Beef and Dairy Substitution Effects Associated with Carbon Labeling and an Information Intervention

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by

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Abstract

Understanding consumer perceptions of carbon emissions in agriculture is a critical step to help increase the sustainability of food consumption. According to the Food and Agriculture Organization of the United Nations, 14.5 percent of all global anthropogenic GHG emissions are estimated to be represented by livestock (FAO), and cattle, raised for beef and milk, are the largest animal species responsible for emissions, comprising over 60 percent of the livestock sector's emissions. This motivates this study's analysis of beef and dairy milk products and alternatives. To better understand how consumers may substitute meat and milk products when provided with information about carbon emissions, two online surveys, one meat and one milk, were distributed to 1,240 U.S. meat consumers and 1,217 milk consumers. The objective of this study is to answer the questions: 1) does a food label that provides estimates of carbon emissions cause substitution effects across products within the categories of meat and milk, and 2) does an information intervention about carbon emissions associated with agricultural production nudge consumers to make carbon-reducing food choices. The study also aims to discover which GHG-reducing mechanisms consumers perceive as most effective and least effective in agriculture. The results of this study are important for producers, consumers, policymakers, and other agriculturalists paving the way towards a more sustainable future so that agriculture can evolve to feed a growing global population. Findings reveal that a carbon label does cause substitution effects across provided meat and milk products and that the information intervention has less effect. Furthermore, respondents favored "carrot" GHG-reducing mechanisms - corporate incentive and government subsidy - more than "stick" mechanisms of corporate regulation and government tax. Ultimately, this study contributes to a deepened understanding of consumer

preferences for beef and dairy and substitutes in the meat and milk categories (including plant-based options).

Acknowledgments

Completion of this project is not an individual accomplishment but is attributed to the contributions and support of many individuals. I would like to express sincere gratitude to Dr. Brandon McFadden for your guidance on this project. Thank you for the time, energy, and thoughtfulness you have devoted to investing in me and making me a stronger critical thinker, communicator, and learner. Thank you to Dr. Lanier Nalley for encouraging me to pursue this graduate program and for shaping my passion for agricultural economics. I am grateful for your mentorship, advice, and the way you have inspired me to think critically and have a global mindset in all I do. Thank you to Dr. Aaron Shew for creating this project idea and for guiding me throughout the survey development process. Thank you to Wei Yang for your insight and input throughout the entirety of this project. Thank you to Dr. Alvaro Durand-Morat for your support and wisdom throughout this project and throughout graduate school. I am inspired by your faith and passion. Thank you to Dr. Rudy Nayga for helping bring this project concept to life and for refining the scope of this work. Thank you all for your willingness to serve on my thesis committee. Thank you to the Tyson Endowment for funding this endeavor.

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I would like to thank my fellow graduate students for your friendship and comradery throughout graduate school. Special thank you to Alexis Skinner. I am so thankful graduate school brought me a best friend like you.

Dedication

I dedicate this work to my parents who are unwaveringly supportive, encouraging, and loving. Dad, thank you for instilling in me a sense of insatiable curiosity and love for learning. Mom, thank you for pushing me beyond what I perceive myself to be capable of doing and for motivating me along the way. Thank you both for teaching me that the world is greater than self. Thank you for igniting in me the desire to utilize my life to serve others and make a positive difference.

Lastly, I dedicate this work to my husband, John Nolen. Thank you for being by my side and dreaming big with me. Thank you for making my dreams yours too. Thank you for believing in me and inspiring me to pour my whole heart into all I do. Thank you for helping us achieve our goals. I am excited for our future together.

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1. Introduction

This study was motivated by the negative externalities associated with greenhouse gas emissions (GHG), gases that trap heat in the atmosphere (EPA 2023), as the environmental impact of food choices is an increasing concern for consumers (Briggeman and Lusk, 2011). While previous studies have analyzed the potential of GHG emissions reductions for meat (de Vries and de Boer 2010, Heller and Keoleian 2018) and dairy products (Winans et al. 2019), questions remain regarding the substitution effects associated with shifts in consumption. Without analyzing substitution effects and accounting for shifts in consumption, carbon emission reduction estimates may be misleading. Thus, this study aims to build upon prior research to fill this gap by analyzing the substitution effects of beef and dairy milk consumption regarding carbon labeling and an information intervention and focusing specifically on how providing a carbon label affects beef and dairy milk market shares.

