumers, environment, and farms) were applied to tomatoes. For the other two products, the focus was put on only one benefit. Namely, spinach respondents received only information about the environmental benefits.

Similarly, for the pork products, the presented information was centered only on the benefits to the consumer.

Table 4: Benefits to Consumers, Environment, and Farmers among products

	Benefits		
Products	*Consumers*	*Environment*	*Farmers*
Tomatoes	Gene-edited – Increased vitamin C, potassium and antioxidants	Gene-edited – Reduced need for pesticides	Gene-edited – Increased resilience of plants against a contagious and potentially deadly plant disease
Spinach		Gene-edited – Produced with 40% less water	
Pork	Gene-edited – Increase the resilience of animals against a contagious or potentially deadly virus.		

Note: Within each product category, the information is associated with both fresh and processed products. For example, the benefits to the consumers, environment, and farmers in the case of tomatoes are used for both fresh and processed products.

The wording across the various products and benefits was relatively similar to allow for comparability. For instance, in the case of consumer benefits for tomatoes, this message used was:

"*The gene-edited grape tomatoes that you have the option to hypothetically purchase in the following section were created by turning on or off pre-existing genes to* ***increase the levels of vitamin C, potassium, and antioxidants, and thus strengthen the nutritional value of the product.***"

Similarly, in the case of fresh spinach, the following message was used to convey the benefits to the environment:

"*The gene-edited spinach that you have the option to hypothetically purchase in the following section was created by turning pre-existing genes from the spinach on or off* ***to use 40% less water in production and thus reducing the environmental impact.***"

In addition, for pork chops:

"The gene-edited pork chops that you have the option to hypothetically purchase in the following section were created by turning pre-existing genes of the pig on or off to increase the ***resilience of***

animals against a contagious and potentially deadly virus and thus enhancing the health care of the animals.

In the choice questions themselves, the gene-editing claim indicated what benefit the product held. For example, the claim for gene-edited tomatoes with the benefit targeting consumers reads *"**Gene-Edited to Improve Nutritional Value**"* (See Figure 4).

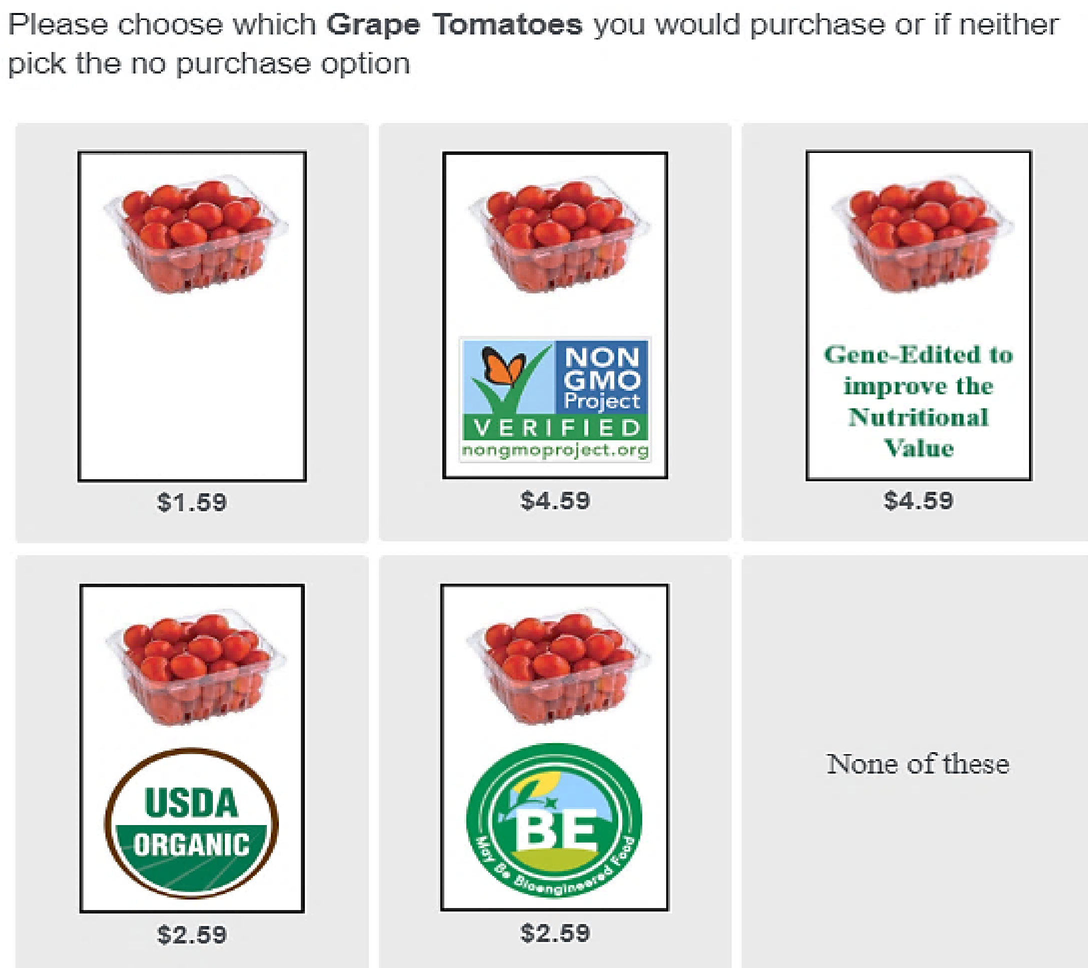


Figure 4: Example of Grape Tomato Choice Question with Consumer Benefit

2.4 KNOWLEDGE AND BELIEFS QUESTIONS

In addition to the various DCEs and information treatments, the consumer survey also includes questions designed to capture consumer awareness, beliefs, knowledge, and understanding regarding gene-editing technology and gene-edited foods (which directly contributes to **Objective 3)**.

To measure respondent's awareness of gene-edited products, we ask them five word-association questions. Each question asks what the respondents think when they hear "GMO", "Gene-Edited", "Organic", "GMO-Free", and "Conventionally grown". In addition, respondents are asked if they have ever heard of gene-edited or GMO foods and if so, which ones.

Beliefs regarding conventional, organic, non-GMO, GMO products, and gene-edited products were elicited by including four Likert-scale questions for plant-based products. Likert-scale questions ask respondents to provide their agreement or disagreement for certain statements within a predefined range (see Figure 5). In addition, we included an additional Likert-scale question for the animal products to inquire about animal welfare. This followed the approach used by Lusk (2018) with questions focusing on the healthiness, tastiness, price expectation, as well as risk and animal welfare perception of the different production methods. For example, consumers were asked to state their level of agreement with statements like *"How healthy or unhealthy do you consider pork chops sold with each of the labels shown below?"* (see Figure 5). Similar questions were used for the other beliefs.

In addition to eliciting respondent's awareness and beliefs, their prior knowledge was also assessed. Following House et al. (2004), we asked each respondent to indicate how knowledgeable they are about the different production methods as well as the facts and issues surrounding GMO and gene-edited foods. For example, we asked respondents "*How knowledgeable are you about gene-editing in animal production?*" The questions were adapted according to the product the respondent was assigned to in order to take into account whether the respondent was exposed to an animal product or plant product.

This was followed by seven true/false questions, which were adapted from House et al. (2004) to measure respondents' objective knowledge. We used statements such as "*Gene-editing involves the transfer of animal genes to plants*" and "*Ordinary animals do not contain genes, but GMO animals do."* From these questions we are able to test hypotheses like "*People who more accurately understand gene-editing are more likely to accept gene-edited foods.".*

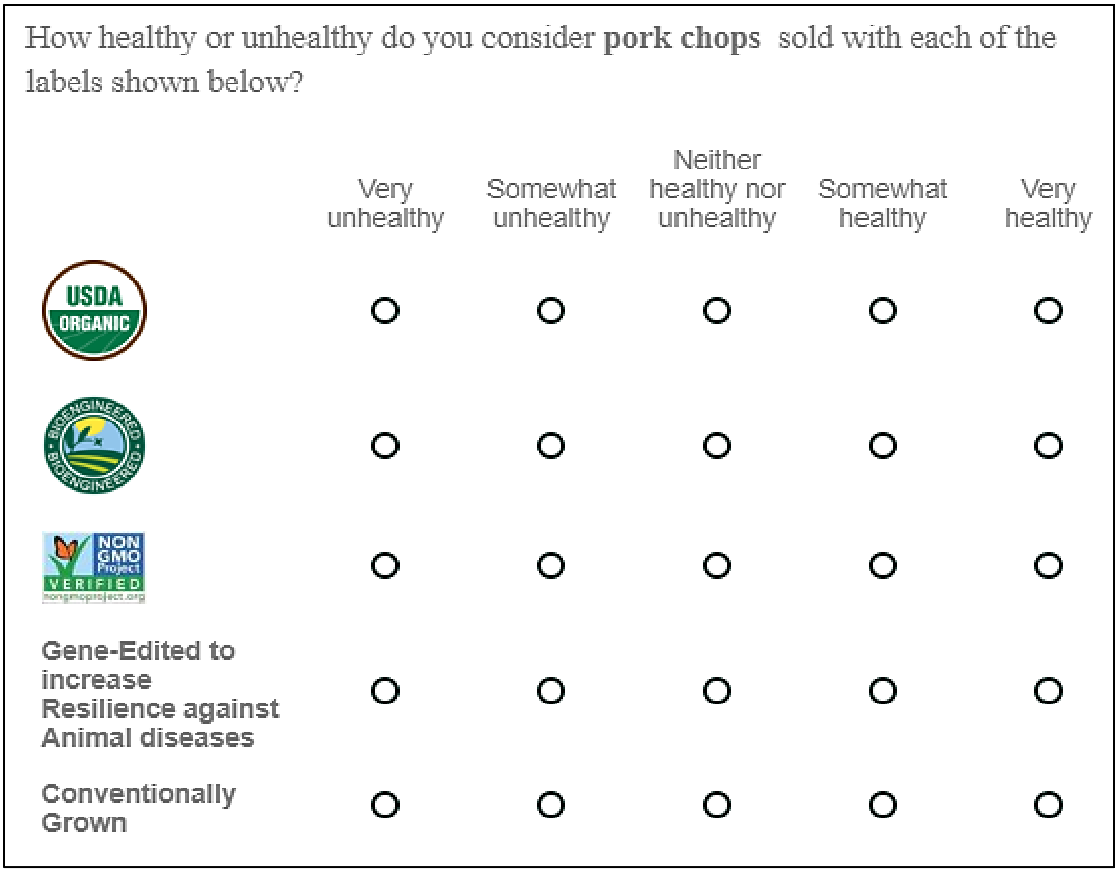


Figure 5: Example of a Beliefs Question

Overall, these questions inform producers of gene-edited foods as to what marketing hurdles they may need to address to increase the acceptance of their products in the market. Finally, by comparing responses to these questions to the choice experiment results, we got some sense of whether consumers' attitudes align with their market behavior. For example, consumers may support organic produce as an idea but not purchase it in the market due to high prices. Comparing beliefs with stated preference data exposes potential barriers to entry for interested consumers.

2.5 RISK PREFERENCE AND MORAL CONCERNS SCALE

House et al. (2004) showed that risk preferences and moral concerns significantly relate to consumers' stated preferences for GMOs, which is likely to also be the case for gene-edited products. Accordingly, the survey also assesses consumer risk preferences and moral concerns using a validated scale adopted from House et al. (2004). More specifically, respondents were asked 15 questions aiming to determine their individual risk attitude and moral concerns towards gene-editing. For example, among other questions we asked respondents to indicate their agreement with statements such as "*Gene-editing in food production could provide benefits for the environment.*" This also allows us to evaluate the level of risk and moral concerns perceived by consumers for gene-editing as well as the sort of risk consumers expect from this new biotechnology. Results can be used to mitigate potential concerns and target specific subgroups of consumers.

CHAPTER 3: DATA ANALYSIS

Summary:

This chapter describes the statistic and econometric techniques used to analyze the consumer survey data. It starts by describing the approach followed to explore the word association data. The econometric methods used to estimate the choice experiment data follows. It ends with an overview of the statistical procedures employed to analyze the survey questions related to consumption habits, beliefs, awareness, knowledge, and risk preferences.

Word Association

To measure what consumers link with different production methods (conventional, organic, non-GMO, GMO, and gene-edited), we prompted them with five different word association tasks. Each task asked respondents to indicate what came to their mind when prompted with the words "Organic", "Non-GMO", "GMO", "Gene-edited", and "Conventional". This approach has commonly been used to evaluate consumers beliefs and is in line with other studies evaluating consumer's associations with food products or production methods (Haas et al., 2013; Son et al., 2014). It is based on associative network conceptualization of memory structure and highlights what a group generally experiences or relates with certain words/stimuli (Son et al., 2014). Similar to Haas et al. (2013) and Son et al. (2014), we counted the frequency of answers to the question to perform our analysis of the respondent's answers. To contextualize the individual frequencies of the words, we then created a word cloud of the terms showing the relative frequency of the phrase or word. The analysis followed two steps. In the first step, we checked the correctness of the words reported by the respondents with regards to spelling. Next, we used "worditout.com," which is a word cloud generator, to visualize the frequencies of the words associated with each product alternative (conventional, organic, non-GMO, GMO, and gene-edited).

Choice Experiment Data

The choice experiment data was analyzed using a Mixed Logit model (MXL). The MXL allows us to account for random taste variation (preference heterogeneity) and has the capacity to approximate any true underlying random utility model (McFadden and Train, 2000; Train, 2009). Following recent food choice studies (Caputo et al., 2013, among others), an error component (EC) was also included in the model to reflect differential substitution patterns among the "none" (or status-quo) option and the product alternatives in the choice questions (Train, 2009; Scarpa et al., 2005). In addition, utilities were specified in WTP space rather than in preference space to allow for heterogeneity in the price coefficient (Train and Weeks, 2005) as the same monetary unit has different values for individuals with different budget constraints.

Formally, the utility U that consumer n derives product alternative j at choice situation t is expressed as follows:

$$U_{njt} = \theta_n(-PRICE_{njt} + \alpha_{njt} + e_{nj}) + \varepsilon_{njt} \quad (1)$$

where θ_n is a random positive scalar representing the price/scale parameter; $PRICE_{njt}$ is a continuous variable populated with the four price levels in the design of each focal product; α_{njt} are alternative-specific constants representing the estimated WTP values for j product alternatives: conventional, organic, non-GMO, GMO, and gene-edited; e_{nj} reflects a mean-zero Normally distributed error component. Following Scarpa et al. (2005), we specified e_{ij} to be individual-specific and the same for all product alternatives except the "none of these" option- for which there is no error component. ε_{ij} is the distributed *i.i.d.* type I extreme value random term. All coefficients were assumed random in the population. More specifically, the alternative specific constants were assumed normally distributed in the population, while the price coefficients were one-side triangularly distributed[4]. As a result, the population WTP estimates from the models are normally distributed. Hence, the mean and median coincide. The utility of the "none of these" option is normalized to zero for identification purposes.

For the tomato experiment, we estimated ten MXL-EC models in the WTP space: one for each treatment (control, basic information, benefits to consumers, benefits to environment, and benefits to farmers) and processing stage (grape tomatoes and pasta sauce). For the spinach and pork experiments, we estimated six MXL-EC models in the WTP space respectively: one for each treatment (control, basic information, benefits to environment/benefits to farmers) and processing stage (fresh spinach and frozen spinach/pork chops and bacon).

When choice models are specified in the WTP space, the coefficients can be directly interpreted as WTP estimates. Accordingly, in this application, the coefficients from the models represent the total WTP for each product alternative *j* (conventional, organic, non-GMO, GMO, and gene-edited) and refer to the dollar premium that would induce a consumer to be exactly indifferent to buying a *j* alternative versus "none" (for example gene-edited fresh tomatoes versus GMO grape tomatoes).Marginal WTP for product j versus product k were also calculated by subtracting the total WTP for product j from total WTP from product k. Unlike total WTP, marginal WTP refers to the dollar premium that would induce a consumer to be exactly indifferent to buying a j

[4] The parameters are estimated via simulation maximum likelihood estimation based on 1000 Halton draws for each parameter (see Train, 2009 for details).

alternative (for example gene-edited grape tomatoes) versus a k alternative other than the "none" option (for example GMO grape tomatoes).

Further, estimates from the models were used to explore distributional features in WTP across focal products and information treatments. We did so by employing the Bayesian procedure illustrated in Train (2009) to calculate total and marginal WTP (means and medians) for each product alternative j at the individual level employing the Bayesian procedure illustrated in Train (2009). WTP values to have gene-edited foods available were also calculated across focal products and information treatments. Calculating the WTP to include or exclude an option from a choice set consisting of multiple options is described in sources such as Carlsson et al. (2011).

Consumption Habits, Beliefs, Awareness, Knowledge, and Risk Preferences

For the remaining sections we focused on reporting descriptive results (means, frequencies, graphical representations). Depending on the section and question, we segmented the results by information treatment, product or both. This allowed us to compare not only the impact of information on respondents' attitudes but also permitted us to closely evaluate the differences between the fresh and processed products as well as between plant-based and animal-based products. In addition, we also performed a k-means-cluster analysis on the risk preference scale. Cluster analysis is used to assemble respondents with similar characteristics into a group, while at the same time keeping those who differ from one another separate (Hsu and Nien, 2008). According to the behavioral economic theory, three consumer groups are expected: risk averse, risk neutral, and risk loving. Consumer preferences for gene-edited foods can vary across diverse consumer groups. To explore the motivating factors behind this preference heterogeneity, further exploratory data analysis was conducted. To illustrate, we used the results of the cluster analysis to compare how risk preferences vary across information treatments.

CHAPTER 4: RESULTS

Summary:

The following sections present the results of our data analysis. Following the design of the survey itself, we report our findings for each section beginning with the consumption questions. We find that respondents tend to purchase most of their products at supermarkets or supercenters irrespective of whether the product is fresh/processed or plant-based/animal-based. However, for fresh spinach the majority of purchases were indicated to be organic, while for all other products the conventional alternative dominates. Correspondingly, price and taste are valued the highest for all products except fresh spinach in which respondents pay particular attention to naturalness and taste.

For the choice questions, we observe that consumers tend to accept GMO products more than gene-edited products, unless benefits information is provided. This evidence is consistent across products (tomatoes, spinach, and pork) and levels of processing (fresh and processed). Moreover, for the plant-based products (tomatoes and spinach) organic is preferred over other alternatives (conventional, non-GMO, GMO, and Gene-Edited). For animal products, on the other hand, conventional is the most preferred option.

In line with the findings of the choice experiment, respondents favor organic products with regards to healthiness, safety, and animal welfare throughout all treatments. Views held for gene-edited products (even when compared with bioengineered products) were predominantly negative; but we were able to observe an increase in average belief when additional information, particularly benefit information was provided. This is likely connected to the overall low awareness of respondents with regards to gene-edited food products: most consumers indicated they have never heard of the technology and considered themselves very unknowledgeable.

Interestingly, we find that when exposed to basic information the share of respondents grouped into the risk averse category increases, while the share of respondents in the risk loving group increases when information about the environmental benefits is provided.

4.1 CONSUMPTION HABITS

After answering the screening questions, respondents were grouped into the above described treatment groups. However, prior to being exposed to any information, respondents answered several consumption questions regarding recent consumption habits for each product (grape tomatoes, pasta sauce, fresh spinach, frozen spinach, pork chops, bacon). Therefore, the sample size amounts to all 4,487 respondents divided among the products as shown in Table 5.

Table 5. Sample Size by Product

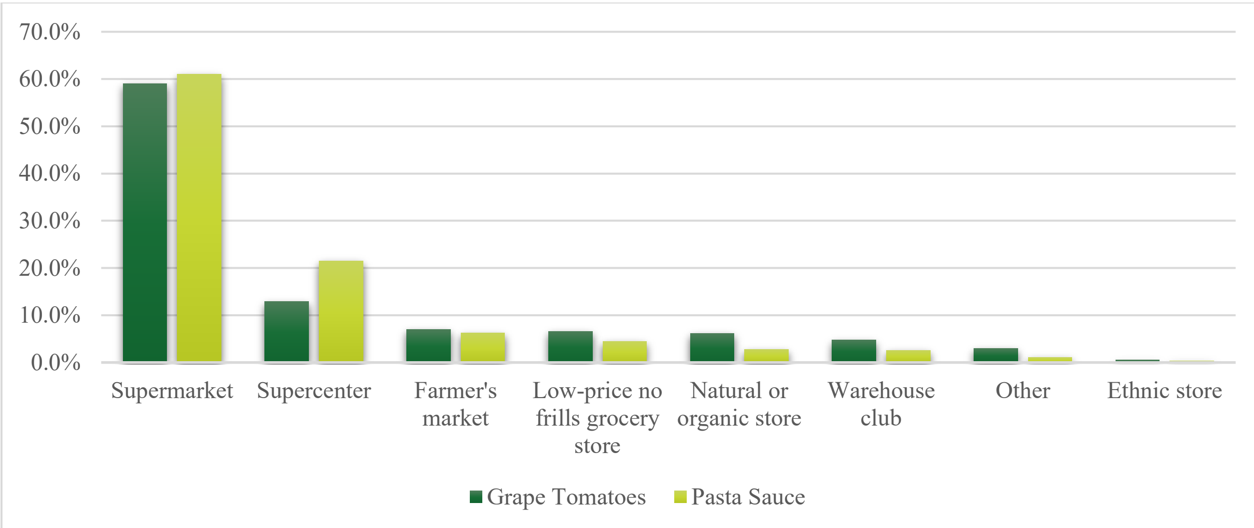
Product	Sample Size
Grape Tomatoes	999
Pasta Sauce	1038
Fresh Spinach	600
Frozen Spinach	600
Pork Chops	599
Bacon	651
Total	4487

The results of these questions are reported below, for each product.