The idea for this study was spurred by the work of a prior study (McFadden et al. 2022) that analyzed the GHG emissions mitigation approach of persuading individuals toward reducing behaviors related to high emissions. Whereas their study evaluated consumer choice relative to the elimination of beef consumption or limiting vehicle use, this study evaluates consumer choice relative to the substitution effects of beef and dairy milk consumption. Further inspiration was derived from a study analyzing dairy milk consumption and plant-based beverage substitutes (Wolf et al. 2020). Their study assessed which consumers substitute dairy for plant-based beverages, and this study furthers this idea by analyzing how carbon labeling and an information intervention impact these substitution effects.

2. Background

While agriculture is often targeted as a major contributor to GHG emissions, U.S. agriculture only accounts for 10% of the nation's total GHG emissions (EPA 2023) - significantly less than transportation (28%), electric power (25%), industry (23%), and commercial & residential (13%) sectors - and actively takes part in enhancing wildlife and absorbing carbon (American Farm Bureau Federation n.d.). Agricultural emissions come from livestock, soils, and rice production (EPA 2023). However, the industry's potential to reduce emissions from a producer and consumer standpoint motivates this study. Primary reduction opportunities for agricultural emissions include land and crop management, livestock management, and manure management. The agriculture industry is playing a key role in reducing GHG emissions due to the industry's unique position to promote environmental stewardship and enhance sustainable production (NIFA). GHG emissions related to agriculture and focused on cattle have resulted in calls to reduce the consumption of cattle-based products, but emission reduction estimates may be overstated without accounting for substitution effects.

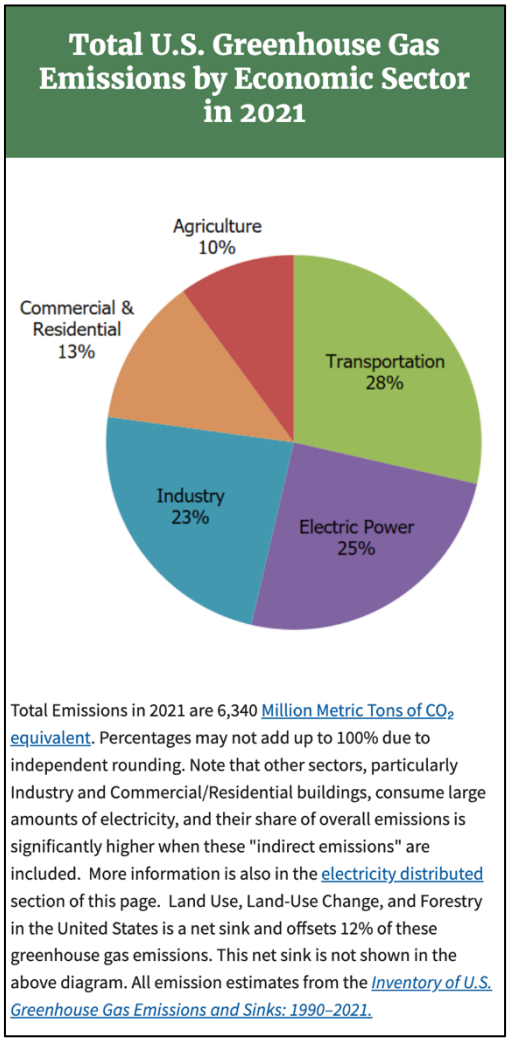

Figure 1. Total U.S. GHG Emissions by Economic Sector in 2021, Retrieved from EPA

According to the Food and Agriculture Organization of the United Nations, 14.5 percent of all global anthropogenic GHG emissions are estimated to be represented by livestock (FAO

2013). Cattle, raised for beef and milk, are the largest animal species responsible for emissions, comprising over 60 percent of the livestock sector's emissions. The two primary sources of emissions are feed production and processing (45 percent of total emissions) and enteric fermentation from ruminants (39 percent of total emissions). Ten percent is attributed to manure storage and processing, and the rest is represented by the processing and transportation of animal products (FAO 2013). Of all livestock emissions, 44 percent are in the form of methane (CH4), 29 percent are in the form of nitrous oxide (N2O), and 27 percent are in the form of carbon dioxide (CO_2). Most of the livestock sector's emissions are attributed to the production of beef (41 percent) and cattle milk (20 percent) which motivates the analysis of beef and dairy milk products and alternatives in this study.