4.2.1 GRAPE TOMATOES AND PASTA SAUCE

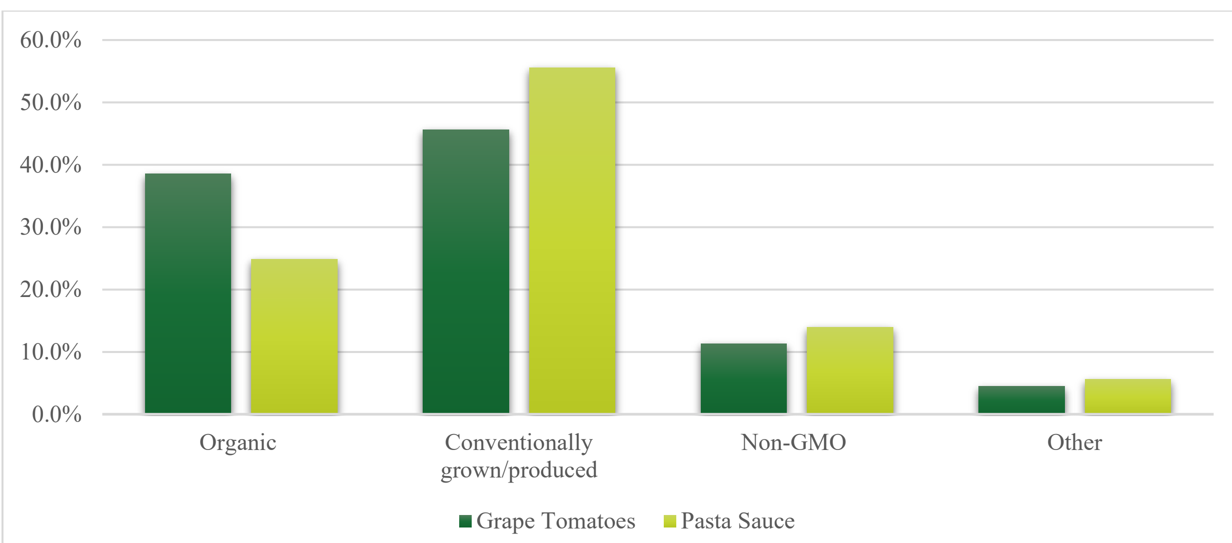
Overall respondents are more likely to purchase grape tomatoes (59.1%) and pasta sauce (61.0%) in supermarkets (see Graph 1). Around 21.5% of respondents also purchase pasta sauce in supercenters compared to only 12.9% of grape tomato purchases. For both grape tomatoes and pasta sauce, we observe that less than 13% and 10% respectively of purchases can be attributed to farmer's markets and natural/organic stores combined. For both products the lowest purchase frequency (with less than 1%) fall to the ethnic stores.

Graph 1. Usual purchasing store for Grape Tomatoes and Pasta Sauce



However, 38.5% of respondents stated they buy organic tomatoes compared to the 11% that noted they purchase non-GMO grape tomatoes (see Graph 2). In comparison, only around 25% and 14% of pasta sauce was bought as organic or non-GMO, respectively. The higher share of organic or non-GMO grape tomatoes is in line with findings of He and Bernard (2011) who found processed foods had greater substitutability when respondents could choose between conventional, organic, and non-GMO foods compared to fresh products. Still, the majority of grape tomatoes and pasta sauce consumed falls to conventionally produced/grown products- with 45.6% for grape tomatoes and 55.6% for pasta sauce.

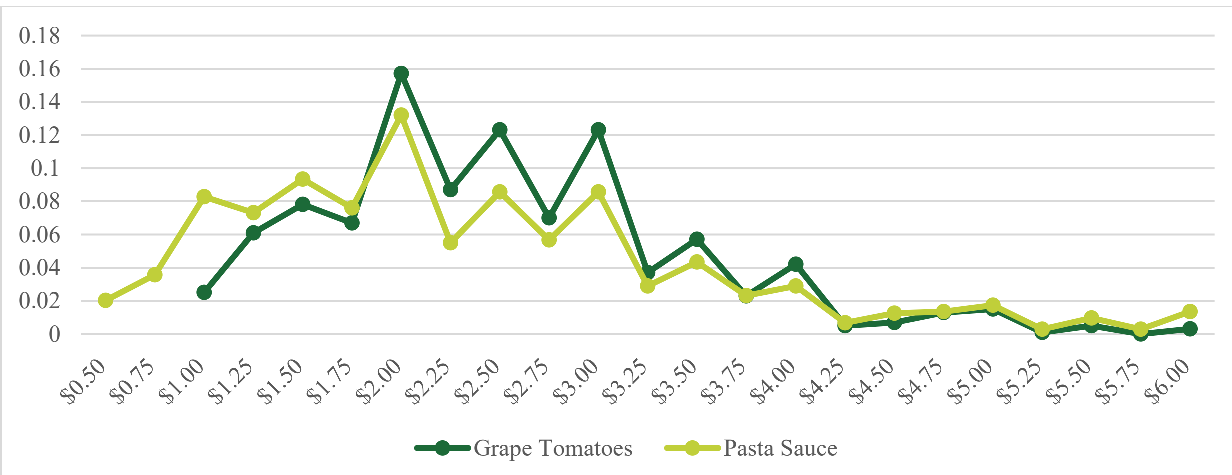
Graph 2. Usual purchasing type of Grape Tomatoes and Pasta Sauce



For grape tomatoes the expected purchase price averages around $2.50 with the majority of respondents expecting a price of $2.00. Only a small share of respondents expected to pay more than $3.75, or less than $1.50 (see Graph 3). The selected price ranges ($1.00-$6.00) fall within the given price ranges of the choice experiment, supporting the external validity of our findings.

Similarly, for pasta sauce we find that the average expected price approximates that of grape tomatoes, with an average value of $2.25 per pint (see Graph 3). Yet, in comparison to grape tomatoes a larger share of consumers expected to pay less than $1.50 for the product (16.4% vs 24.9%). In addition, approximately the same percentage share of people as for the grape tomatoes expected to pay more than $3.75. The ranges given correspond to those defined for the choice experiment.

Graph 3. Expected price to pay (per pint) of Grape Tomatoes and Pasta Sauce at the store

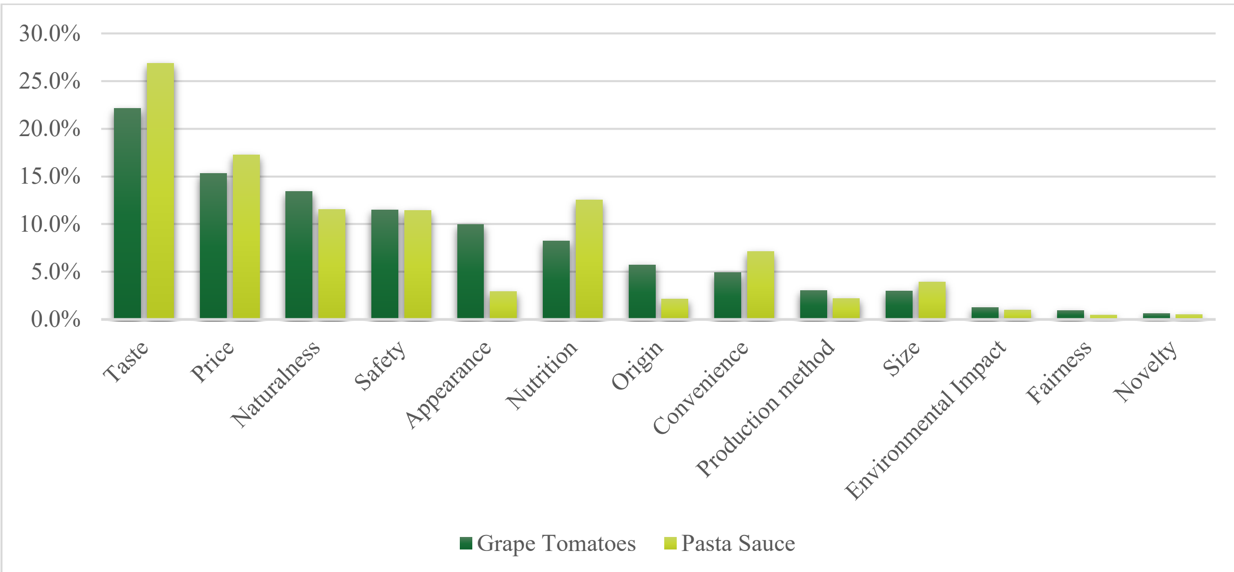


Following Lusk and Briggeman (2009) we also analyzed respondents' preferences for food values. We find that when purchasing grape tomatoes, respondents particularly value the taste, the price of the product, and if the product is natural (22.3%, 15.3%, and 13.4% respectively) (see Graph 4).

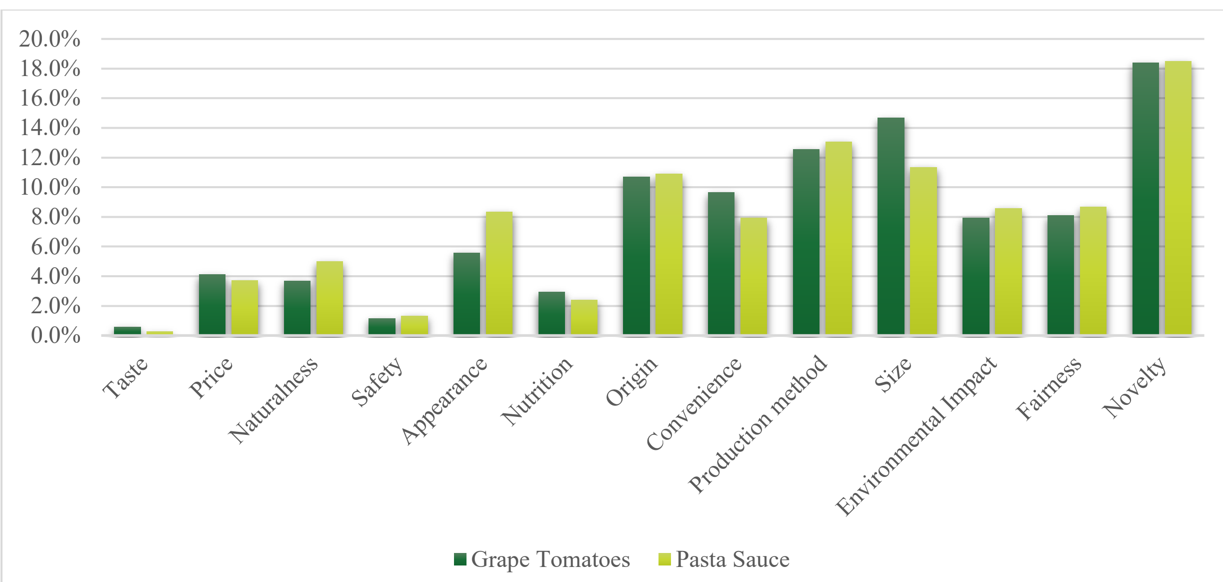
Correspondingly, price was among the three most important attributes of pasta sauce for 17.3% of respondents, ranking second after taste (26.8%) and before nutrition (12.6%). Considering the different benefit categories, we focused on for gene-editing, this indicates an underlying appreciation of consumers for health or direct consumer benefits.

Yet, for both products between 3.7% and 5% of respondents also indicated that price and naturalness were among the least important attributes of the products (see Graph 5). Although, novelty was perceived to be the least important attribute for both products (around 18.5% each). Moreover, for both products, the production method (about 13%) and environmental impact (7.9%-8.6%) were considered to not be very important. With regards to gene-editing, the discounting of the novelty attribute indicates that marketing strategies (which are solely based on the gene-editing aspect of the product) are likely to fail as consumers are not considering novelty a relevant factor in their decision-making process. However, considering that a large share of respondents did not perceive the production method as important, it holds promise for the acceptance of gene-edited products among consumers as other aspects are more of interest to consumers.

Graph 4. Most important characteristics when purchasing Grape Tomatoes and Pasta Sauce



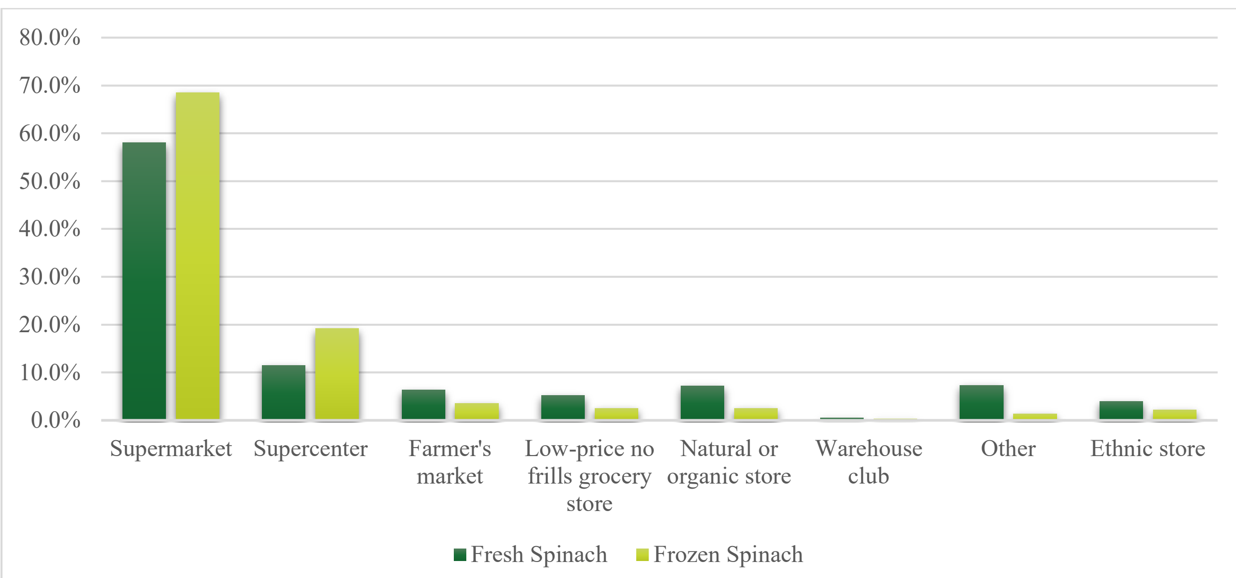
Graph 5. Least important characteristics when purchasing Grape Tomatoes and Pasta Sauce



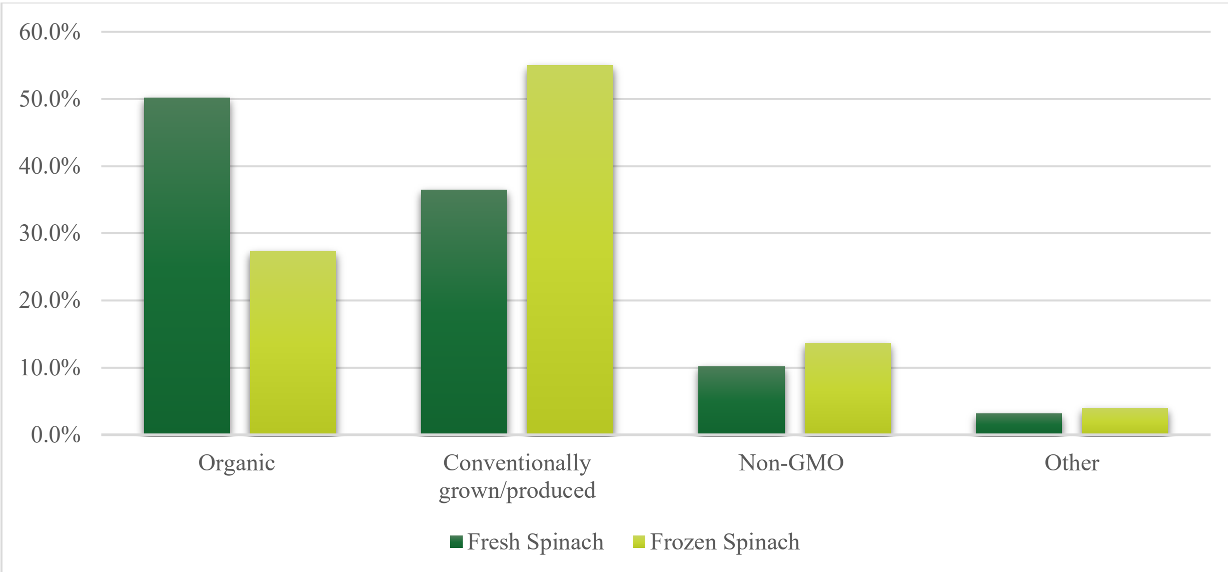
4.2.3 FRESH SPINACH AND FROZEN SPINACH

Continuing the trend of the previous products, fresh spinach is also predominantly purchased in supermarkets (58%) or supercenters (11.5%) (see Graph 6). The share is even higher for frozen spinach with 68.5% of respondents mainly purchasing the product at supermarkets and 19.2% purchasing it in supercenters. A larger share of respondents indicated that they buy fresh spinach product from either farmer's markets (7.3%) or at the natural/organic store (7.2%) compared to frozen spinach which was purchased there less than 4% combined. Correspondingly, the majority of respondents purchase organic spinach (50.2%), while 36.5% of respondents purchase conventional spinach (see Graph 7). In the US organic spinach sales in 2016 had a total value of around $118 million (USDA, 2017) , while the total sales of spinach accounted for around $378 million (USDA, 2018), indicating that the share of organic spinach in the market accounts for about 31% in the market, which is slightly below our findings. For frozen spinach, we observe that the majority of it bought by our respondents was produced conventionally (55%) and organic frozen spinach is the most frequently bought type for only 27.3% of respondents; while non-GMO spinach is popular among 13.7% of respondents. This shows how consumer perception of a good can vary between the fresh and processed stage.

Graph 6. Usual purchasing store for Fresh or Frozen Spinach



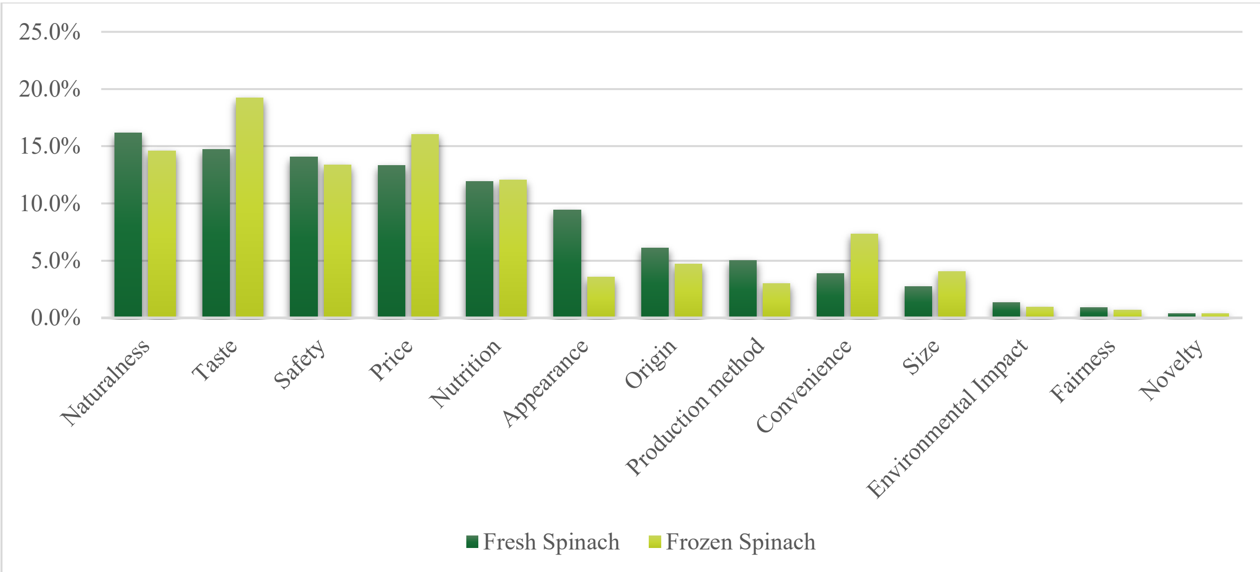
Graph 7. Usual purchasing type of Fresh or Frozen Spinach



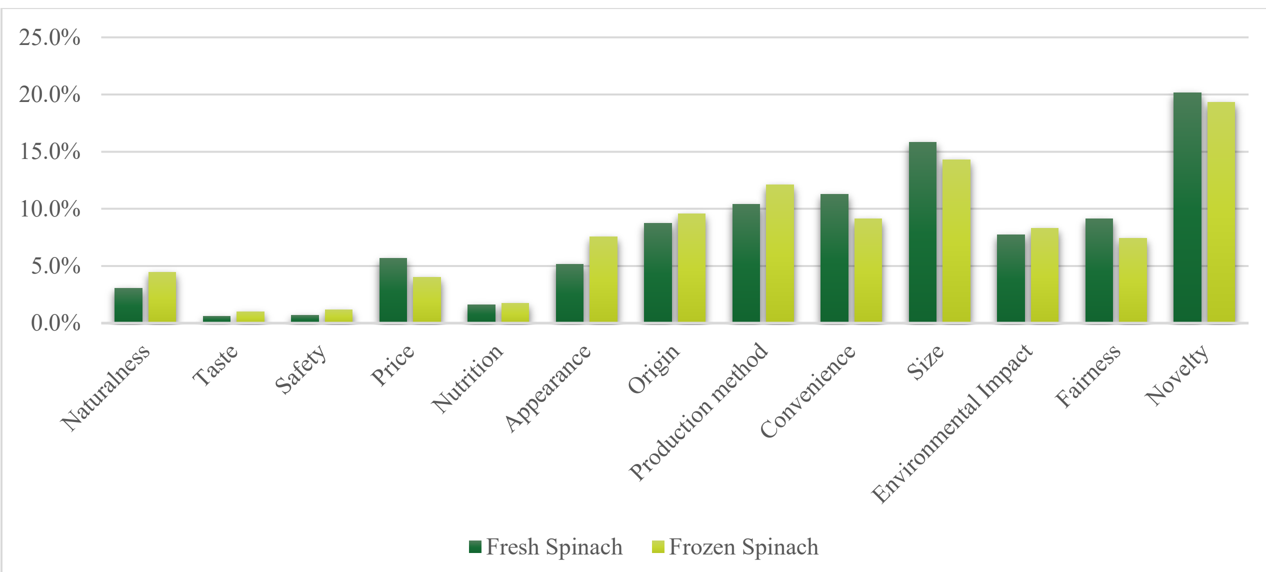
Further in line with this are our results regarding the attributes of spinach valued most by producers (see Graph 8). Contrary to both tomato products, taste (14.7%) and price (13.3%) do not rank first, but naturalness of fresh spinach does with 16.2% of respondents choosing this attribute. Moreover, safety of the product ranks third (14.1%). This is likely a result of past food health crises associated with spinach, in particular the 2006 E. coli crisis, which resulted in a tremendous loss of confidence in the product (Karst, 2016). However, while respondents did put an emphasis on spinach being organic, a significant share also deemed the production method of spinach as least important (10.4%) (see Graph 9). The environmental impact of fresh spinach, which is related to the benefit message delivered for this product, ranked somewhat in the middle with 1.3% of respondents considering it to be most important, while 7.7% saw it as least important.

In comparison, the results for frozen spinach align more with those of the tomato products as taste (19.2%) and price (16.2%) of respondents were most frequently indicated to be important. Around 12.1% of respondents selected the production method to be an unimportant attribute, letting it rank third behind size (14.3%) and novelty (19.3%)- matching the result of fresh spinach. In the case of frozen spinach, size might be an attribute which is difficult to observe for consumers given the typical packaging of it. Similar to fresh spinach, the environmental impact ranks in the middle. This ranking shows a low level of consideration among consumers for the environmental attribute.

Graph 8. Most important characteristics when purchasing Fresh or Frozen Spinach

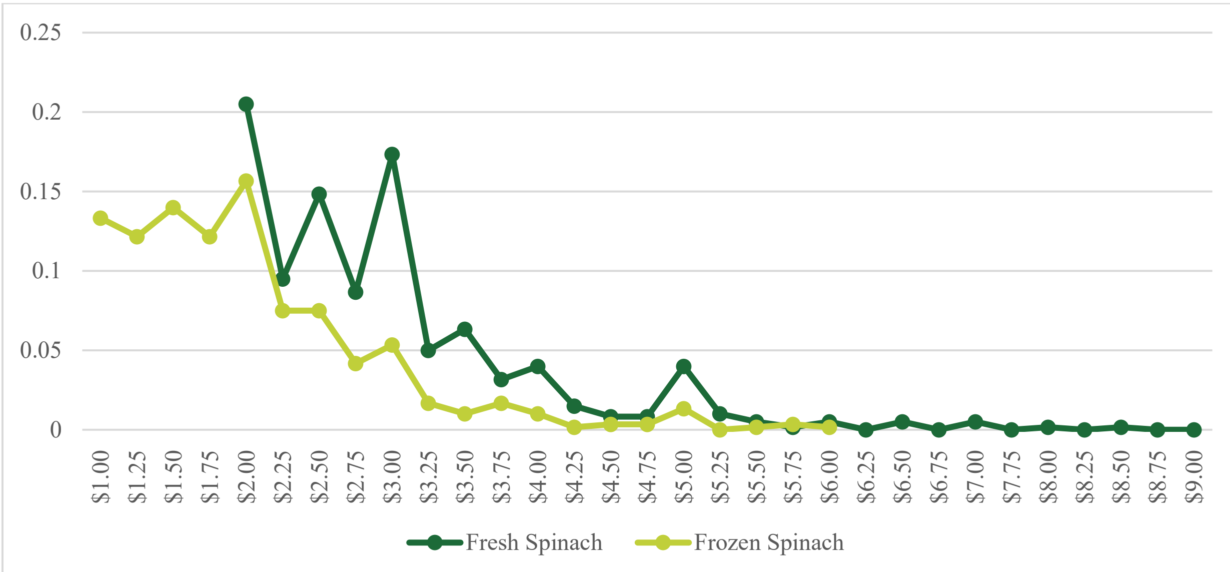


Graph 9. Least important characteristics when purchasing Fresh or Frozen Spinach



With regards to the price respondents were expecting to pay for 10 ounces of fresh spinach, we find an average expected price of $2.75 for fresh spinach. However, most respondents either indicated they would expect a price of $2.00 or $3.00 (see Graph 10). Only few respondents expect a price above $4.00, with a slight spike at $5.00 (4%). For frozen spinach we observe a large share of respondents (64.4%) who expected prices of or below $2.00. Correspondingly, the average expected price given by respondents was $1.75. Still, around 13.5% of respondents were expecting prices above $2.50. For both spinach products the ranges provided in the choice question cover the prices, which are most expected by respondents.

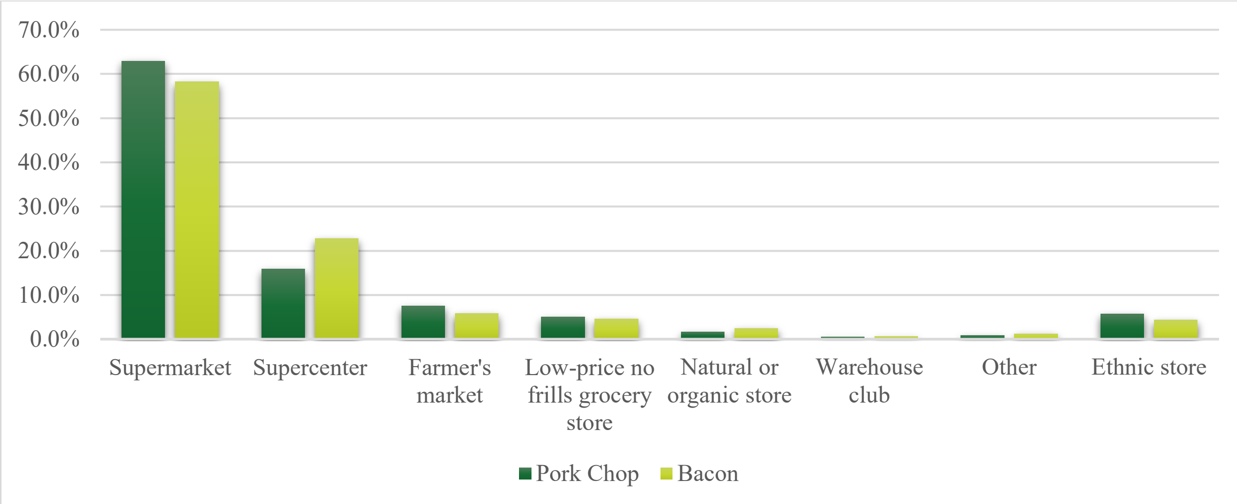
Graph 10. Expected price to pay (per 10oz) for Fresh or Frozen Spinach at the store



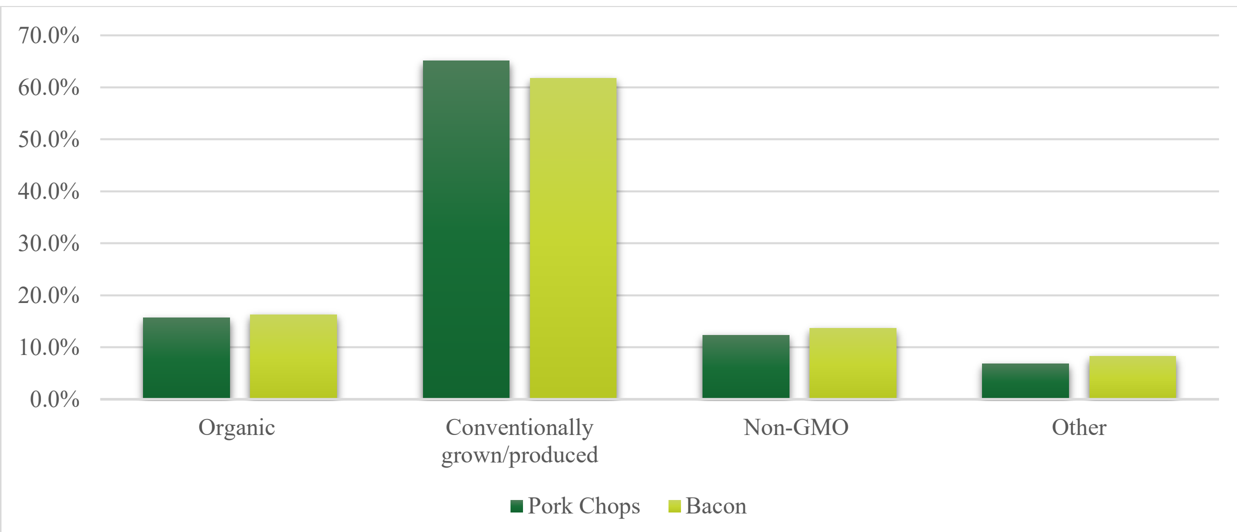
4.2.5 PORK CHOPS AND BACON

For pork chops and bacon, we observe the so far lowest purchasing rate in natural/organic stores (1.7% and 2.5%, respectively) compared to the other focal products studied (see Graph 11). However, like the other products, supermarkets (62.9% and 58.2%, respectively) and supercenters (15.9% and 22.7%, respectively) dominate as typical purchase places. Furthermore, we also find that 65.1% of respondents typically purchase conventional pork chops alongside 61.8% of respondents doing so for bacon (see Graph 12). For both products, this is double the share attributed to the combination of organic (15.7% and 16.3%) and non-GMO (12.4% and 13.7%) pork chops and bacon respectively.

Graph 11. Usual purchasing store for Pork Chops or Bacon

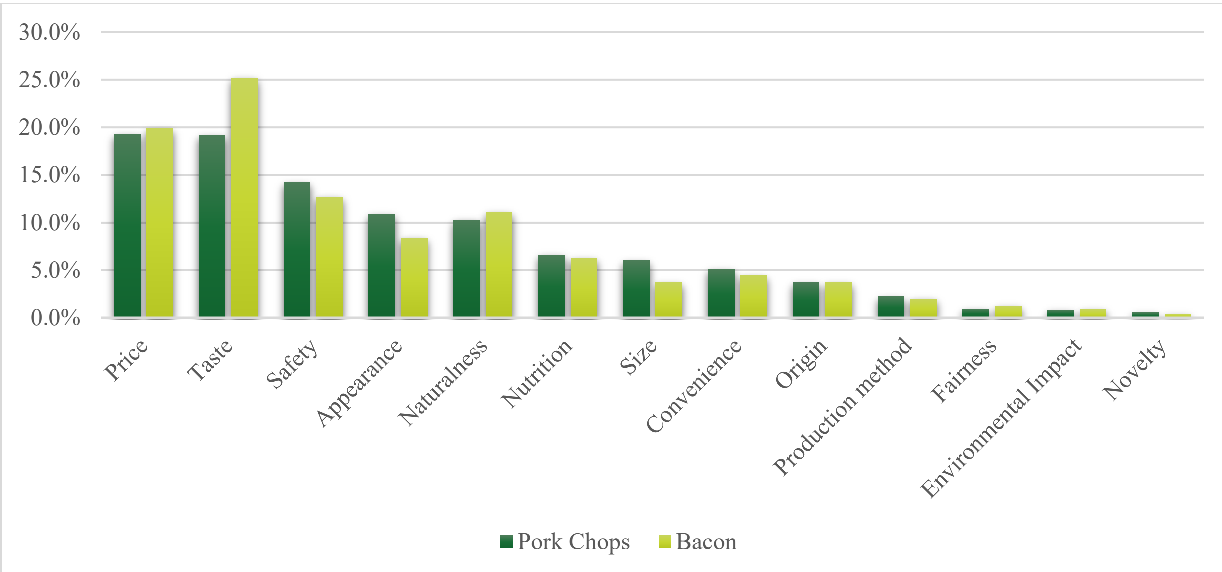


Graph 12. Usual purchasing type of Pork Chops or Bacon

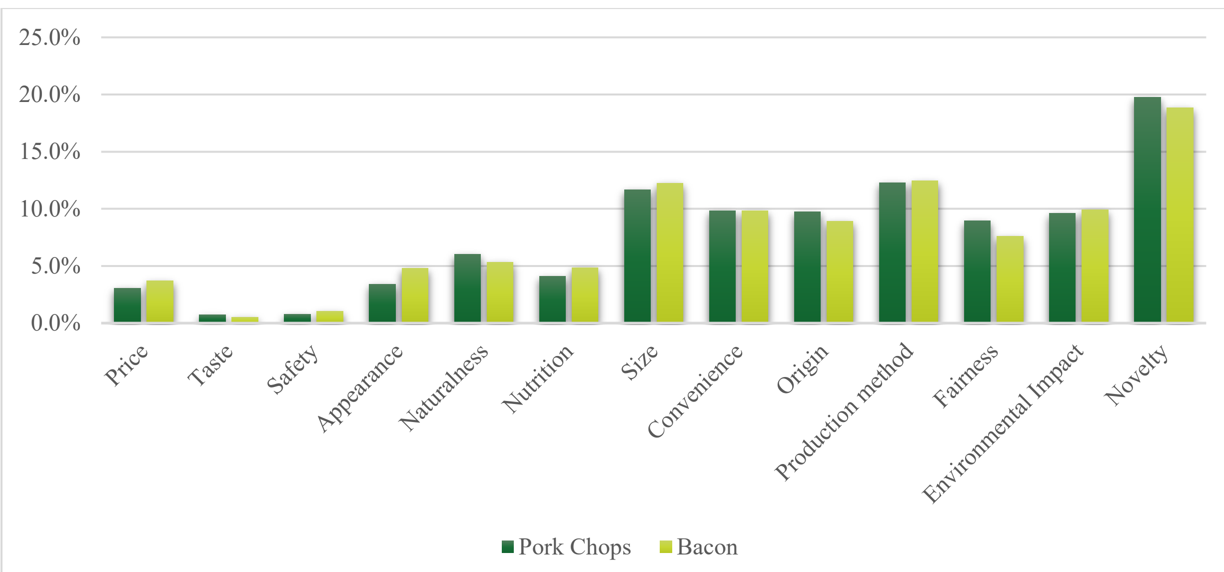


As observed for the majority of other products, respondents also find the price of pork chops (19.3%) and bacon (19.9%) to be the most important attribute. Taste ranks first and second between pork chops and bacon respectively. In addition, taste was chosen by 25.2% of respondents as most important for bacon compared to 19.2% for pork chops (see Graph 13). Yet, in contrast to the other foods, appearance ranks fourth with 10.9% for pork chops but fifth for bacon being chosen by 8.4% of respondents. This is consistent with existing literature showing consumers tend to form quality expectations of meat on the basis of its visual attributes (Grunert et al., 2004). As for the other products, respondents most frequently indicated novelty (19.8% and 18.8%, respectively) as the least important attribute of pork chops and bacon; which was followed by production method (around 12.3% each) and size (11.7% and 12.2%, respectively).

Graph 13. Most important characteristics when purchasing Pork Chops or Bacon

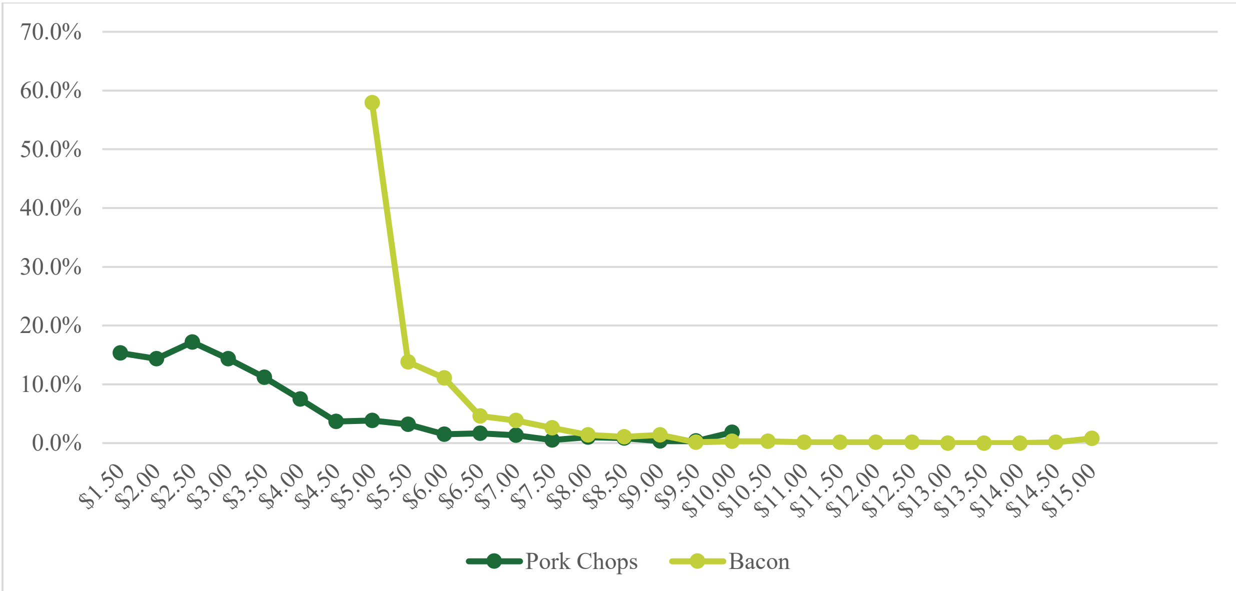


Graph 14. Least important characteristics when purchasing Pork Chops or Bacon



Looking at the expected prices for pork chops, we find an average expectation of around $3.00/lbs. This expectation (which is lower than anticipated) is lower than the average expected price of $5.50/lbs for bacon. We observe the highest individual expectation for pork chops at $2.50 and a rapidly decreasing share of respondents who believe the price to be much higher (see Graph 15). Similarly, only 17.2% of respondents expect to pay more than the average price for bacon and 57.9% expect to pay $5.00. For both products, the results align with the price ranges provided in the choice experiment ($2.59-$7.59 for pork chops and $3.99-$8.99 for bacon, see Table 2).

Graph 15. Expected price to pay (per pound) for Pork Chops or Bacon at the store



4.2 WORD ASSOCIATIONS

To measure what consumers link with different production methods (conventional, organic, non-GMO, GMO, and gene-edited), we prompted the respondents with five different word association tasks. Each task asked respondents to indicate what came to their mind when prompted with the words "Organic," "Non-GMO," "GMO," "Gene-edited," and "Conventional." This approach has commonly been used to evaluate consumers' beliefs and is in line with other studies evaluating consumers' associations with food products or production methods (Haas et al., 2013; Son et al., 2014). It is based on associative network conceptualization of memory structure and highlights what a group generally experiences or relates with certain words/stimuli (Son et al., 2014). Similar to Haas et al. (2013) and Son et al. (2014), we counted the frequency of answers to the question to perform our analysis of the consumers' answers. To contextualize the individual frequencies of the words, we then created a word cloud of the terms showing the relative frequency of the phrase or word.

Figures 6 and 7 show that consumers may be generally wary of GMOs and gene-editing. For example, when the consumers heard the word "GMO", they typically associated this word with attributes such as "**Not Healthy,**" **"Unnatural," "Fake,"** or **"Bad."** These responses indicate that consumers generally know about GMOs but may have an unfavorable opinion of them. On the other hand, when asked what comes to the consumers' mind when they hear "Gene-edited," the most popular answers were "**I Don't Know," "Bad," "Fake," "Scary," "Science," and "Modified."** These answers indicate that consumers aren't entirely informed about gene-editing..

From their word sentiment, most respondents seem unaware of what gene-editing is. This lack of information leads them to be wary of gene-editing and the potential benefits it may provide.

Figure 6: Consumer Word Association for: GMO

Figure 7: Consumer Word Association for: Gene-Edited

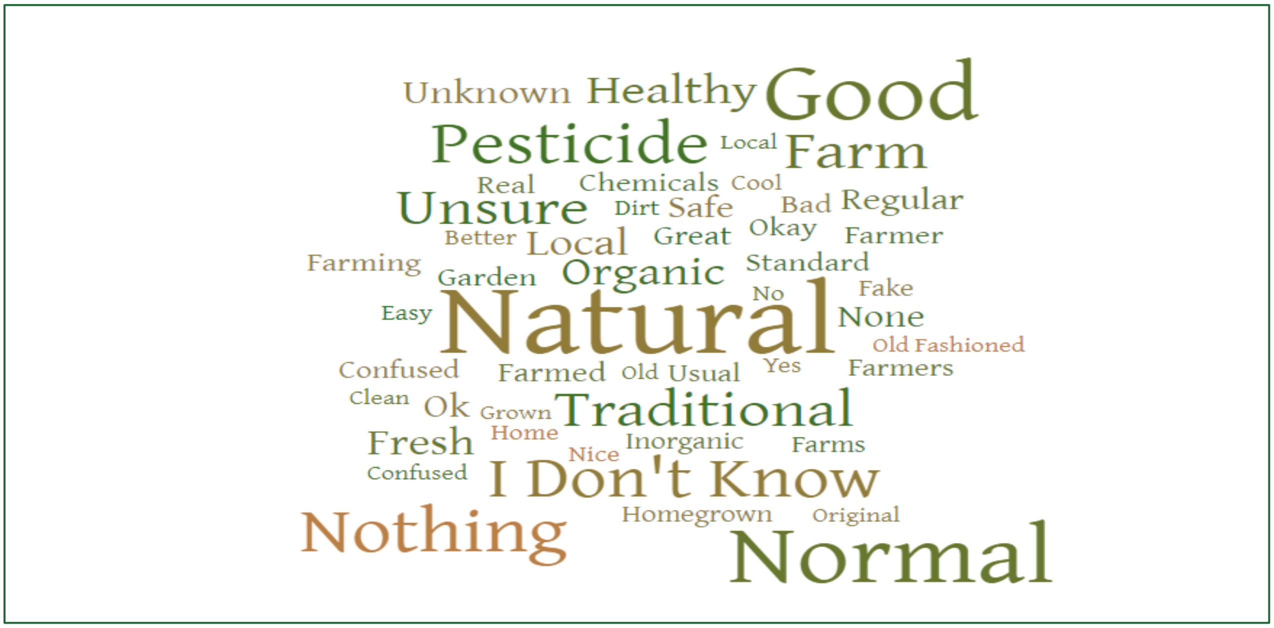
Furthermore, when respondents were asked what comes to mind when they hear "Organic" and "Non-GMO" (figures 8 and 9, respectively) the most popular answers were **"Healthy," "Good,"** and **"Natural,"** Interestingly, when asked about "Non-GMO", consumers also associated this phrase with **"Organic."** This may imply that respondents are not fully aware what constitutes organic foods and just assume that if something does not have GMOs then it must be organic.