Quantifying the sustainability of beef presents challenges due to the complexity of the supply chain associated with production (Rotz et al. 2019). In 2019, a team led by the USDA Agricultural Research Service (ARS) quantified U.S. beef cattle production's resource use and environmental impact through a comprehensive life-cycle analysis. Through analyzing different types of cattle operations over five years and throughout seven cattle-producing regions, the analysis sought to establish baseline measures for the U.S. beef industry to improve its environmental impact and sustainability. Furthermore, the purpose was to systematically measure the use of inputs - such as fuel, feed, forage, electricity, water, and fertilizer – to raise beef cattle throughout their entire lifecycle. The study utilized data from 2,270 survey responses and site visits to determine U.S. beef cattle production's life cycle environmental impacts. ARS identified two primary areas for improvement: 1) water use and 2) reactive nitrogen losses. The study found the average annual GHG emissions associated with beef cattle production over the past five years to be 243±26 Tg carbon dioxide equivalent (CO_2e). CO_2e refers to the amount of

carbon emissions with the same impact as one unit of another GHG (EPA n.d.). The reality of an increasing population and predictions of increases in per capita meat consumption globally (Alexandratos and Bruinsma, 2012) illustrate the potential for the U.S. beef industry's increased productivity from environmental, economic, and social sustainability standpoints (Rotz et al. 2019).

Plant-based options have developed as alternatives throughout the food industry, and this study focuses on those in the meat and milk realms. As consumer demands have changed, alternatives have arisen to meet evolving wants and needs. Globally, the plant-based meat market is projected to reach $85 billion by 2030, up from $4.6 billion in 2018 (Gordon et al., 2019). Plant-based meats advertise the benefits of meat consumption without the environmental impacts (Santo et al. 2020, Lim and Nayga n.d.). This study focuses on the plant-based burger as an alternative, also known as a Beyond Burger or an Impossible Burger, which is considered functionally and nutritionally comparable to beef (Heller and Keoleian 2018). From a milk standpoint, plant-based alternatives such as oat, soy, and almond milk have developed to address problems such as cow milk allergy and lactose intolerance (Sethi et al. 2016).

Through a review of twenty-five peer-reviewed studies, de Vries and De Boer (2010) assessed the environmental impacts of livestock products and alternatives. Using their research, our study identified the following emissions values for one pound of each product: 10.43 kg CO_2e for beef, 2.40 kg CO_2e for chicken, and 3.15 kg CO_2e for pork. Another study by Heller and Keoleian (2018) conducted a life cycle analysis (LCA) of the Beyond Burger, a plant-based patty, to find that per one pound of the plant-based burger, 1.60 kg of CO_2e is emitted. Further explanation of these analyses can be found in the methods section of this paper.

A study from Winans et al. (2019) included a life cycle assessment to analyze the environmental footprints of dairy milk and plant-based alternatives. Based on this analysis, our study identified the following emissions values per half gallon of each product: 2.42 kg CO_2e for dairy milk, 0.61 kg CO_2e for almond, 0.97 kg CO_2e for soy milk, and 0.72 kg CO_2e for oat milk. More details on these calculations can be found in the methods section of this paper.

Nudging has been demonstrated to be a potentially valuable technique in encouraging consumers toward environmentally-friendly purchases (Vandenbreole et al. 2019). The authors define nudging as aiming "to change people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" while leveraging the customer's freedom of choice rather than enforcing regulations. Labeling is one form of a cognitively oriented intervention, or nudge, to influence consumer behavior by gaining their attention and eliciting emotional and behavioral responses (Vandenbreole et al. 2019). Carbon labeling is one form of such.

Asioli et al. identify four contributions provided by sustainability-related labels, including the following: 1) Labels provide consumers with information that they otherwise may not have; 2) Labels provide consumers with information in an understandable, comprehensible format; 3) Labels are opportunities to build consumer trust through provision of accurate and understandable information; and 4) Labels can empower consumers by enabling them to express their valuation of product characteristics (Asioli et al. 2020)

Carbon labeling has emerged as an instrument to motivate GHG emission reductions (Liu et al. 2016). The world's first carbon label initiative, the Carbon Reduction Label, was introduced by the Carbon Trust in the United Kingdom in 2006. This has led to developing

conversations and standards in other countries such as the United States, Japan, France, Canada, and Switzerland.