Figure 8: Consumer Word Association for: Organic

Figure 9: Consumer Word Association for: Non-GMO

To conclude, we asked respondents what they thought of when they heard the word "Conventional" (Figure 10). The most popular answers were **"Natural," "Normal," "Good," and "Pesticide."** These answers imply that respondents are generally aware of what it means for food to be grown conventionally. However, while their attitudes are not as negative as "GMO" and "Gene-edited," consumers still did not think as positively about conventionally grown food compared to "Non-GMO" and "Organic." This may be due to respondents associating pesticides with negative attitudes.

Figure 10: Consumer Word Association for: Conventional



4.3 CHOICE QUESTIONS AND TREATMENT EFFECTS

Table 6 summarizes the choice frequencies (number of times each product alternative has been chosen) across treatments. Looking at the grape tomatoes results, it can be noted that consumers who participated in the benefits treatments chose the gene-edited alternative more frequently than consumers in the control and basic information treatment. However, in comparison to organic grape tomatoes, the most popular option throughout the treatments, the gene-edited product, was chosen only a fraction of times. The same observation can be made for pasta sauce. However, the fresh and processed food differ in the sense that non-GMO grape tomatoes were more frequently purchased in the control compared to the other treatments, but it was relatively constant across treatments for the processed product. Moreover, we find an overall higher frequency of respondents choosing the no-buy option among respondents in the pasta sauce treatments compared to the fresh grape tomatoes.

For fresh spinach we find the highest frequency of respondents choosing the organic alternative throughout all treatments. Interestingly, for frozen spinach, the conventional alternative is chosen with the same frequency as the organic one for the control treatment. For the basic and benefits treatment, the conventional option is still chosen more frequently than the non-GMO alternative.

In both treatments, we find that gene-edited fresh spinach was chosen with the lowest frequency in the control and basic information treatment, but more frequently than the GMO alternative in the benefits treatment displaying the effect the information had on respondent's choice behavior. Similar to the tomatoes, we observe respondents choosing the no-buy option more frequently for the processed product compared to the fresh product.

For the animal products, we interestingly find that the conventional option was chosen most frequently for both the pork chops and the bacon. This could be motivated by differential price effects between organic and conventional meat products. For gene-edited pork products, we again observe a clear effect of the benefit information, which expresses itself in a frequency higher than that of the GMO alternative for bacon.

Overall the findings allow us to conclude that it is not sufficient to merely provide respondents with information about the label, but rather it is necessary to supplement this information with specific benefit messages.

Table 6. Choice Frequencies across information treatments, by product

	Fresh					Processed				
	Control	Basic	Consumers	Environment	Farmers	Control	Basic	Consumers	Environment	Farmers
Grape Tomatoes						**Pasta Sauce**				
Conventional	22	20	19	15	18	26	21	20	18	21
Organic	**35**	**45**	**40**	41	**41**	**26**	**32**	**28**	**28**	**29**
Non-GMO	18	12	15	14	14	21	22	18	21	19
GMO	10	7	7	8	7	9	9	7	8	7
Gene-Editing	**6**	**4**	**10**	**12**	**10**	**5**	**4**	**15**	**12**	**10**
None	8	11	10	10	10	14	12	12	12	15
Fresh Spinach						**Frozen Spinach**				
Conventional	16	19		15		**24**	**24**		**20**	
Organic	**36**	**43**		**36**		**24**	**31**		**26**	
Non-GMO	23	16		17		21	15		19	
GMO	8	7		6		8	8		7	
Gene-Editing	**5**	**3**		**13**		3	5		13	
None	12	11		12		20	17		16	
Pork Chops						**Bacon**				
Conventional	**37**	**34**	**28**			**35**	**33**	**32**		
Organic	16	18	17			19	19	19		
Non-GMO	14	13	13			15	14	11		
GMO	13	11	11			10	10	8		
Gene-Editing	**5**	**4**	**11**			5	6	16		
None	15	20	20			16	18	15		

However, although informative, the choice frequencies provide only a general indication of how consumers selected the various alternatives across treatments and focal products. To further examine respondents' acceptance of the new food technology and the corresponding WTP, the choice data were also analyzed using a MXL model. The estimates from this model were then used to calculate the WTPs and market shares as described in the "Data Analysis" section. A likelihood ratio test rejects the hypothesis ($p<0.01$) that preferences are the same in each information treatment, suggesting that information significantly impacted consumer choice. Hence, for each product of interest, the results are reported separately for each information treatment. Tables A1~A6 in appendix report the estimates from the MXL-EC model in WTP Space. For each product of interest, the following sub-sections report the WTPs for each alternative (conventional, organic, non-GMO, GMO, and gene-editing) disaggregated by focal products (tomatoes, spinach, and pork) and levels of processing (fresh and processed).

GRAPE TOMATOES AND PASTA SAUCE

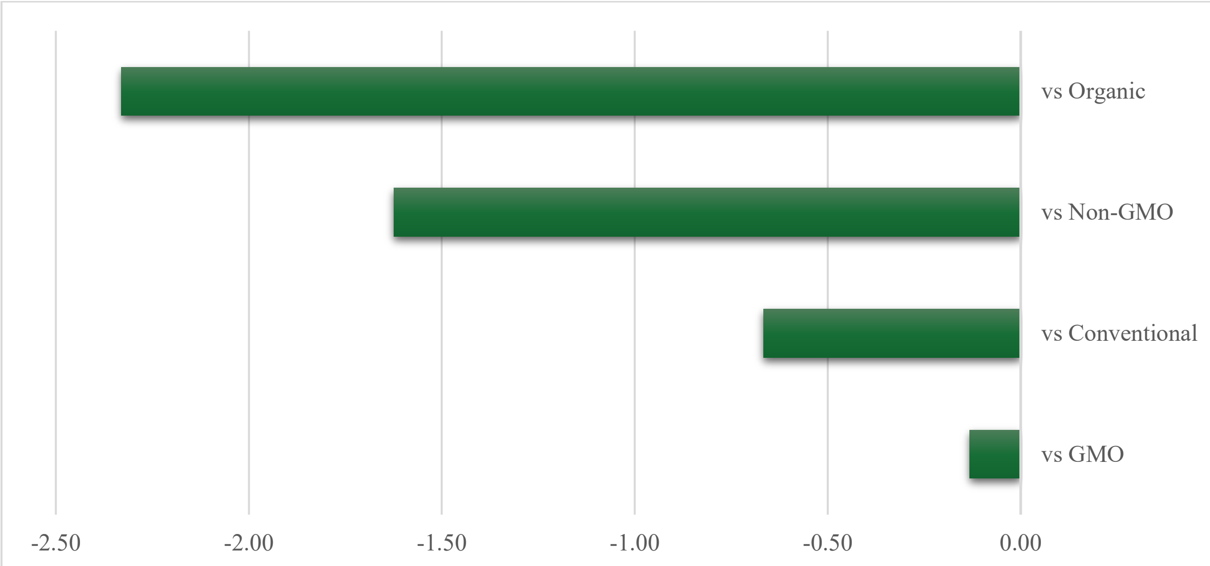
Table 7 presents the population mean WTP estimates for conventional, organic, non-GMO, GMO, and gene-edited grape tomatoes (the underlying estimates of the models are provided in the Appendix, see Table A1). Both total and marginal WTP estimates are reported and discussed. Focusing on the total WTP estimates (WTP for each alternative vs None), it can be noted that irrespective of the treatment a clear order of preferences exists with respondents showing the highest total WTP for organic grape tomatoes, followed by Non-GMO and conventional grape tomatoes. The order is in line with existing literature which finds consumers tend to pay a premium for organic food products (Lin et al., 2008). With regards to the GMO and gene-edited alternatives, we find that while respondents show a higher WTP for GMO grape tomatoes compared to gene-edited grape tomatoes in most treatments; we can observe a smaller gap between them once information is provided to them. Most notably, in the case of the benefits to consumers treatment, we note a reversal of preferences with a higher average WTP for gene-edited grape tomatoes ($2.95) compared to GMO grape tomatoes ($2.63). In line with Shew et al. (2018), this shows that the general provision as well as the depth of it can have an influence on consumer preferences.

Correspondingly, when looking at the marginal WTP of respondents compared to the other production methods, we find a clear display of the preference order discussed above: respondents show the highest marginal premium for the organic alternative and the lowest for GMO grape tomatoes (see Graph 16). The difference between mean and median for all marginal comparisons does not exceed $0.05 indicating that in the general comparison the distribution of respondents was relatively even.

Table 7. Individual Willingness-to-Pay ($/pint) Estimates from the MXL-EC Model in WTP Space by Information Treatment, Grape Tomatoes

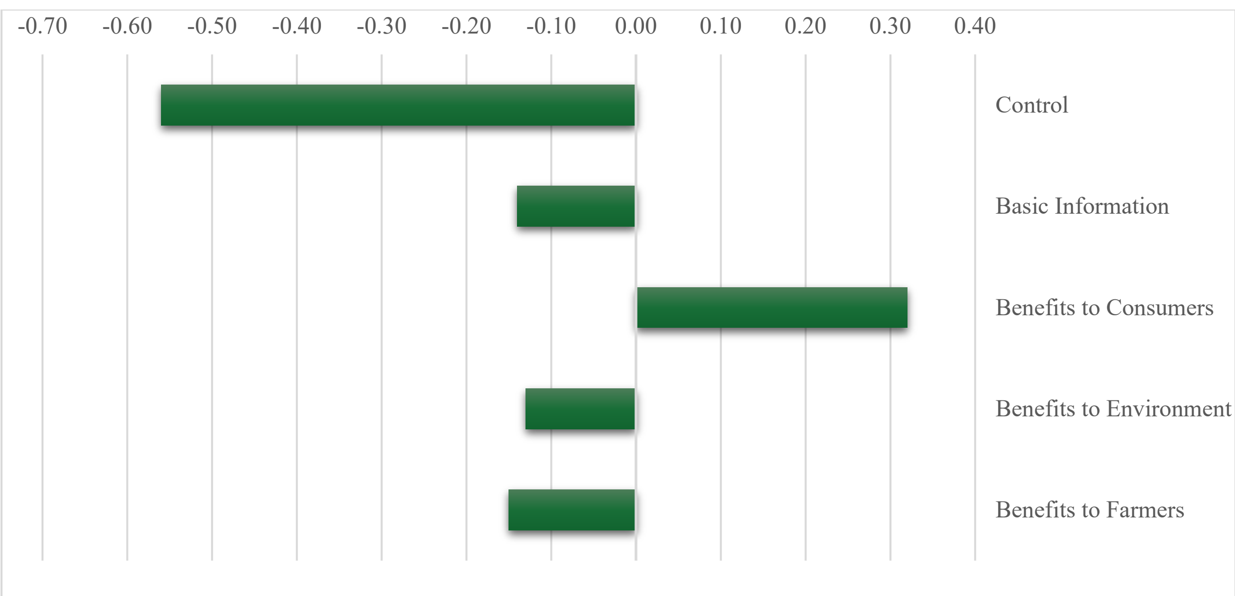
	Control No Information	Basic Information	Benefits to Consumers	Benefits to Environment	Benefits to Farmers
Total WTP					
Conventional vs None	$3.10	$3.09	$3.42	$2.86	$3.06
Organic vs None	$5.27	$4.56	$4.86	$4.56	$4.60
Non-GMO vs None	$4.70	$3.53	$4.08	$3.84	$4.17
GMO vs None	$3.39	$1.81	$2.63	$2.49	$2.54
Gene-Edited vs None	$2.83	$1.67	$2.95	$2.36	$2.39
Marginal WTP					
Gene-Edited vs Conventional	$-0.27	$-1.42	$-0.47	$-0.50	$-0.67
Gene-Edited vs Organic	$-2.44	$-2.89	$-1.91	$-2.20	$-2.21
Gene-Edited vs Non-GMO	$-1.87	$-1.86	$-1.13	$-1.48	$-1.78
Gene-Edited vs GMO	$-0.56	$-0.14	$0.32	$-0.13	$-0.15
GMO vs Conventional	$0.29	$-1.28	$-0.79	$-0.37	$-0.52
GMO vs Organic	$-2.44	$-2.89	$-1.91	$-2.20	$-2.21
GMO vs Non-GMO	$-1.31	$-1.72	$-1.45	$-1.35	$-1.63
Organic vs Conventional	$2.17	$1.47	$1.44	$1.70	$1.54
Organic vs Non-GMO	$0.57	$1.03	$0.78	$0.72	$0.43
Non-GMO vs Conventional	$1.60	$0.44	$0.66	$0.98	$1.11

Graph 16. Marginal WTP for Gene-edited Grape Tomatoes vs other alternatives



Yet, when focusing on the marginal WTP for gene-edited grape tomatoes compared to GMO ones broken down by treatment, we observe a negative average price premium for gene-editing in comparison with GMO for all treatments except for the benefits to the consumer treatment (see Graph 17). This indicates that for grape tomatoes this information resonated most with respondents. This finding can be seen as consistent with Lusk et al. (2005) as respondents are directly affected by the benefit instead of indirectly as in the case for the other benefits.

Graph 17. Marginal WTP Gene-edited Grape Tomatoes vs GMO Grape Tomatoes by treatment



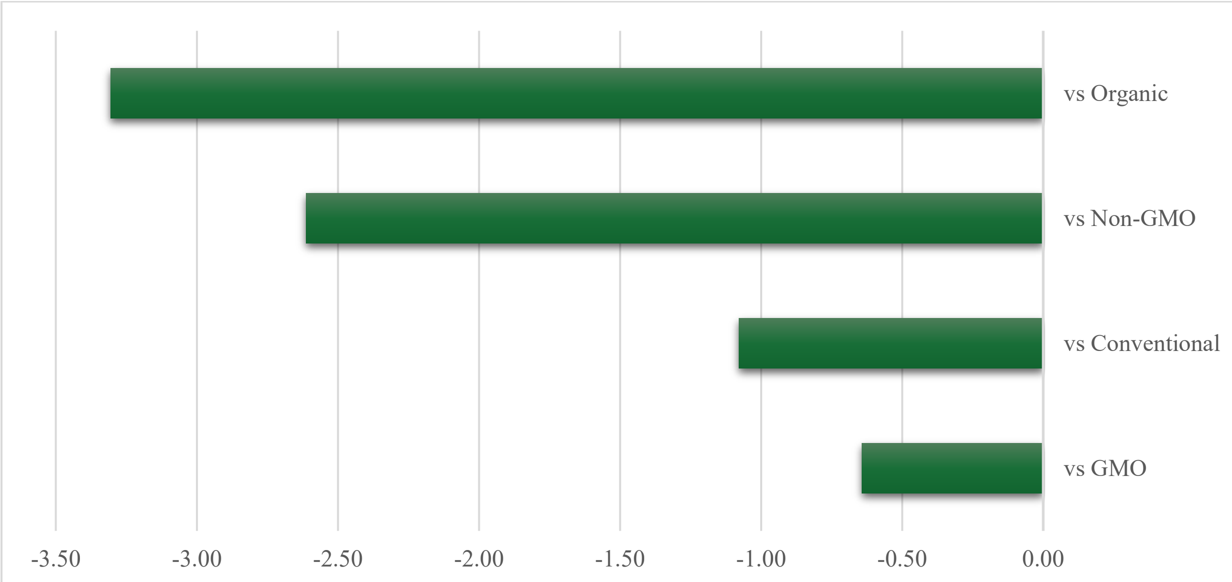
Similarly, in Table 8, we report the aggregate mean total and marginal WTP estimates for conventional, organic, non-GMO, GMO, and gene-edited pasta sauce (the underlying estimates of the models are provided in the appendix, see Table A2). These results are in line with what we found for the grape tomato option. Respondents value the organic option the most and their WTP decreases as the product appears edited. With regards to GMO vs gene-edited, GMO has a higher WTP for all treatments except for the 'Benefits to Environment' and the 'Benefits to Farmers' treatments where we see a preference reversal.

Table 8. Willingness-to-Pay ($/24oz bottle) Estimates from the MXL-EC Model in WTP Space by Information Treatment, Pasta Sauce

	Control	Basic Information	Benefits to Consumers	Benefits to Environment	Benefits to Farmers
Total WTP					
Conventional vs None	$2.45	$2.64	$2.75	$0.76	$1.90
Organic vs None	$4.05	$4.60	$4.73	$4.19	$4.07
Non-GMO vs None	$3.99	$3.64	$3.46	$3.71	$3.37
GMO vs None	$2.28	$1.96	$1.70	$1.75	$1.62
Gene-Edited vs None	$0.99	$0.76	$0.77	$1.76	$1.82
Marginal WTP					
Gene-Edited vs Conventional	$-1.46	$-1.88	$-1.98	$ 1.00	$-0.08
Gene-Edited vs Organic	$-3.06	$-3.84	$-3.96	$-2.43	$-2.25
Gene-Edited vs Non-GMO	$-3.00	$-2.88	$-2.69	$-1.95	$-1.55
Gene-Edited vs GMO	$-1.29	$-1.20	$-0.93	$0.01	$0.20
GMO vs Conventional	$-0.17	$-0.68	$-1.05	$0.99	$-0.28
GMO vs Organic	$-3.06	$-3.84	$-3.96	$-2.43	$-2.25
GMO vs Non-GMO	$-1.71	$-1.68	$-1.76	$-1.96	$-1.75
Organic vs Conventional	$1.60	$ 1.96	$1.98	$3.43	$2.17
Organic vs Non-GMO	$0.06	$ 0.96	$1.27	$0.48	$0.70
Non-GMO vs Conventional	$1.54	$ 1.00	$0.71	$2.95	$1.47

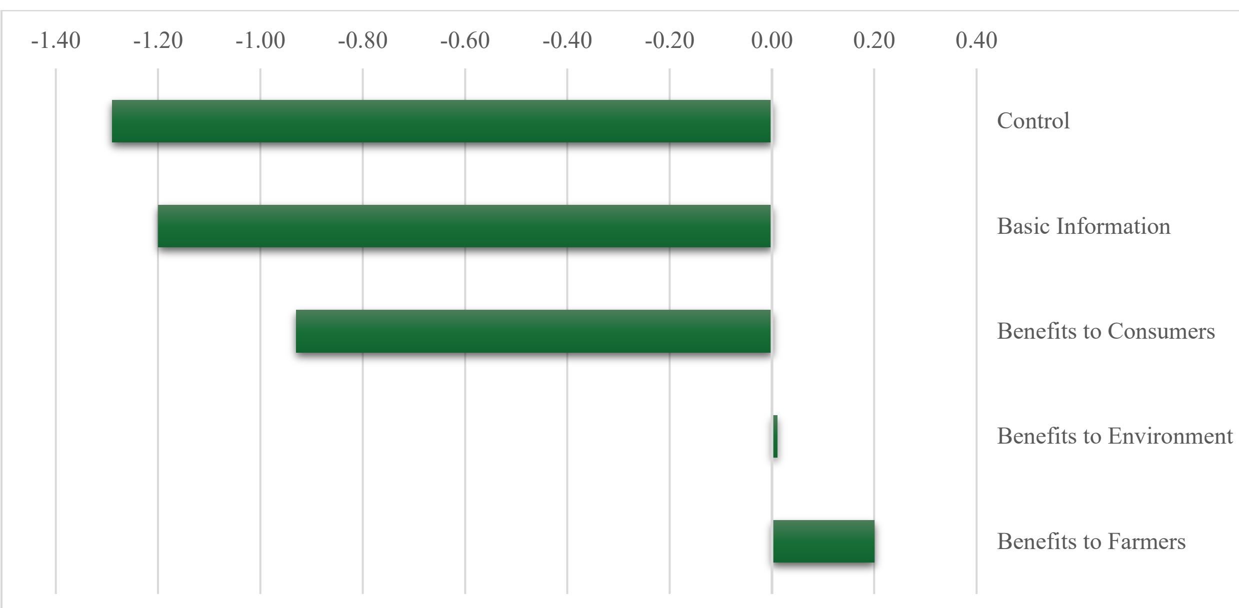
Furthermore, we find the same story as for grape tomatoes when we look at the marginal WTP of gene-edited pasta sauce versus the other alternatives. The highest WTP is still organic with GMO pasta sauce coming in last. Furthermore, these WTP values appear to be larger compared to the fresh alternative.

Graph 18. Marginal WTP for Gene-edited Pasta Sauce vs other alternatives



However, when we look at Graph 19 comparing gene-edited pasta sauce vs GMO pasta sauce by treatments, we see a role reversal compared to the grape tomato case. This is interesting because consumers are supporting treatments that indirectly benefit them unlike the grape tomato case where consumers supported a treatment that directly benefits them. This may signal that consumers would be willing to pay more for treated processed goods if these goods benefit their community. Moreover, given that the provided benefit was a higher nutrient content it could indicate that respondents perceive this benefit to disappear throughout the stages of processing.

Graph 19. Marginal WTP Gene-edited Pasta Sauce vs GMO Pasta Sauce by treatment



FRESH SPINACH AND FROZEN SPINACH

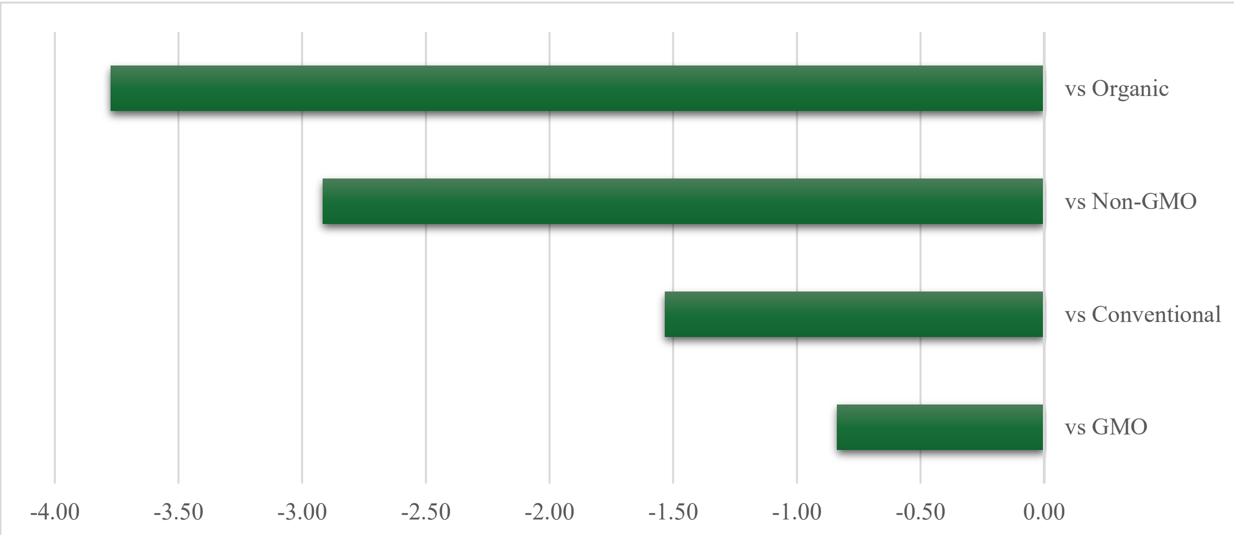
When looking at respondent's WTP for fresh spinach, the results are very similar to the grape tomato experiment. However, one key difference is that fresh spinach only received three treatments compared to the five given in the grape tomato case. Still, we find that consumers have the highest WTP for organic goods ($5.04-$5.66) and the lowest WTP for GMO and gene-edited spinach ($1.10-$2.54). Moreover, we find that consumers have a higher WTP for the GMO alternative compared to the gene-edited one in the control and basic information treatment, but this reverses when provided with information on the benefits to the environment, which is in line with the previous findings.

Table 9. Total and Marginal Willingness-to-Pay ($/10oz) Estimates from the MXL-EC Model in WTP Space by Information Treatment, Fresh Spinach

	Control	Basic Information	Benefits to Environment
Total WTP			
Conventional vs None	$ 2.60	$ 3.66	$ 2.77
Organic vs None	$ 5.04	$ 5.66	$ 5.05
Non-GMO vs None	$ 4.99	$ 4.53	$ 3.66
GMO vs None	$ 2.54	$ 2.23	$ 2.17
Gene-Edited vs None	$ 1.10	$ 1.10	$ 2.23
Marginal WTP			
Gene-Edited vs Conventional	$-1.50	$-2.56	$-0.54
Gene-edited vs Organic	$-3.94	$-4.56	$-2.82
Gene-Edited vs Non-GMO	$-3.89	$-3.43	$-1.43
Gene-Edited vs GMO	$-1.44	$-1.13	$ 0.06
GMO vs Conventional	$-0.06	$-1.43	$-0.60
GMO vs Organic	$-3.94	$-4.56	$-2.82
GMO vs Non-GMO	$-2.45	$-2.30	$-1.49
Organic vs Conventional	$ 2.44	$ 2.00	$ 2.28
Organic vs Non-GMO	$ 0.05	$ 1.13	$ 1.39
Non-GMO vs Conventional	$ 2.39	$ 0.87	$ 0.89

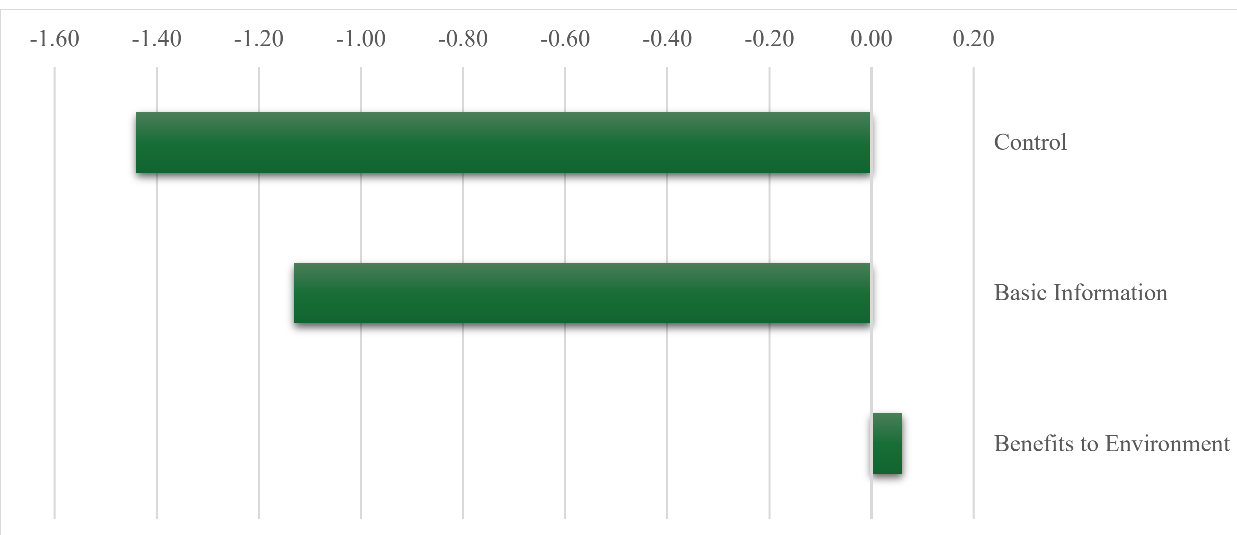
Furthermore, when looking at the marginal WTP for gene-edited spinach compared to other alternatives, we see that the results follow a similar pattern as the previous two food items (grape tomatoes and pasta sauce). The organic alternative has the highest premium and the GMO one the lowest when compared to gene-edited spinach. Furthermore, we see that the magnitude of the estimates is much larger for fresh spinach case compared to the estimates of grape tomatoes. While we do not have the data to definitively say, this behavior may result from the recent food safety scares concerning spinach, which might have resulted in consumers being pickier and more health aware concerning spinach than other products. It may also be a selection effect; the type of people who buy spinach may be more health conscious than buyers of other products.

Graph 20. Marginal WTP for Gene-edited Fresh Spinach vs other alternatives



In addition, similar to both grape tomatoes and pasta sauce, consumers have a negative WTP for gene-editing spinach compared to GMO spinach under the control and basic information treatments. In line with pasta sauce, we see a slightly positive WTP under the benefits to environment treatment, which aligns with the findings by Siegrist (2000) and Siegrist (2003) regarding consumers' translation of product benefits into product acceptance and a resulting increase in WTP (Lusk, 2005)

Graph 21. Marginal WTP Gene-edited Fresh Spinach vs GMO Fresh Spinach by treatment

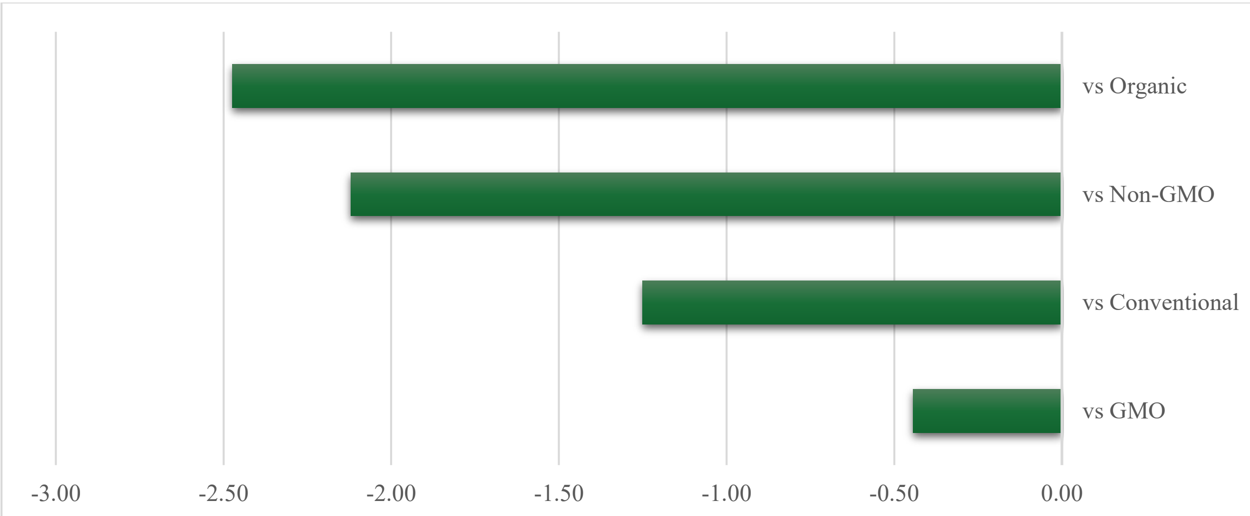


Frozen spinach aligns with the findings of fresh spinach. We find that respondents have the highest WTP for organic frozen spinach ($3.21-$3.81) and the lowest WTP for gene-edited frozen spinach ($0.59-$1.89). However, the magnitude of the estimates is not as high as for the fresh spinach. This may imply that consumers do not care as much about the production method of the food if it is processed. Furthermore, as in the case of fresh spinach, we see the WTP for gene-edited frozen spinach surpass the WTP of the GMO one under the benefits to the environment treatment. Yet overall, we can see in Graph 22, that the general ordering remains intact for the alternatives.

Table 10. Total and Marginal Willingness-to-Pay ($/10oz) Estimates from the MXL-EC Model in WTP Space by Information Treatment, Frozen Spinach

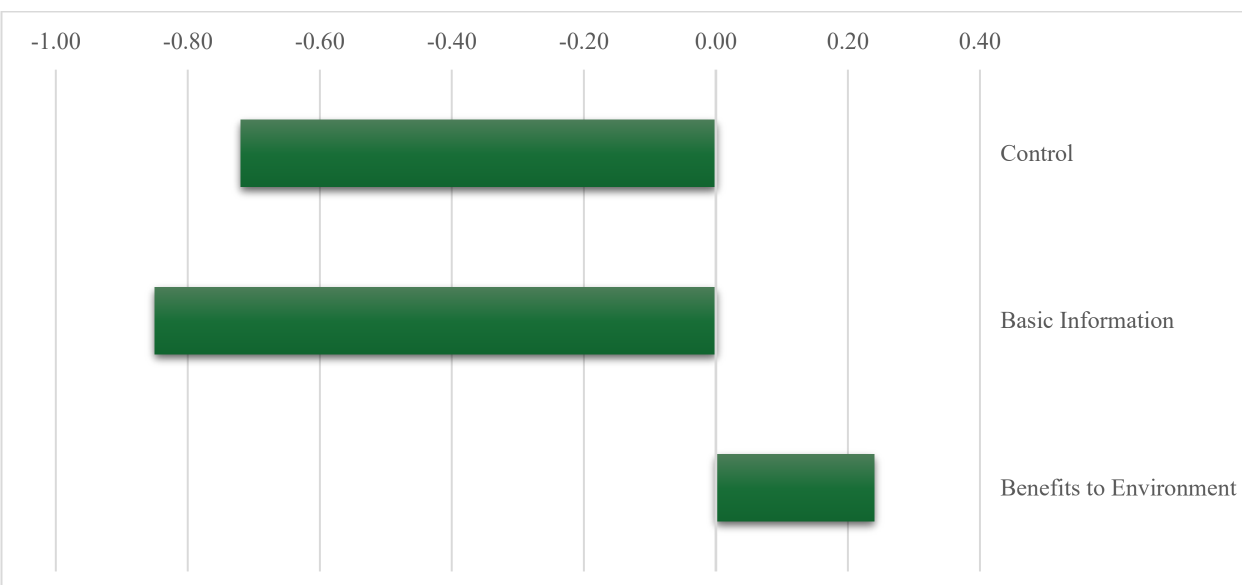
	Control	Basic Information	Benefits to Environment
Total WTP			
Conventional vs None	$ 1.88	$ 2.15	$ 2.80
Organic vs None	$ 3.21	$ 3.48	$ 3.81
Non-GMO vs None	$ 3.13	$ 2.69	$ 3.62
GMO vs None	$ 1.31	$ 1.45	$ 1.65
Gene-Edited vs None	$ 0.59	$ 0.60	$ 1.89
Marginal WTP			
Gene-Edited vs Conventional	$-1.29	$-1.55	$-0.91
Gene-edited vs Organic	$-2.62	$-2.88	$-1.92
Gene-Edited vs Non-GMO	$-2.54	$-2.09	$-1.73
Gene-Edited vs GMO	$-0.72	$-0.85	$ 0.24
GMO vs Conventional	$-0.57	$-0.70	$-1.15
GMO vs Organic	$-2.62	$-2.88	$-1.92
GMO vs Non-GMO	$-1.82	$-1.24	$-1.97
Organic vs Conventional	$ 1.33	$ 1.33	$ 1.01
Organic vs Non-GMO	$ 0.08	$ 0.79	$ 0.19
Non-GMO vs Conventional	$ 1.25	$ 0.54	$ 0.82

Graph 22. Marginal WTP for Gene-edited Frozen Spinach vs other alternatives



When looking at the marginal WTP for gene-edited frozen spinach compared to GMO frozen spinach across treatments, we observe similar results for both the control and the benefits to environment treatments for fresh spinach. However, the WTP for gene-edited frozen spinach decreases under the basic information case compared to what happened under the fresh spinach case. Given that the WTP for GMO frozen spinach increased alongside gene-edited spinach when information was provided, this finding is not surprising and consistent with prior research showing less concern about GMOs in processed vs fresh products (Lusk et al., 2015).

Graph 23. Marginal WTP Gene-edited Frozen Spinach vs GMO Frozen Spinach by treatment



PORK CHOPS AND BACON

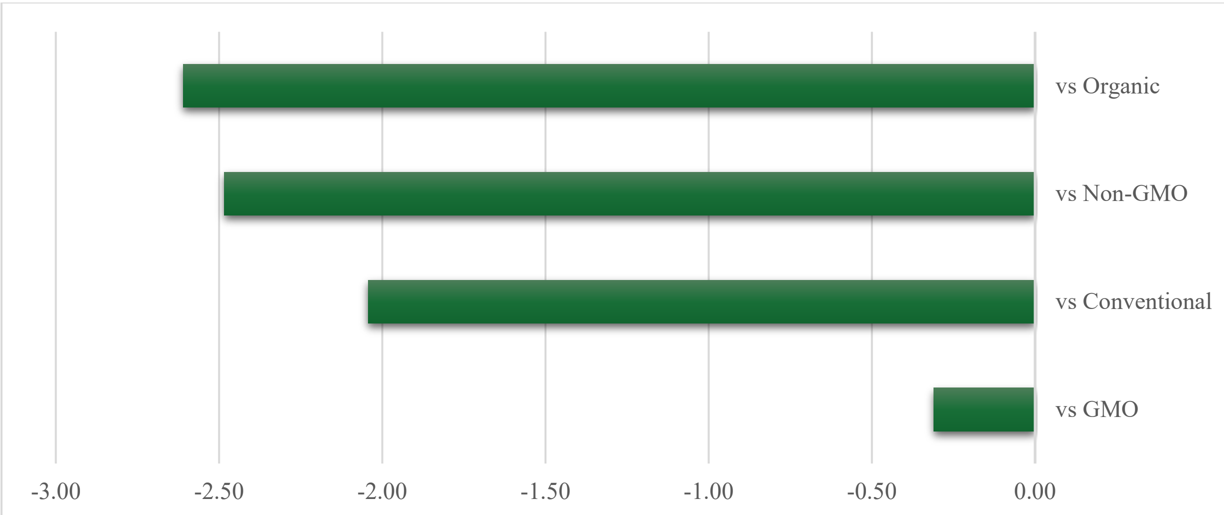
As in the case of fresh spinach, pork chops only received three treatments, and throughout these treatments, respondents value organic pork chops the most and gene-edited/GMO pork chops the least (see Table 11). As for the other products respondents have a higher WTP for GMO pork chops than for gene-edited ones in the control and basic information treatment, but a lower one in the benefits treatment.

Table 11. Total and Marginal Willingness-to-Pay ($/lbs) Estimates from the MXL-EC Model in WTP Space by Information Treatment, Pork Chops

	Control	Basic Information	Benefits to Consumers
Total WTP			
Conventional vs None	$ 5.20	$ 3.14	$ 4.20
Organic vs None	$ 5.48	$ 4.95	$ 3.81
Non-GMO vs None	$ 5.78	$ 4.46	$ 3.62
GMO vs None	$ 3.43	$ 2.26	$ 1.65
Gene-Edited vs None	$ 2.94	$ 1.58	$ 1.89
Marginal WTP			
Gene-Edited vs Conventional	$-2.26	$-1.56	$-2.31
Gene-edited vs Organic	$-2.54	$-3.37	$-1.92
Gene-Edited vs Non-GMO	$-2.84	$-2.88	$-1.73
Gene-Edited vs GMO	$-0.49	$-0.68	$ 0.24
GMO vs Conventional	$-1.77	$-0.88	$-2.55
GMO vs Organic	$-2.54	$-3.37	$-1.92
GMO vs Non-GMO	$-2.35	$-2.20	$-1.97
Organic vs Conventional	$ 0.28	$ 1.81	$-0.39
Organic vs Non-GMO	$-0.30	$ 0.49	$ 0.19
Non-GMO vs Conventional	$ 0.58	$ 1.32	$-0.58

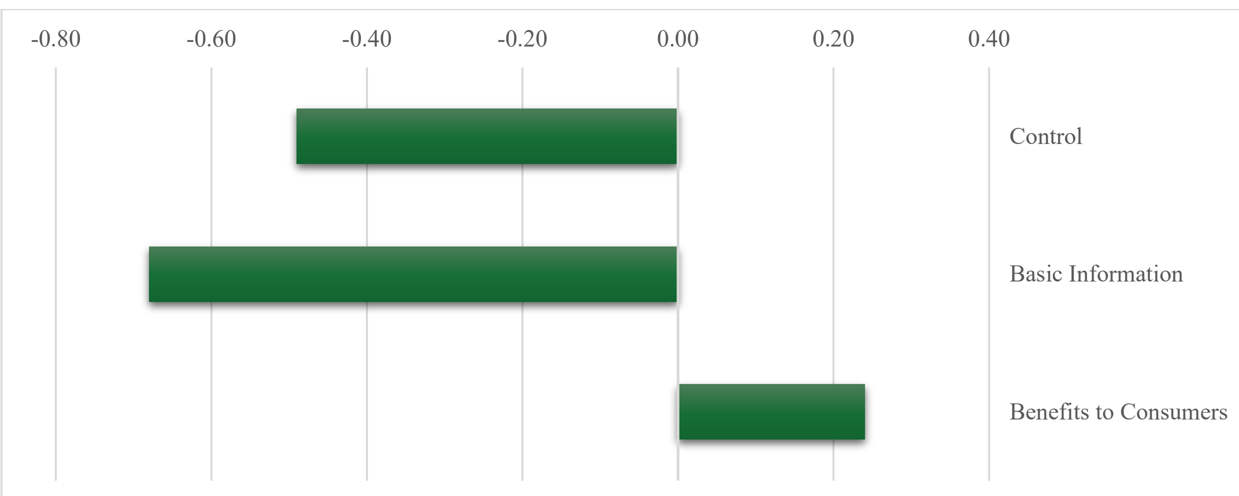
We find that the marginal WTP of gene-edited pork chops compared to the other alternatives follows the same pattern as the previous reviewed food items (see Graph 24). Consumers are willing to pay the highest premium for organic pork chops and the lowest for GMO pork chops compared to gene-edited pork chops. However, compared to the plant-based products, the difference between the premium for conventional and GMO is much bigger for pork chops highlighting respondents' reluctance when it comes to animal-based products as shown in previous studies (Lusk et al., 2015; Lusk et al., 2005)

Graph 24. Marginal WTP for Gene-edited Pork Chops vs other alternatives



Furthermore, if we look at the marginal WTP of gene-edited vs GMO pork chops throughout the treatments (see Graph 25), we observe that respondent's marginal WTP for gene-edited pork chops is lowest and negative in the basic information treatment, but a positive price premium exists for the benefit treatment. This could again be induced by respondents' apprehension related to new food technologies in animals.

Graph 25. Marginal WTP Gene-edited Pork Chops vs GMO Pork Chops by treatment



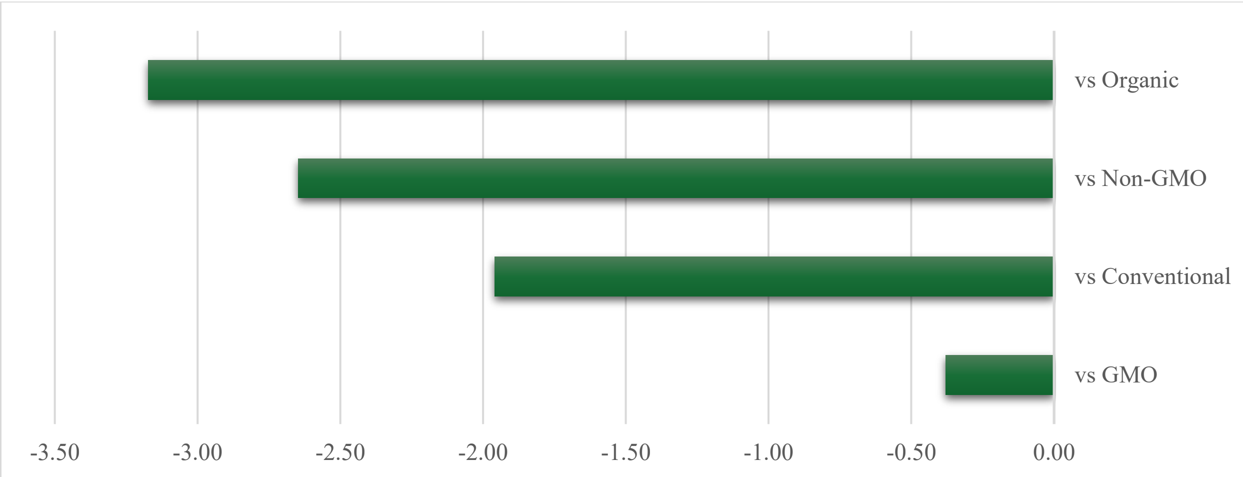
With regards to bacon we find a similar but slightly different path to what we have seen for all previous products (Table 12) when looking at the total WTP. Unlike all former products, total WTP is not always the highest for organic bacon but is exceeded by non-GMO bacon in the control treatment. As for pork chops, the gene-edited option surpasses that of the GMO option under the benefit information treatment.