Previous literature suggests positive preferences for a carbon label (Van Loo et al. 2014). This study analyzes consumer perception of a carbon label within the context of the choice experiment. Wolfson highlighted that climate-impact menu labels may promote sustainable food choices within the context of a restaurant (Wolfson et al. 2022), and this study seeks to analyze this concept in a supermarket setting. Literature highlights the role supermarkets play in facilitating sustainable decision-making (Bauer et al. 2022), thus, the context of this choice experiment is in a supermarket setting. Due to their high volume, grocery products are a key contributor to emissions and have become a focus for behavior change efforts (Sharp and Wheeler 2013).

Educating consumers on agricultural sustainability must be a priority so that consumers understand producer efforts. The intrinsic biological processes associated with agricultural production have the potential to reduce significantly more emissions than they produce (NALC 2022) through carbon sequestration and emissions reduction. Carbon dioxide can either be removed through the process of "carbon sequestration," or it can be prevented or decreased at the source through "emissions reduction" practices such as clean energy production including wind, solar, hydro, and biofuels.

Producer-focused sustainability efforts focused on reducing emissions can be communicated to consumers via supermarket advertising or food packaging. The American Farm Bureau Federation articulates the story of sustainability in agriculture by explaining that sustainability and efficiency on the farm are indispensable to one another. Innovation and technology empower farmers to do more with less through smarter farm equipment, precision ag

tools, and biotechnology. These advancements help farmers care for their crops while using less resources such as water, fertilizer, and pesticides (AFBF). With a rise in farm efficiency comes a decrease in emissions. An array of mitigation efforts is being utilized to reduce emissions in agriculture. Carbon markets, renewable energy, and research and innovation are examples of these efforts.

USDA supports various approaches to estimate and mitigate GHG emissions from agriculture and forestry. According to USDA, agriculture and forestry are uniquely positioned to contribute to the limitation of the build-up of GHGs in the atmosphere. Through conservation and land management, emissions of carbon dioxide, methane, and nitrous oxide can be reduced; the amount of carbon stored in soils and above-ground vegetation may increase; and renewable fuels can be generated that recycle CO_2 from the atmosphere (USDA). In addition to agricultural production GHG mitigation efforts, sustainability-related food labels have also developed to inform consumers of the environmental impact of food purchasing (Asioli et al. 2020).

As policies are developed and decisions are made – such as carbon labeling or carbon markets - involving agricultural sustainability, farmers and ranchers must be at the forefront. The ability of farmers and ranchers to innovate and overcome challenges must be upheld. Farmers for a Sustainable Future is a coalition comprised of 22 organizations representing U.S. farmers and ranchers who are committed to sustainability producing the world's food, feed, and fiber supply. From promoting soil health to conserving water, enhancing wildlife, efficiently using nutrients, and caring for their animals, farmers and ranchers are leading the way toward a sustainable future. According to the coalition, U.S. agriculture would have needed almost 1 million more acres in 1990 to meet 2018 production levels. Information such as this can be creatively

communicated to consumers through supermarkets where the producer's product becomes the consumer's purchase.

In addition to communicating information about agricultural sustainability, beef-focused sustainability efforts should also be advocated to consumers to ensure informed decision-making. From a beef perspective, the U.S. industry has emphasized a heightened focus on sustainability demonstrated through goal setting. In April 2022, The U.S. Roundtable for Sustainable Beef announced sustainability goals for the U.S. beef supply chain. The six priority areas include "air and GHG emissions, land resources, water resources, employee safety and well-being, animal health and well-being, and efficiency and yield." The association has pledged for the U.S. beef supply chain to achieve climate neutrality by 2040. In addition to the U.S. beef industry's commitment to sustainability, the U.S. dairy industry also recognizes its importance (USRSB n.d.). According to the National Cattlemen's Beef Association, through sustainability efforts and resource stewardship, the U.S. beef industry has decreased emissions per pound of beef by over 40% and produced over 60% more beef per animal (NCBA 2023). U.S. beef producers are global leaders in sustainable production, having the lowest GHG emissions footprint of all beef-producing countries (FAO 2006). Furthermore, dairy-related sustainability efforts should also be communicated to consumers.

According to the International Dairy Foods Association, the U.S. dairy industry has committed to environmental stewardship goals including GHG neutrality, optimization of water use, and improved water quality by 2050 (IDFA n.d.). Through technological investment in product innovation, the industry is investing in sustainability so that dairy's environmental footprint may be further reduced and the use of resources may be optimized. The Innovation Center for U.S. Dairy, a forum that brings together industry stakeholders to align on shared

social responsibility priorities, has established three specific goals to help shape a sustainable future including: 1) Achieve GHG neutrality; 2) Optimize water use while maximizing recycling; and 3) Improve water quality by optimizing utilization of manure and nutrients (IDFA n.d.).

This study assesses consumer preferences amongst beef and dairy substitutes regarding substitution effects associated with carbon labeling and an information intervention. Two surveys, one meat and one milk, were distributed to 2,457 U.S. consumers, reflecting 1,240 meat consumers and 1,217 milk consumers. The study aims to identify the substitution effects associated with meat and milk consumer preferences and potential focus areas for future related research. The meat choice experiment consists of beef, chicken, pork, and plant-based burger products emphasizing beef substitution effects; the milk choice experiment includes dairy milk, almond milk, oat milk, and soymilk products emphasizing dairy milk substitution effects. The study seeks to understand which GHG-reducing mechanisms consumers perceive as most effective and least effective in agriculture. The results of this study are important for producers, consumers, policymakers, and other agriculturalists paving the way towards an increasingly sustainable future so that agriculture can evolve and adapt to feed a growing global population.

The paper is organized as follows. First, the Methodology section describes survey data collection, study hypotheses, and how the data were analyzed to test the hypotheses. Then, the Results section discusses key findings for meat and milk products and substitution effects related to carbon labeling and the information intervention. Lastly, the Conclusions section summarizes the findings and highlights pathways for future research.

3. Methodology

3.1. Survey Overview

To complete the objectives of this study, two surveys were distributed to online respondent panels. In one survey, respondents completed a meat substitute survey that included a choice experiment for products in the meat category (i.e., beef, chicken, pork, or plant-based), and respondents in the other survey completed a milk substitute survey that included a choice experiment for products in the milk category (i.e., dairy, oat, soy, and almond). The meat survey collected data from 1,240 respondents and the milk survey collected data from 1,217 respondents. The surveys were designed and administered online via Qualtrics between November 18 and December 13, 2022.

After consenting to participate in the survey, respondents answered several basic demographic questions used for a quota-based sampling approach to be representative of the U.S. population. Quotas were used for age, sex, education, income, and region of residence. Respondents were required to be 18 years or older and the main food purchaser in the household to complete the survey. Also, only respondents willing to consume all products presented in each choice experiment (beef, chicken, pork, and plant-based burger in the meat survey; dairy milk, oat milk, soy milk, and almond milk in the milk survey) were permitted to complete the survey. This was done to narrow the sample of respondents to consumers who would consume the products included in the survey.

Respondents then completed a choice experiment with meat or milk substitutes consisting of eight questions (more details in Section *#2. "Choice Experiment Details"* below) to estimate substitution effects for beef and dairy milk. Then, respondents answered a series of questions about the most effective/least effective GHG-reducing mechanisms (more details in Section *#.5*

Most Effective/Least Effective Question Details below) to better understand which mechanisms consumers perceive to be most effective/least effective in reducing carbon emissions in agriculture. The survey concluded with a series of food purchasing questions and final demographics. The survey flow is displayed in Figure 2 below.