Table 12. Total and Marginal Willingness-to-Pay ($/lbs) Estimates from the MXL-EC Model in WTP Space by Information Treatment, Bacon

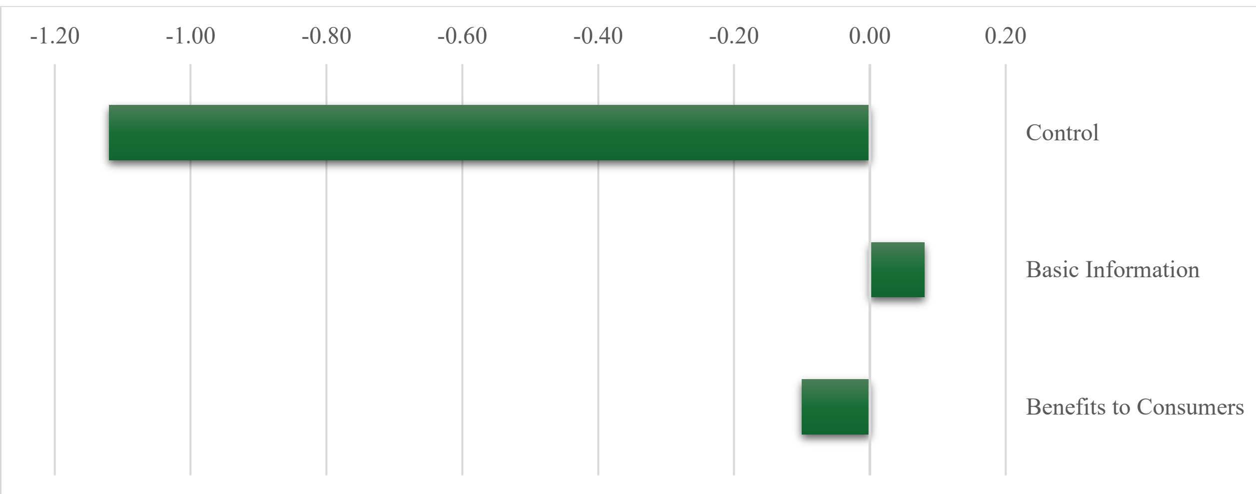
	Control	Basic Information	Benefits to Consumers
Total WTP			
Conventional vs None	$ 6.69	$ 6.56	$ 6.19
Organic vs None	$ 7.60	$ 7.90	$ 7.58
Non-GMO vs None	$ 7.95	$ 6.47	$ 7.08
GMO vs None	$ 4.64	$ 4.92	$ 5.14
Gene-Edited vs None	$ 3.52	$ 5.00	$ 5.04
Marginal WTP			
Gene-Edited vs Conventional	$-3.17	$-1.56	$-1.15
Gene-edited vs Organic	$-4.08	$-2.90	$-2.54
Gene-Edited vs Non-GMO	$-4.43	$-1.47	$-2.04
Gene-Edited vs GMO	$-1.12	$ 0.08	$-0.10
GMO vs Conventional	$-2.05	$-1.64	$-1.05
GMO vs Organic	$-4.08	$-2.90	$-2.54
GMO vs Non-GMO	$-3.31	$-1.55	$-1.94
Organic vs Conventional	$ 0.91	$ 1.34	$ 1.39
Organic vs Non-GMO	$-0.35	$ 1.43	$ 0.50
Non-GMO vs Conventional	$ 1.26	$-0.09	$ 0.89

Similar to the case of pork chops, consumers are willing to pay the most for organic bacon and the least for GMO bacon compared to gene-edited bacon with a similar gap between the conventional and GMO alternative (see graph 26). Yet, interestingly respondents display a positive marginal WTP for gene-edited bacon in the basic information treatment and a negative one in the benefits treatment.

Graph 26. Marginal WTP for Gene-Edited Bacon vs other alternatives



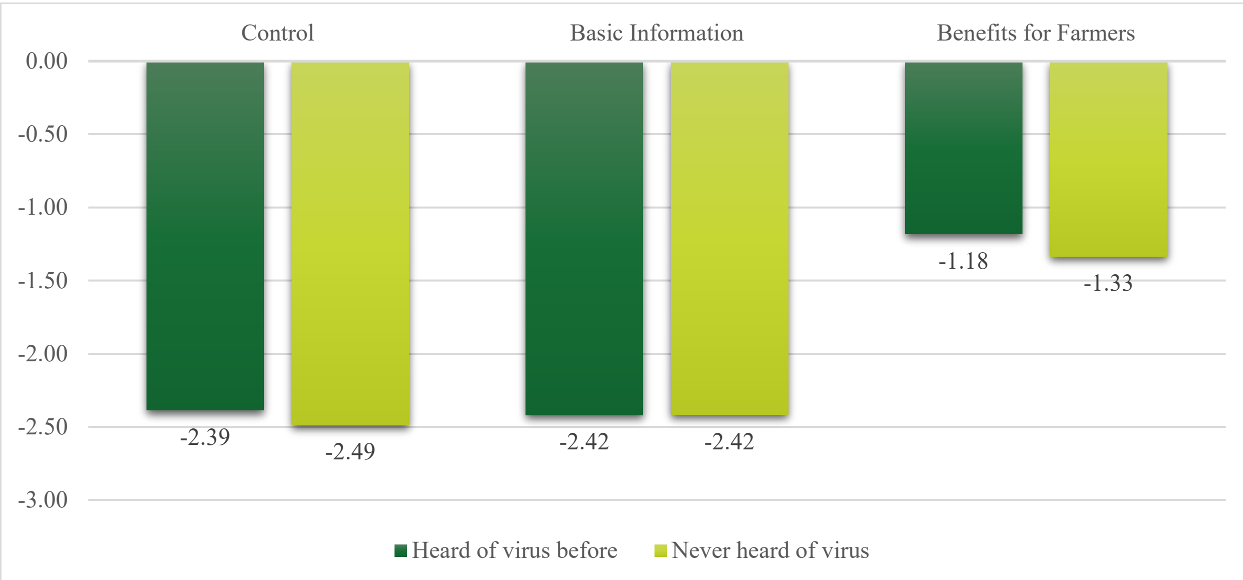
Graph 27. Marginal WTP Gene-edited Bacon vs GMO Bacon by treatment



Finally, when evaluating these results, it needs to be taken into consideration that consumer preferences and WTP for pork chops and bacon could be influenced by the recent media attention to the African swine virus. To capture this we asked respondents whether they have had previously heard of the African Swine Virus. We then evaluated whether this influenced respondents WTP for gene-edited pork chops and bacon. More specifically, we analyzed respondents average marginal WTP for these products compared to the conventional and GMO alternative conditional on whether they had previously heard of the virus.

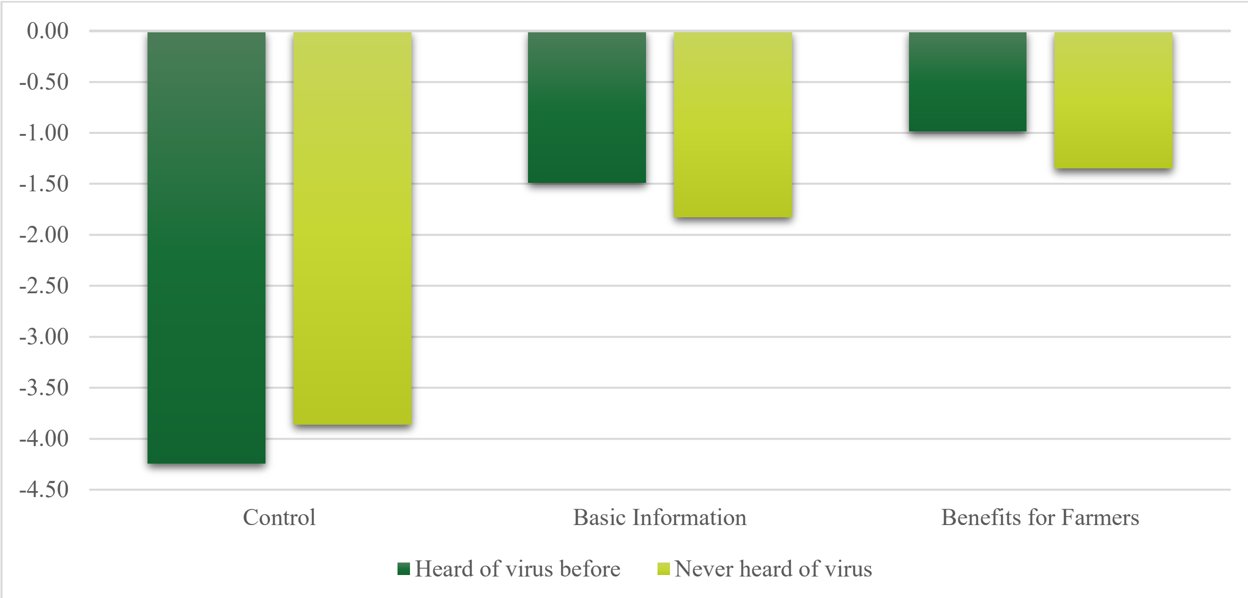
We find that 37% of respondents had previously hear of the virus and as can be seen in Graph 28 the marginal WTP for gene-edited pork chops compared to conventional pork chops does not differ noticeably between whether or not they heard of the virus. However, the biggest difference is observable in the benefits treatment, where it is explained that gene-editing can actually prevent pigs from contracting a virus.

Graph 28. Respondents marginal WTP for gene-edited Pork Chops compared to conventional ones conditional on their awareness of the African Swine Virus



Similarly, for bacon we find that in all treatments but the control, the marginal WTP for gene-edited bacon compared to the conventional one is higher for those respondents who had heard of the virus compared to those that had not heard of it as shown in Graph 29. The difference is significantly higher than that for pork chops, but likely a result of the generally higher price of bacon. This indicates that current events do indeed have a noticeable influence on respondents WTP for gene-edited food products, which can be utilized by marketers to promote their product.

Graph 29. Respondents marginal WTP for gene-edited bacon compared to conventional one conditional on their awareness of the African Swine Virus



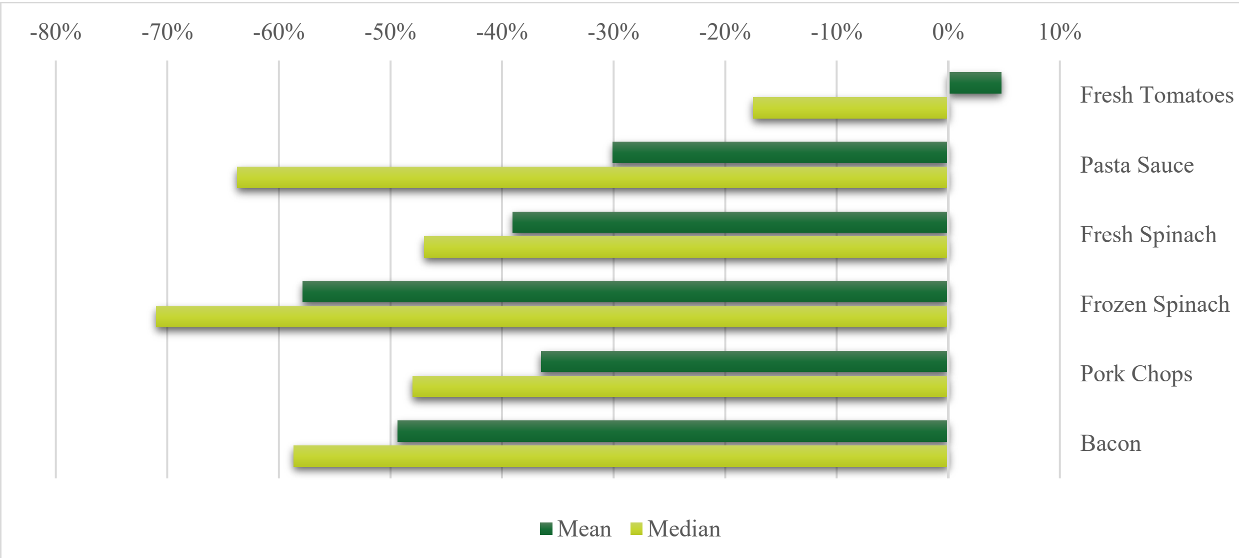
DIFFERENCES IN CONSUMER VALUATION ACROSS FOCAL PRODUCTS: KEY FINDINGS

To explore whether consumer valuation for gene-edited food varies across focal products and processing levels, we calculated WTP values (mean and medians) for Gene-edited vs Conventional alternatives within each information treatment. Individual WTP estimates were used. Percentages[5] are reported to ease comparison.

For the control treatment (Graph 30), we find that consumers value gene-edited tomatoes more than spinach and pork. We also find substantial differences between mean and median for all products. In this regard, a clear pattern is that the mean percentage difference is lower than the median difference suggesting that some consumers show a very high WTP for gene-edited products compared to conventional ones. This is particularly pronounced for fresh tomatoes where we observe that respondents are willing to pay 5% more on average for gene-edited fresh tomatoes compared to -17% for the median.

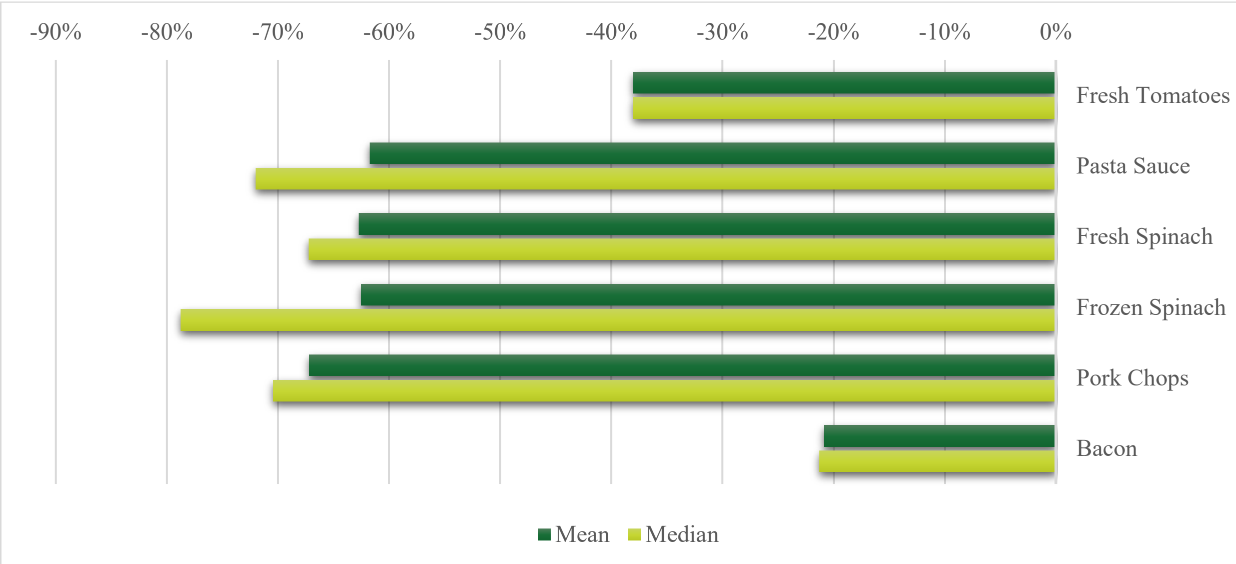
[5] The percentage WTPs were calculated as follows: (WTP for gene-edited - WTP for conventional)/ WTP for conventional.

Graph 30. Percentage WTP for Gene-edited vs Conventional alternatives by product, Control Treatment



On the other hand, when consumers receive basic information about the alternative food products (Graph 31), the difference between mean and median diminishes suggesting that information homogenizes WTP for gene-edited products. Focusing on the difference in valuation across products, results show that less than 40% difference in WTP for fresh tomatoes and bacon and between 60% to 70% for the remaining products. Interestingly, while gene-edited bacon has the lowest difference in mean WTP (-21%), pork chops have the highest difference with an average of 67%. This is consistent with Lusk et al. (2015) who found that fresh genetically engineered foods are liked less than the processed ones.

Graph 31. Percentage WTP for Gene-edited vs Conventional alternatives by product, Basic Information Treatment

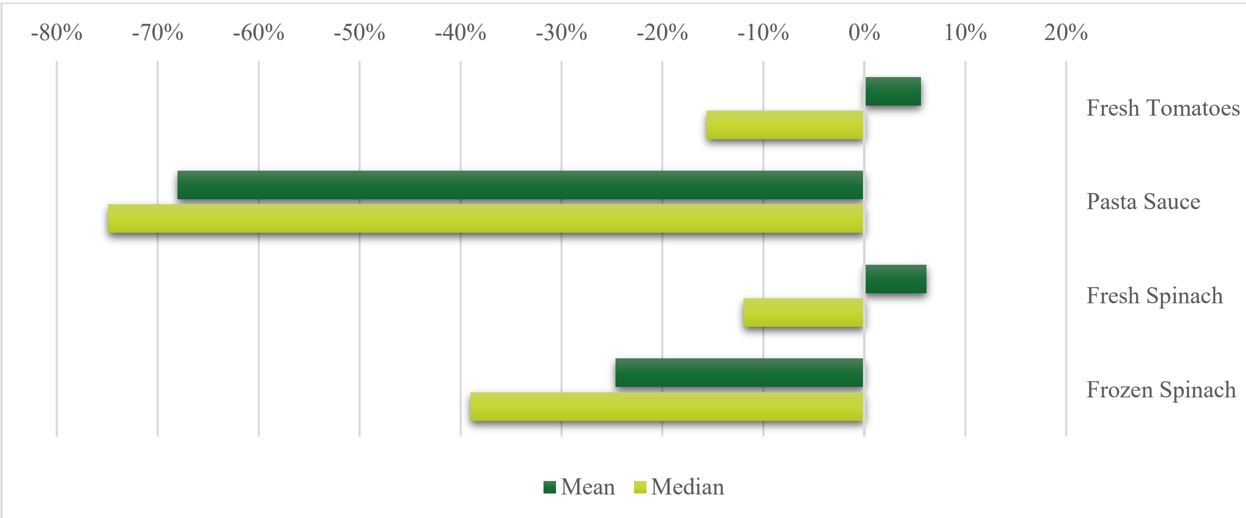


Interestingly, when considering the benefit to the environment treatment[6] (Graph 32) the results show preference reversal pattern and contrast Lusk et al. (2015) for both products (tomatoes and spinach) as we find the difference in WTP for the fresh products in the benefits for the environment treatment is lower than that of the processed ones. However, the authors did not use any information treatment in their study indicating the impact information can have on respondents WTP. Possibly, respondents perceive processed food to have a greater environmental impact due to the additional processing steps along the supply chain.

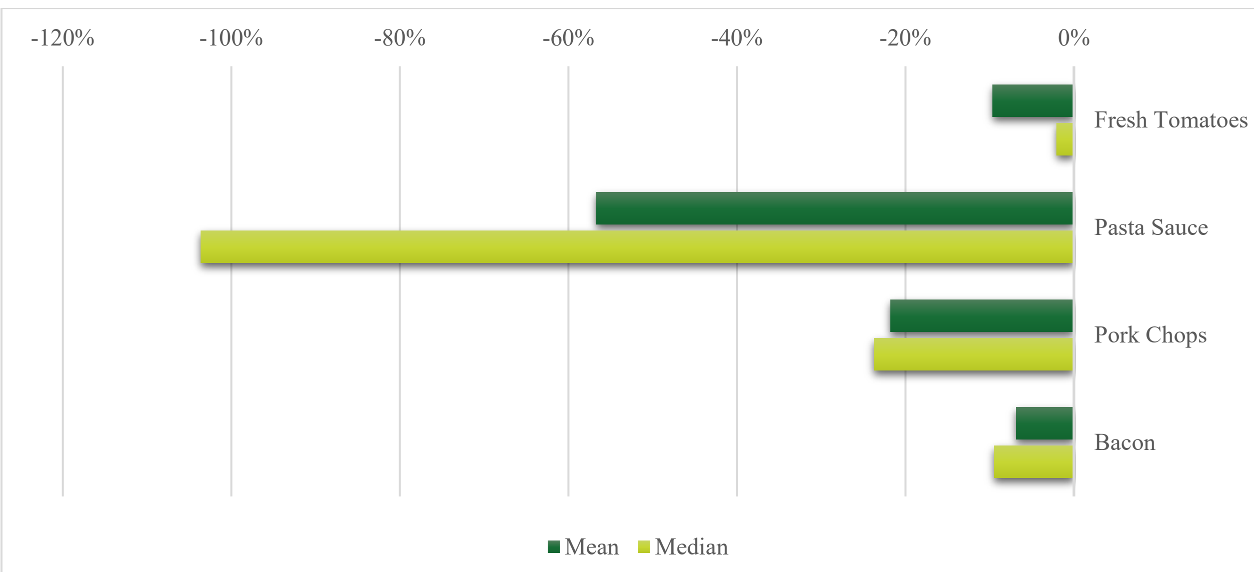
This trend continues for tomatoes in the benefits to the consumers treatment (Graph 33), where respondents have a substantially higher acceptance for the fresh tomatoes compared to the pasta sauce. Moreover, we also find that, on average, respondents are willing to pay more for gene-edited pasta sauce when presented with benefits to consumers compared to benefits for the environment. Turning to the meat products, we find that fresh meat (pork chops) is less accepted than the processed meat (bacon).