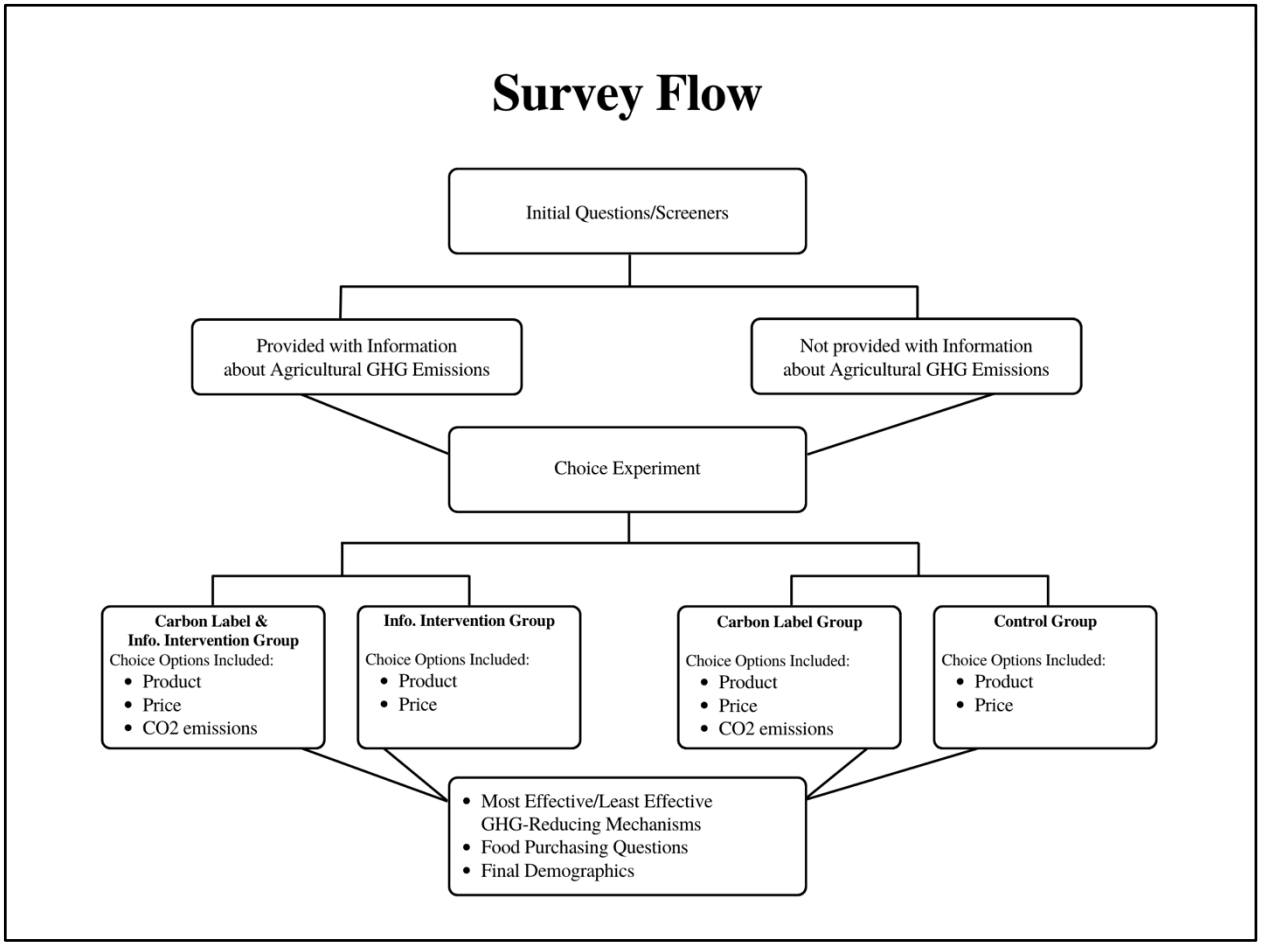

Figure 2. Survey Flow

The following subsections discuss the details of the survey design including the choice experiment (Subsection 2), experimental groupings (Subsection 3), calculation of carbon emissions (Subsection 4), most effective/least effective GHG-reducing emissions questions (Subsection 5), and food purchasing questions and final demographics (Subsection 6). The final

subsections articulate the hypotheses of this study (Subsection 6) and data analyses performed to evaluate research findings (Subsection 7).

3.2. Choice Experiment Details

The choice experiment consisted of eight questions, each asking "Which product would you choose to purchase?" Each question included five choice options: the four meat or milk products previously described and an "I would not purchase any of these" option. All respondents were presented with the products and product prices, and some were randomized to experimental groups (more information about the experimental groups is provided in Subsection 3). For the meat survey, the product unit was one pound, and the product unit for the milk survey was a half-gallon. Price levels were determined using U.S. Bureau of Labor Statistics 2021 Consumer Price Index (CPI) average price data along with actual market prices averaged from major retailers, and prices varied across products to be balanced and orthogonal so that no product had a higher or lower average price for the eight questions. Price levels were determined to be $2, $5, $8, and $11 for meat and $2, $3, $4, and $5 for milk.