[6] Given that for the pork and spinach treatments respondents were only grouped into three treatments (i.e. control, basic information and one benefit treatment), we only report the differences for tomatoes and spinach for the benefits to the environment treatment and for tomatoes and pork for the benefits to the consumer treatment.

Graph 32. Percentage WTP for Gene-edited vs Conventional alternatives by product, Benefits to the Environment Treatment



Graph 33. Percentage WTP for Gene-edited vs Conventional alternatives by product, Benefits to the Consumers Treatment



To further explore differences in consumer valuation for gene-edited foods, Table 13 reports the respondent WTP to have gene-edited foods as an available option in the market. Results confirm our earlier findings that the benefits information results in the highest WTP for having gene-edited food available. More specifically, for fresh tomatoes the benefits to the environment information shows the greatest impact ($0.11), while pasta sauce the benefits to consumers information results in the highest WTP per choice ($0.23). In the case of spinach, we observe smaller differences between the treatments for fresh spinach with the benefits information resulting in the highest price premium ($0.06). In line with this, frozen spinach also shows the highest price premium for the benefit treatment ($0.16). This trend continues for pork chops with a $0.10 per choice premium. Again, respondents are willing to pay more for processed gene-edited meat (bacon) with a premium of $0.14. In addition, for bacon we find the highest price premium in the control group ($0.15), which is likely a result of respondents not fully understanding the meaning of the alternative labels/claims as demonstrated by the substantial drop in WTP for gene-edited in the basic information treatment.

Table 13: Willingness to pay to have gene-edited foods available ($/choice)

Focal Products/Treatments	Fresh	Processed
Tomatoes		
Control	$ 0.03	$ 0.04
Basic Information	$ 0.03	$ 0.02
Benefits to Consumers	$ 0.04	$ 0.23
Benefits to the Environment	$ 0.11	$ 0.11
Benefits to Farmers	$ 0.04	$ 0.08
Spinach		
Control	$ 0.03	$ 0.03
Basic Information	$ 0.01	$ 0.03
Benefits to Environment	$ 0.06	$ 0.16
Pork		
Control	$ 0.03	$ 0.15
Basic Information	$ 0.00	$ 0.04
Benefits to Farmers	$ 0.10	$ 0.14

4.4 BELIEFS

Following the choice questions, respondents answered the above discussed beliefs questions. Given that respondents were exposed to information prior to these questions, we segment the results by product and information treatments.

GRAPE TOMATOES AND PASTA SAUCE

As can be seen in Table 14 respondents perceived organic as the healthiest and safest option, but also the priciest one irrespective of the information treatment for both grape tomatoes and pasta sauce. Surprisingly, while respondents did believe organic grape tomatoes to taste the best throughout all treatments, they consistently deemed conventional pasta sauce to be the tastiest option.

In contrast, gene-edited tomato products were perceived to be the least tasty, healthy, and safe option in all treatments (even compared to bioengineered ones). Potentially, respondents either liked the new bioengineered logo or dislike the uncertainty associated with the term gene-edited. Moreover, even though the benefits to consumer treatment reported an increase in nutritional value for gene-edited tomatoes, respondents ranked it second to last and last in the healthiness aspect for grape tomatoes and pasta sauce respectively. Yet, an overall slight increase in healthiness belief for the gene-edited products is observable for those treatments in which information about the benefits was provided to respondents and similarly also for beliefs about the safety of the product. Furthermore, we also observe a positive impact of providing even basic information on perceived tastiness of gene-edited tomato products as well as an increase in average expected cost. These findings indicate that at least with regards to consumer beliefs, the provided information in its basic and its more extensive benefit form were not able to substantially reverse respondents' opinions when confronted with other alternatives.

Table 14. Consumer beliefs about labels/claims for Grape Tomatoes or Pasta Sauce by information treatment

Label	Healthiness[a]		Cost[b]		Tasty[c]		Safety[d]	
	Grape Tomatoes	Pasta Sauce	Grape Tomatoes	Pasta Sauce	Grape Tomatoes	Pasta Sauce	Grape Tomatoes	Pasta Sauce
Control - No Information								
Organic	4.19	3.90	2.35	2.18	3.99	3.58	4.07	4.01
Bioengineered	3.25	3.09	2.76	2.57	3.32	3.15	3.24	3.25
Non-GMO	4.07	3.79	2.43	2.30	3.82	3.51	3.91	3.78
Gene-edited	2.83	2.80	2.88	2.79	3.20	3.09	2.86	2.96
Conventionally grown	3.64	3.58	3.21	3.24	3.92	3.71	3.67	3.63
Basic Information								
Organic	4.44	4.15	2.26	2.17	4.13	3.76	4.32	4.10
Bioengineered	2.99	2.98	2.67	2.74	3.49	3.35	3.04	3.08
Non-GMO	3.89	3.90	2.43	2.34	3.77	3.66	3.79	3.82
Gene-edited	2.85	2.81	2.77	2.84	3.31	3.30	2.87	2.87
Conventionally grown	3.70	3.51	3.55	3.45	3.86	3.82	3.63	3.52
Benefits to consumers								
Organic	4.24	4.07	2.07	2.14	4.05	3.76	4.22	4.17
Bioengineered	3.13	3.00	2.37	2.54	3.36	3.36	3.10	3.11
Non-GMO	3.87	3.66	2.24	2.36	3.81	3.59	3.86	3.77
Gene-edited	3.12	3.13	2.39	2.58	3.31	3.31	2.98	3.06
Conventionally grown	3.63	3.40	3.41	3.39	3.93	3.91	3.60	3.62
Benefits to environment								
Organic	4.30	4.02	2.15	2.16	4.22	3.70	4.24	4.16
Bioengineered	3.12	2.95	2.57	2.56	3.45	3.24	3.16	3.18
Non-GMO	3.91	3.79	2.26	2.32	3.91	3.63	3.92	3.85
Gene-edited	3.16	3.02	2.46	2.52	3.40	3.24	3.10	3.06
Conventionally grown	3.56	3.37	3.53	3.17	3.91	3.74	3.62	3.56
Benefits to farmers								
Organic	4.33	4.20	2.06	1.97	4.21	3.85	4.31	4.13
Bioengineered	3.03	3.06	2.61	2.48	3.45	3.37	3.17	3.13
Non-GMO	3.93	3.87	2.29	2.27	3.89	3.78	3.94	3.85
Gene-edited	3.06	2.98	2.78	2.61	3.39	3.34	3.10	3.06
Conventionally grown	3.55	3.52	3.54	3.40	3.98	3.86	3.57	3.51

a Mean score on scale from 1 = very unhealthy to 5 = very healthy
b Mean score on scale from 1 = very expensive to 5 = very inexpensive
c Mean score on scale from 1 = very untasty to 5 = very tasty
d Mean score on scale from 1 = very risky to 5 = very safe

Note: green highlight indicates highest value in a column/treatment, red highlight indicates lowest value in a column/treatment, and yellow highlight indicates second lowest value in a column/treatment.

FRESH SPINACH AND FROZEN SPINACH

Reflecting our findings for grape tomatoes, we find that the average values for healthiness, tastiness and safety, for the organic alternative to be the highest and for the cost expectation the lowest throughout all treatments for both products. One exception between the groups is found with regard to tastiness in the control treatment. This exception is frozen organic spinach. Fresh organic spinach is believed to be tastier compared to the alternatives, while for frozen spinach the conventional option ranks first.

In the case of healthiness, we further observe that for fresh and frozen spinach the gene-edited option has the lowest believed ranking in the control and basic information group. Yet, when it comes to the benefits treatment, the gene-editing alternative instead ranks second to last behind the bioengineered spinach. Correspondingly, we observe an increase for both the fresh and processed option in perceived healthiness when more information is provided. The same can be observed for tastiness and for frozen spinach in regard to cost, where the expectation of the product being more expensive increases parallel to the information given. This continues the trend observed in previous products and backs our hypothesis that information can indeed mitigate consumer concerns about gene-edited products and might eventually lead to an adjustment of beliefs.

Table 15. Consumer beliefs about labels/claims for Fresh or Frozen Spinach by information treatment

Label	Healthiness[a]		Cost[b]		Tasty[c]		Safety[d]	
	Fresh Spinach	**Frozen Spinach**	**Fresh Spinach**	**Frozen Spinach**	**Fresh Spinach**	**Frozen Spinach**	**Fresh Spinach**	**Frozen Spinach**
Control - No Information								
Organic	4.36	4.17	2.21	2.26	4.19	3.72	4.29	4.04
Bioengineered	3.08	3.14	2.76	2.67	3.42	3.32	3.16	3.17
Non-GMO	4.11	4.02	2.25	2.35	3.98	3.79	4.01	3.94
Gene-edited	2.70	2.84	2.85	2.84	3.24	3.21	2.93	2.95
Conventionally grown	3.64	3.79	3.30	3.45	3.85	3.87	3.55	3.71
Basic Information								
Organic	4.52	4.28	2.22	2.20	4.30	4.12	4.35	4.33
Bioengineered	3.07	3.10	2.79	2.66	3.46	3.50	3.07	3.17
Non-GMO	3.98	3.88	2.50	2.34	3.92	3.90	3.87	3.96
Gene-edited	2.85	2.93	2.87	2.72	3.30	3.30	2.85	2.97
Conventionally grown	3.48	3.69	3.42	3.55	3.79	3.95	3.44	3.79
Benefits to environment								
Organic	4.43	4.32	2.19	2.14	4.21	4.07	4.29	4.23
Bioengineered	2.98	3.22	2.74	2.65	3.48	3.47	3.05	3.10
Non-GMO	4.01	4.02	2.39	2.30	3.91	3.89	3.89	3.90
Gene-edited	3.06	3.24	2.81	2.60	3.46	3.50	3.06	3.10
Conventionally grown	3.55	3.72	3.52	3.65	3.83	3.93	3.51	3.71

a Mean score on scale from 1 = very unhealthy to 5 = very healthy
b Mean score on scale from 1 = very expensive to 5 = very inexpensive
c Mean score on scale from 1 = very untasty to 5 = very tasty
d Mean score on scale from 1 = very risky to 5 = very safe
Note: green highlight indicates highest value in a column/treatment, red highlight indicates lowest value in a column/treatment, and yellow highlight indicates second lowest value in a column/treatment.

PORK CHOPS AND BACON

In line with the observations for the plant-based products, the organic alternative was perceived to be the healthiest and safest option throughout all treatments for both pork chops and bacon. Moreover, organic also was considered to provide the highest animal welfare, but also be the most expensive option. Yet, in contrast to the previous products, organic pork chops only received the highest rating among the available options for tastiness in the basic information treatment, while conventionally produced pork chops received higher ratings in the other two treatments and conventional bacon in all treatments. The lowest average ratings for tastiness in all treatments are associated with the gene-edited pork products. For healthiness, safety, and animal welfare the gene-edited alternative received the lowest rating in the control and basic information treatment for both products but came second to last (healthiness, safety) and third (animal welfare) for the benefits treatment. This finding further supports our initial hypothesis regarding the positive effect of information on consumer beliefs. In line with this, for bacon and pork chops, we observe an increase in average ratings for gene-edited pork chops in the healthiness, taste, and safety categories when the benefits information was provided. Interestingly, for pork chops we observe a decrease in ratings for the gene-edited option in the animal welfare category when basic information is provided; but this is compensated when the information is supplemented with the benefit message. This indicates that context plays an important role and the sole provision of information about claims/labels is insufficient to sway consumers' beliefs.

Table 16. Consumer beliefs about labels/claims for Pork Chops or Bacon by information treatment

Label	Healthiness[a]		Cost[b]		Tasty[c]		Safety[d]		Animal Welfare[e]	
	Pork Chops	Bacon	Pork Chops	Bacon	Pork Chops	Bacon	Pork Chops	Bacon	Pork Chops	Bacon
Control - No Information										
Organic	3.92	3.74	2.07	2.05	3.74	3.79	4.02	3.97	3.56	3.39
Bioengineered	3.08	2.86	2.68	2.51	3.22	3.26	3.19	3.04	2.99	2.98
Non-GMO	3.72	3.71	2.29	2.26	3.61	3.74	3.81	3.91	3.47	3.30
Gene-edited	2.78	2.65	2.83	2.78	3.15	3.18	2.95	2.85	2.92	2.82
Conventionally produced	3.55	3.32	3.24	3.06	3.83	3.98	3.57	3.60	3.24	3.06
Basic Information										
Organic	4.05	3.83	1.93	2.04	4.00	3.93	4.15	4.07	3.63	3.79
Bioengineered	2.82	2.79	2.68	2.64	3.31	3.35	2.92	3.01	2.88	2.93
Non-GMO	3.75	3.72	2.20	2.13	3.86	3.86	3.84	3.91	3.34	3.53
Gene-edited	2.67	2.48	2.78	2.86	3.19	3.26	2.70	2.76	2.78	2.80
Conventionally produced	3.48	3.13	3.40	3.30	3.88	3.94	3.46	3.48	3.06	3.00
Benefits to consumers										
Organic	3.94	3.86	1.97	2.01	3.89	3.86	4.05	4.05	3.69	3.70
Bioengineered	2.86	2.93	2.59	2.60	3.32	3.37	3.07	3.09	2.92	3.00
Non-GMO	3.73	3.67	2.21	2.27	3.76	3.75	3.88	3.88	3.41	3.49
Gene-edited	3.03	2.96	2.56	2.62	3.32	3.36	3.10	3.12	3.05	3.14
Conventionally produced	3.52	3.29	3.41	3.17	3.93	3.99	3.54	3.60	3.03	3.09

a Mean score on scale from 1 = very unhealthy to 5 = very healthy
b Mean score on scale from 1 = very expensive to 5 = very inexpensive
c Mean score on scale from 1 = very untasty to 5 = very tasty
d Mean score on scale from 1 = very risky to 5 = very safe
Note: green highlight indicates highest value in a column/treatment, red highlight indicates lowest value in a column/treatment, and yellow highlight indicates second lowest value in a column/treatment.

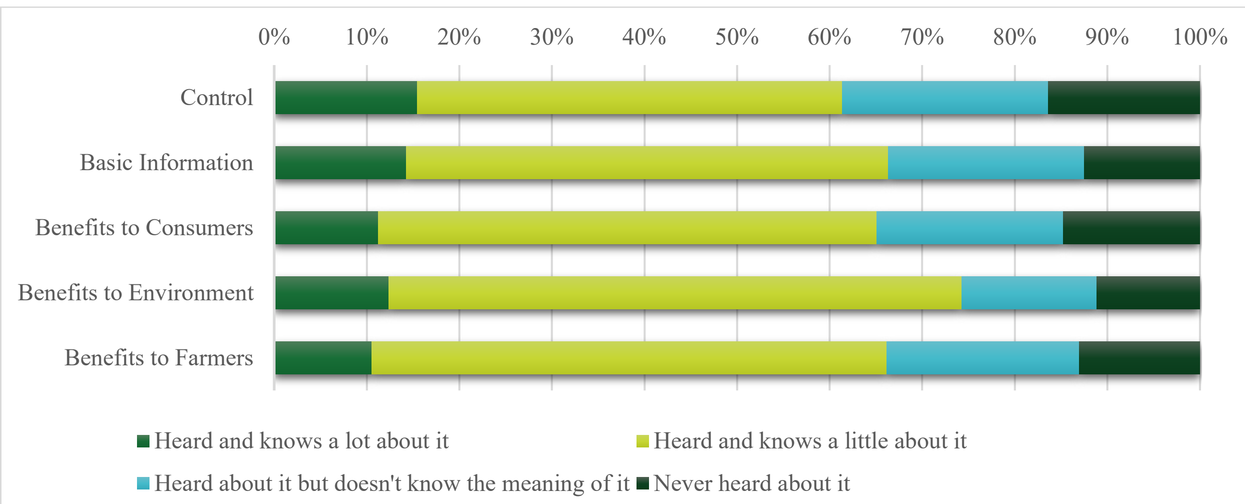
4.5 AWARENESS AND KNOWLEDGE

Following the beliefs section, respondents were faced with a number of questions aimed at capturing their level of awareness and knowledge about GMO and gene-editing technologies. Similar to the beliefs, results are reported for each product and information treatment and findings are discussed by information treatments.

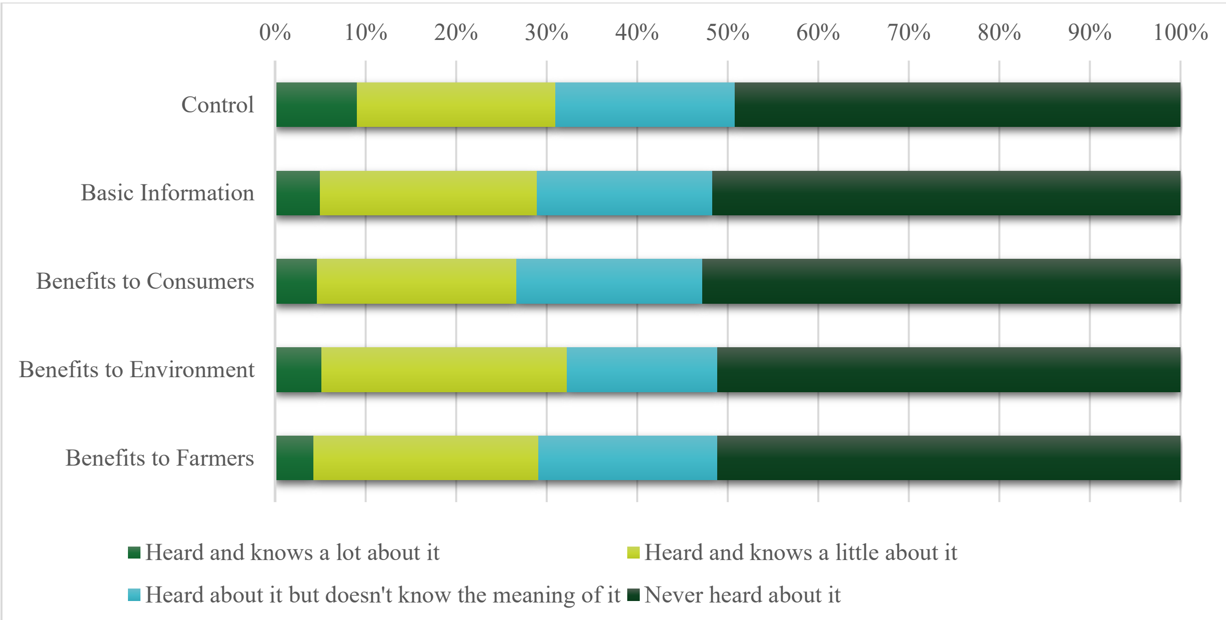
Throughout all treatments we observe the highest share of respondents (46%-62%) indicating that they have limited awareness of GMOs and only 11%-15% claimed to know a lot (see Graph 34). This is most pronounced within the benefits for the environment treatment and least in the control groups. This indicates that respondents answered based on what they knew prior to the survey rather than reporting their current knowledge level. Similarly, we find that depending on the treatment, between 15% (Benefits to the environment) and 22% (Control) of respondents had heard of GMOs but did not know what the term meant.

In contrast to this, we observe that many of respondents (49%-53%), irrespective of their treatment, had never heard of gene-editing and only 4-9% of respondents considered themselves experts (see Graph 35).

Graph 34. Consumer Awareness of GMO

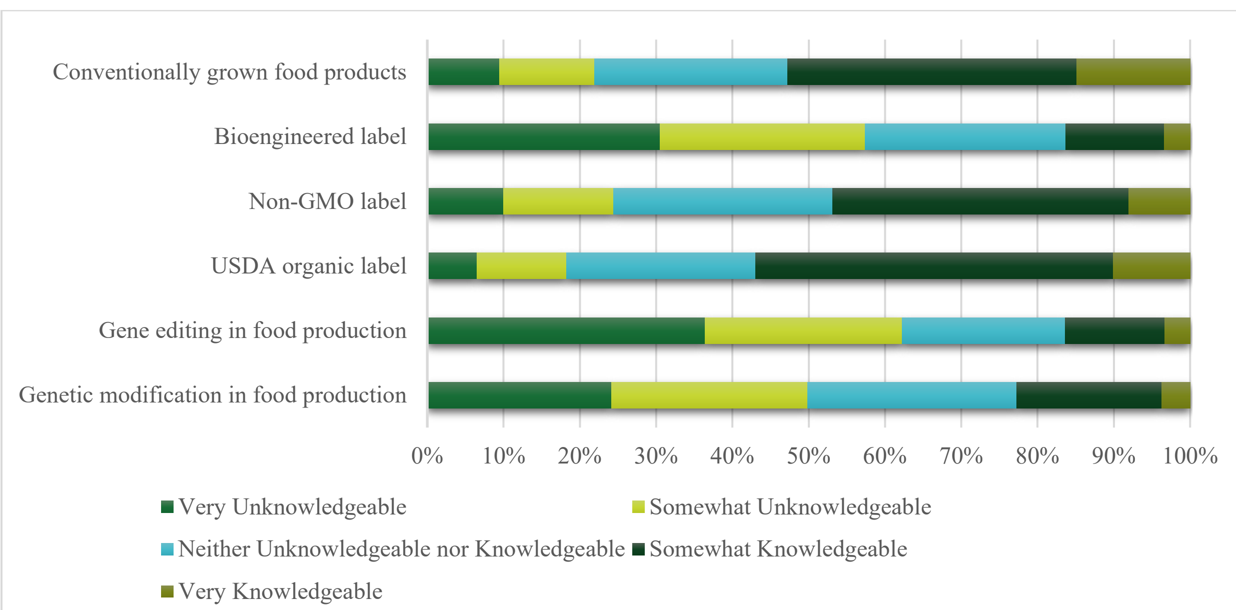


Graph 35. Consumer Awareness of Gene-Editing



Correspondingly to respondents' awareness of gene-editing and GMO, we find that the majority of respondents considers themselves very unknowledgeable (36%) or somewhat knowledgeable (26%) about gene-editing, while most respondents indicated to be neither knowledgeable nor unknowledgeable about GMO (27%) (see Graph 36). Overall, we observe the highest average for subjective knowledge for the USDA organic label, followed by the non-GMO label.

Graph 36. Consumer Subjective Knowledge of Different Labels



Following this, we examined the objective knowledge of respondents, which was evaluated using seven true/false statements. We find that a higher share of respondents provided correct answers if they received either the basic or benefit information, compared to the control group (see Table 17). This is particularly pronounced for the first statement "*GMO (bioengineered) foods are the same as Gene-edited foods,"* where 42% of respondents falsely assumed the statement was correct, while in all other treatments less than 34% of respondents provided the wrong answer. This indicates a clear effect of the information treatment. As expected, we do not find significant differences within the benefit treatments themselves or between the benefits treatment and basic information. This is because in the information treatments respondents were provided with basic information about the different product alternatives (conventional, organic, non-GMO, GMO, gene-edited) elevating the respondents to a similar level of knowledge.

Overall our findings show that the general awareness of GMOs generally exceeds that of gene-edited food, with a correspondingly low level of subjective knowledge among respondents. However, we also find that the provision of information can positively influence respondents' objective knowledge, which in turn has the potential to affect the subjective knowledge.

Table 17. Consumer Objective Knowledge by Treatment

		Control	Basic Information	Benefits to Consumers	Benefits to Environment	Benefits to Farmers
1	Ordinary fruits and vegetables do not contain genes, but GMO fruits and vegetables do	30%	23%	17%	23%	23%
2	GMO fruits and vegetables have foreign genes inserted in their DNA	62%	68%	67%	67%	69%
3	Eating GMO fruits and vegetables put a person at risk to get infected with new diseases	43%	39%	36%	34%	34%
4	Gene-edited fruits and vegetables do not have any gene(s) from other species inserted at random	41%	37%	39%	42%	36%
5	Gene-edited fruits and vegetables are always larger than ordinary fruits and vegetables	45%	39%	36%	35%	36%
6	Gene-edited fruits and vegetables always need pesticides.	37%	34%	29%	24%	26%
7	GMO (bioengineered) foods are the same as Gene-edited foods	42%	33%	32%	31%	34%

Note: Percentages reflect the share of consumers who answered "True" to the respective statement. All statements but statement 2 are false.

4.6 RISK PREFERENCES AND MORAL CONCERNS

Beyond knowledge and awareness, studies have shown that risk preferences and moral concerns can influence consumers' attitudes towards GMO (Lusk and Coble, 2005). Consequently, we evaluated respondents' risk preferences and moral concerns for gene-edited food products.

Results indicate that the average response was close to the median answer of "Neither agree nor disagree" irrespective of the treatment. Furthermore, there was only little variation observable between treatments for the questions (see Table 18). Yet, for the statements "*Gene-editing in food production is morally wrong*" we find that between the control and basic information treatments and the benefit treatments, the support for gene-editing increases with the provision of additional information. This indicates that information not only affects the acceptance of gene-edited food products but can also positively affect the perceived risk from the technology.

We also find the highest average agreement for the statement "*The side-effects from eating food produced using gene-editing are largely unknown.*" This is likely a result of respondents' low level of knowledge as discussed above. Correspondingly, we find the highest level of disagreement with the statement "*My family and I could benefit from gene-editing in food production.*" Given that respondents only have a vague idea of gene-editing, it is understandably that they struggle to see the associated benefits. This explanation corresponds with the fact that for the benefits treatments the disagreement is lower than in the control and basic information treatment. The respondents uncertainty further shows when evaluating the results for the statements "*There is little danger that gene-editing in food production will result in new diseases for humans*" and "*Gene-editing will improve the quality of food products*"; for both statements the average answers is very close to neither agree nor disagree highlighting that respondents seem to be unsure about what to expect from gene-editing in food production.

Table 18. Respondents level of disagreement to risk and moral concerns statements

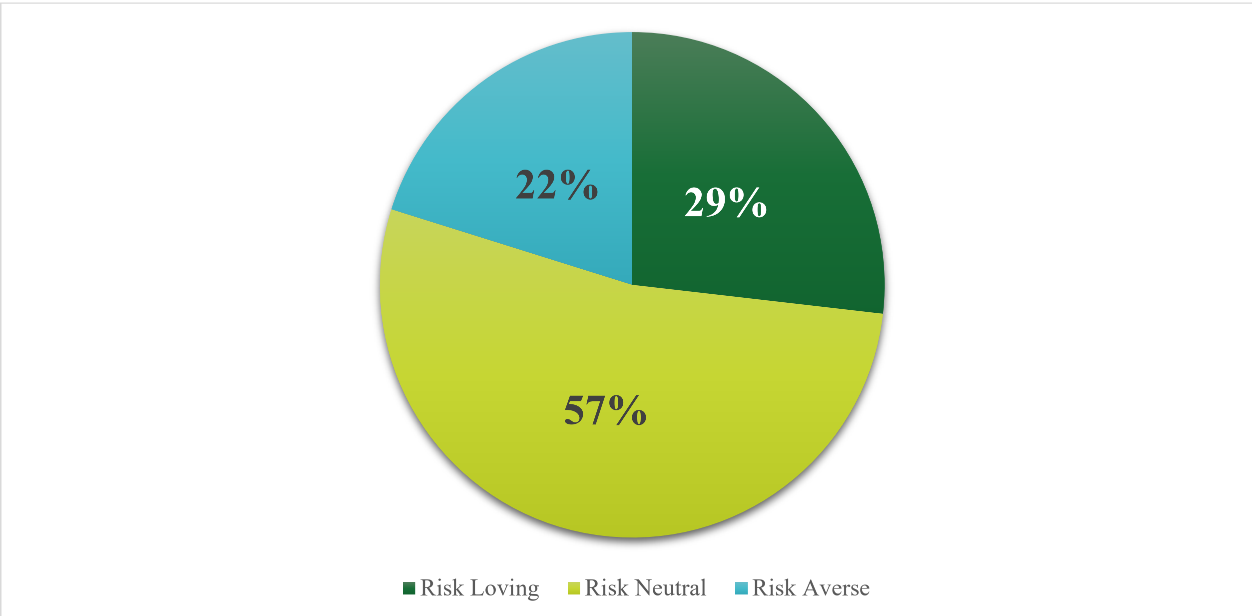
Statement	**Treatments**					
	Control	Basic Information	Benefits to Consumer	Benefits to Environment	Benefits to Farmers	Overall
Gene-editing in food production will pose risks for agricultural and food businesses	2.53	2.54	2.66	2.67	2.74	2.61
Agricultural and food businesses could receive great benefits from gene-editing in food production	2.76	2.83	2.71	2.64	2.64	2.73
My family and I could be exposed to great risks from gene-editing in food production	2.62	2.60	2.77	2.70	2.79	2.68
My family and I could benefit from gene-editing in food production	3.12	3.23	3.07	3.09	3.08	3.12
The developing world could be exposed to great risk from gene-editing in food production	2.70	2.74	2.82	2.84	2.82	2.78
The developing world could receive great benefit from gene-editing in food production	2.90	2.92	2.76	2.76	2.76	2.82
The environment could be exposed to great risks from gene-editing in food production	2.65	2.70	2.77	2.82	2.79	2.74
Gene-editing in food production could provide benefits for the environment	2.97	3.04	2.91	2.70	2.89	2.91

The side-effects from eating food produced using gene-editing are largely unknown	2.35	2.22	2.28	2.27	2.36	2.29
There is little danger that gene-editing in food production will result in new diseases for humans	3.05	3.13	3.06	3.07	3.04	3.06
Gene-editing will improve the quality of food products	3.01	3.09	2.93	2.99	2.92	2.99
Thanks to gene-editing in food production enough food will be produced to feed the world's growing production	2.74	2.73	2.75	2.67	2.67	2.71
Man has no right to "play God" with nature	2.59	2.56	2.72	2.74	2.78	2.67
Gene-editing in food production is morally wrong	2.81	2.90	3.06	3.10	3.14	2.98
Gene-editing in food production threatens the natural order of things	2.64	2.60	2.75	2.78	2.80	2.70

*Average level of agreement was determined from respondents' answers to the statement on a 5-point Likert scale, where 5=Strongly Disagree and 1=Strongly Agree.

To further explore how risk preferences influence consumer preferences for gene-edited products, we performed a cluster analysis. The initial cluster analysis showed no significant differences between results if the data was clustered as whole or if it was segmented by product or treatment. Therefore, we decided to run a second cluster analysis for the entire data set. Overall, we found three distinct groups of respondents as highlighted in Graph 37.

Graph 37. Results Cluster-Analysis Full Data



Using this data, we then proceeded to cross-reference our findings with the previously determined WTP estimates and analyzed how the three risk categories vary with information provision. Table 19 reports the three consumer segments across information treatments. Results indicate that information about gene-editing not only affects marginal and total WTP for gene-edited foods, but it also affects risk preferences. More specifically, we find that when presented with basic information the share of respondents grouped into the risk averse segment increases by about 5%. Yet, when information on the environmental benefits of gene-editing is given to the respondents almost 33% of respondents are grouped into the risk loving segment and only around 16% fall into the risk averse category.

Table 19. Risk Preference Segments Across Information Treatments (%)

	Risk Loving	Risk Neutral	Risk Averse
Control	24.90	53.76	21.33
Basic Information	19.00	54.17	26.83
Benefits to the Consumers	22.28	56.70	21.03
Benefits to the Environment	33.00	50.38	16.63
Benefits to the Farmers	22.56	57.14	20.30

CHAPTER 5: IMPLICATIONS

Overall, we find a lower WTP for gene-edited products compared to all other alternatives. However, we also see significant increases in WTP for gene-edited products with the provision of information, particularly information about the benefits of gene-editing technology. This suggests that willingness-to-pay for gene-edited food products is not only influenced by the general provision of information but needs to be supplemented with specific benefit messages if the technology is to be more widely accepted. Looking at the differences in impact between the three benefit messages, we find that benefits to the environment and consumers show an overall stronger impact than benefits to the farmers, indicating more efficient pathways for future marketing.

With regards to WTP, we further observe that it varies across types of products and levels of processing. As for the former, consumers are willing to pay relatively more for fresh, gene-edited vegetables (tomatoes and spinach) compared to fresh meat when information is provided to them. For fresh plant products, the WTP is higher compared to their processed counterpart. On the other hand, the WTP for gene-edited meat is higher for bacon than for pork chops. This shows that future marketing efforts need to be directed and adapted to the specific food product in question and cannot be guided by a single, overall approach.

Several other findings are also notable:

- Respondents have a very low level of knowledge as well as awareness about gene-editing and associated predominantly negative feelings with the technology.
- Despite these somewhat negative opinions about gene-edited food, we find that when consumers are informed of the benefits of gene-editing, the market share for gene-edited products compared to the other alternative is more than 15%. More specifically, consumers are willing to pay up to $0.23 per choice to have the option of buying gene-edited food products.
- The provision of information also affects respondents’ risk preferences. More specifically, when given information about the environmental benefits of the technology the share of respondents identified as risk averse decreases significantly.

Together these results demonstrate that while gene-editing is likely to face challenges that are mostly borne out of a lack of knowledge, these challenges can be mitigated with the provision of information that includes the benefits of the technology.

CHAPTER 6: REFERENCES

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APPENDICES

Table A1: Estimates from the MXL Model in WTP-Space, Grape Tomatoes

		Control	Basic Information	Benefits to Consumers	Benefits to Environment	Benefits to Farmers
Alternative Specific Constants						
Conventional						
	mean	3.10*(0.21)	3.10*(0.14)	3.49*(0.13)	2.92*(0.11)	3.20*(0.14)
	St. Dev	2.40*(0.19)	1.22*(0.09)	1.49*(0.09)	1.45*(0.09)	1.42*(0.09)
Organic						
	mean	5.27*(0.14)	4.38*(0.11)	4.96*(0.12)	4.47*(0.12)	4.49*(0.15)
	St. Dev	1.52*(0.10)	1.59*(0.10)	1.61*(0.08)	1.57*(0.09)	1.35*(0.08)
Non-GMO						
	mean	4.70*(0.16)	3.66*(0.13)	4.21*(0.14)	3.84*(0.13)	4.39*(0.15)
	St. Dev	1.68*(0.12)	1.64*(0.12)	1.99*(0.13)	1.47*(0.10)	1.21*(0.07)
GMO						
	mean	3.39*(0.15)	1.79*(0.19)	2.63*(0.14)	2.46*(0.14)	2.50*(0.16)
	St. Dev	0.64*(0.11)	1.38*(0.14)	0.69*(0.12)	0.61*(0.11)	0.61*(0.11)
Gene-Editing						
	mean	2.83*(0.13)	1.67*(0.17)	2.92*(0.10)	2.31*(0.16)	2.35*(0.16)
	St. Dev	0.06 (0.16)	1.16*(0.13)	0.81*(0.05)	1.57*(0.10)	1.13*(0.07)
Price						
	mean	-2.34*	-3.20*	*-3.17	-2.98*	-3.66*
	St. Dev	2.34*	3.20*	3.17*	2.98*	3.66*
ERC						
	St. Dev	1.33*	0.95*	1.60*	1.26*	1.60*
Model Statistics						
Choices		2400	2400	2400	2400	2388
Log-likelihood		-2521	-2031	-2091	-2158	-2022
Parameters		12	12	12	12	12
AIC/N		2.111	1.705	1.753	1.808	1.703

Note: Numbers in parentheses are standard errors; * statistically significant at the 0.05 level or lower.

Table A2: Estimates from the MXL Model in WTP-Space, Pasta Sauce

		Control	Basic Information	Benefits to Consumers	Benefits to Environment	Benefits to Farmers
Alternative Specific Constants						
Conventional						
	mean	2.45*(0.17)	2.64*(0.11)	2.75*(0.12)	0.76*(0.17)	1.90*(0.16)
	St. Dev	2.72*(0.17)	1.70*(0.11)	1.77*(0.12)	2.62*(0.14)	2.85*(0.19)
Organic						
	mean	4.05*(0.15)	4.60*(0.12)	4.73*(0.15)	4.19*(0.10)	4.07*(0.14)
	St. Dev	2.12*(0.12)	2.25*(0.13)	2.52*(0.16)	1.78*(0.09)	2.05*(0.13)
Non-GMO						
	mean	3.99*(0.16)	3.64*(0.17)	3.46*(0.18)	3.71*(0.11)	3.37*(0.19)
	St. Dev	2.52*(0.18)	1.91*(0.14)	2.19*(0.16)	1.88*(0.11)	2.26*(0.17)
GMO						
	mean	2.28*(0.13)	1.96*(0.14)	1.70*(0.13)	1.75*(0.16)	1.62*(0.17)
	St. Dev	0.14(0.18)	0.93*(0.12)	0.98*(0.12)	1.81*(0.19)	0.84*(0.11)
Gene-Editing						
	mean	0.99*(0.19)	0.76*(0.21)	0.77*(0.23)	1.75*(0.12)	1.82*(0.16)
	St. Dev	1.47*(0.11)	1.32*(0.16)	3.38*(0.26)	1.65*(0.09)	1.29*(0.13)
Price						
	mean	-1.92*	-2.37*	-1.97*	-2.38*	-2.34*
	St. Dev	1.92*	2.37*	1.97*	2.38*	2.34*
ERC						
	St. Dev	2.89*	1.90*	1.65*	1.75*	1.98*
Model Statistics						
Choice		2856	2400	2400	2400	2400
Log-likelihood		-2902	-2296	-2437	-2405	-2265
Parameters		12	12	12	12	12
AIC/N		2.041	1.923	2.041	2.014	1.897

Note: Numbers in parentheses are standard errors; * statistically significant at the 0.05 level or lower.

Table A3: Estimates from the MXL Model in WTP-Space, Fresh Spinach

		Control	Basic Information	Benefits to the Environment
Alternative Specific Constants				
Conventional				
	mean	2.60*(0.19)	3.66*(0.09)	2.77*(0.11)
	St. Dev	2.25*(0.16)	1.56*(0.10)	1.49*(0.09)
Organic				
	mean	5.04*(0.17)	5.66*(0.12)	5.05*(0.09)
	St. Dev	1.81*(0.11)	2.63*(0.13)	2.08*(0.10)
Non-GMO				
	mean	4.99*(0.16)	4.53*(0.12)	3.66*(0.12)
	St. Dev	1.42*(0.12)	2.4*(0.13)	1.46*(0.10)
GMO				
	mean	2.54*(0.19)	2.23*(0.15)	2.17*(0.12)
	St. Dev	1.09*(0.17)	0.90*(0.10)	0.86*(0.08)
Gene-Editing				
	mean	1.10*(0.35)	1.10*(0.23)	2.23*(0.11)
	St. Dev	1.57*(0.19)	1.57*(0.23)	1.27*(0.07)
Price				
	mean	-1.98*	-2.86*	-2.74*
	St. Dev	1.98*	2.86*	2.74*
ERC				
	St. Dev	1.86*	1.53*	2.09*
Model Statistics				
Choices		2400	2400	2400
Log-likelihood		-2383	-1955	-2205
Parameters		12	12	12
AIC/N		1.996	1.639	1.847

Note: Numbers in parentheses are standard errors; * statistically significant at the 0.05 level or lower.

Table A4: Estimates from the MXL Model in WTP-Space, Frozen Spinach

		Control	Basic Information	Benefits to the Environment
Alternative Specific Constants				
Conventional				
	mean	1.88*(0.11)	2.15*(0.14)	2.80*(0.14)
	St. Dev	1.78*(0.11)	1.74*(0.12)	1.22*(0.10)
Organic				
	mean	3.21*(0.14)	3.48*(0.12)	3.81*(0.16)
	St. Dev	2.13*(0.14)	2.18*(0.13)	2.28*(0.15)
Non-GMO				
	mean	3.13*(0.13)	2.69*(0.15)	3.62*(0.16)
	St. Dev	2.26*(0.16)	1.81*(0.13)	2.23*(0.15)
GMO				
	mean	1.31*(0.12)	1.45*(0.12)	1.65*(0.15)
	St. Dev	0.44*(0.11)	0.68*(0.12)	0.93*(0.14)
Gene-Editing				
	mean	0.59*(0.14)	0.60*(0.17)	1.89*(0.19)
	St. Dev	0.26(0.19)	1.15*(0.09)	1.90*(0.17)
Price				
	mean	-2.51*	-2.51*	2.11*
	St. Dev	2.51*	2.51*	2.11*
ERC				
	St. Dev	1.94*	1.75*	1.88*
Model Statistics				
Choices		2400	2400	2400
Log-likelihood		-2306	-2227	-2456
Parameters		12	12	12
AIC/N		1.931	1.866	2.056

Note: Numbers in parentheses are standard errors; * statistically significant at the 0.05 level or lower.

Table A5: Estimates from the MXL Model in WTP-Space, Pork Chops

		Control	Basic Information	Benefits to the Farmers
Alternative Specific Constants				
Conventional				
	mean	5.20*(0.17)	3.14*(0.05)	4.20*(0.16)
	St. Dev	2.16*(0.15)	4.55*(0.04)	1.22*(0.13)
Organic				
	mean	5.48*(0.25)	4.95*(0.05)	3.81*(0.22)
	St. Dev	2.84*(0.26)	3.41*(0.04)	2.28*(0.24)
Non-GMO				
	mean	5.78*(0.25)	4.46*(0.04)	3.62*(0.22)
	St. Dev	3.29*(0.29)	1.18*(0.02)	2.23*(0.25)
GMO				
	mean	3.43*(0.20)	2.26*(0.04)	1.65*(0.26)
	St. Dev	1.90*(0.24)	1.83*(0.03)	0.93*(0.22)
Gene-Editing				
	mean	2.94*(0.19)	1.58*(0.05)	1.89*(0.18)
	St. Dev	0.70*(0.17)	0.14*(0.04)	1.90*(0.14)
Price				
	mean	-1.91*	-7.51*	-1.96*
	St. Dev	1.91*	7.51*	1.96*
ERC				
	St. Dev	1.95*	6.27*	2.18*
Model Statistics				
Choices		2400	2400	2388
Log-likelihood		-2290	-2542	-2168
Parameters		12	12	12
AIC/N		1.919	2.128	1.826

Note: Numbers in parentheses are standard errors; * statistically significant at the 0.05 level or lower.

Table A6: Estimates from the MXL Model in WTP-Space, Bacon

		Control	Basic Information	Benefits to the Farmers
Alternative Specific Constants				
Conventional				
	mean	6.69*(0.19)	6.56*(0.19)	6.19*(0.13)
	St. Dev	2.51*(0.17)	2.14*(0.15)	2.58*(0.20)
Organic				
	mean	7.60*(0.24)	7.90*(0.25)	7.58*(0.16)
	St. Dev	2.66*(0.18)	3.52*(0.26)	2.74*(0.18)
Non-GMO				
	mean	7.95*(0.21)	6.47*(0.28)	7.08*(0.21)
	St. Dev	2.35*(0.22)	3.35*(0.28)	2.90*(0.25)
GMO				
	mean	4.64*(0.28)	4.92*(0.20)	5.14*(0.16)
	St. Dev	2.27*(0.18)	1.33*(0.17)	1.05*(0.17)
Gene-Editing				
	mean	3.52*(0.41)	5.00*(0.15)	5.04*(0.15)
	St. Dev	3.34*(0.38)	0.46*(0.12)	1.98*(0.15)
Price				
	mean	-1.68*	-2.15*	-2.45*
	St. Dev	1.68*	2.15*	2.45*
ERC				
	St. Dev	3.18*	2.31*	1.89*
Model Statistics				
Choices		3012	2400	2400
Log-likelihood		-2907	-2197	-2164
Parameters		12	12	12
AIC/N		1.938	1.841	1.814

Note: Numbers in parentheses are standard errors; * statistically significant at the 0.05 level or lower.