Before respondents viewed the eight questions in the choice experiment, they were provided with a "cheap talk" script, shown in Figure 3 below, containing information about making hypothetical purchasing decisions. Cheap talk, the process of explaining hypothetical bias to individuals before asking a valuation question (Lusk 2003), was included to decrease the influence of hypothetical bias. Cummings and Taylor (1999) define hypothetical bias as "…the difference that we continually see in the way people respond to hypothetical referenda as compared to real referenda." Thus, the cheap talk script was included to reduce this bias and reflect consumers' decisions in a supermarket setting. After receiving the cheap talk script,

respondents were asked to choose which hypothetical meat/milk they would purchase from the provided choice set. Examples of these choice profiles are below in Figures 5-8 within Section *#3. Experimental Group Details.*

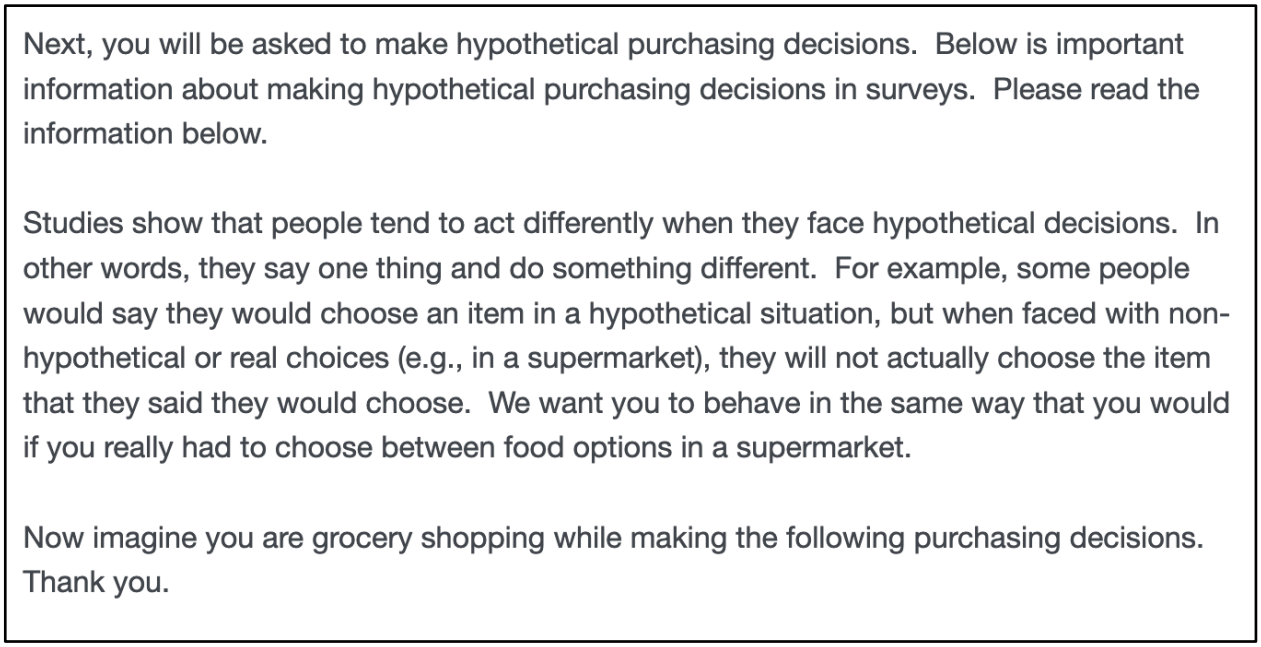

Figure 3. Hypothetical Purchasing Decisions Information

3.3. Experimental Group Details

In each survey, respondents were randomized across two experiments: an information intervention and a carbon label. Respondents were assigned to one of four groups: 1) Control, 2) Carbon Label, 3) Information Intervention, and 4) Carbon Label and Information Intervention. Table 1 lists each of the four groups and the information received. The meat and milk surveys began with a series of questions and screeners seen by all respondents. Then, respondents were split into two groups. Approximately half of the respondents were presented with information about agricultural GHG emissions (more details about the information intervention are provided

below). Table 1 below displays the four respondent groups and the information they received within the survey.

Table 1. Respondent Groups and Corresponding Information Received

Group	**Information Received**
Carbon Label and Information Intervention	• Information Intervention • Product • Price • Carbon emissions
Information Intervention	• Information Intervention • Product • Price
Carbon Label	• Product • Price • Carbon emissions
Control	• Product • Price

Figure 4 below shows the information intervention shown to respondents in the Carbon Label and Information Intervention group and Information Intervention group. This information was sourced from the Environmental Protection Agency website and was included to provide respondents with an overview of GHG emissions in agriculture. Since the development of the survey, this pie chart has been updated to include 2021 information. The updated information can be found in this paper's "Introduction and Literature Review" section.

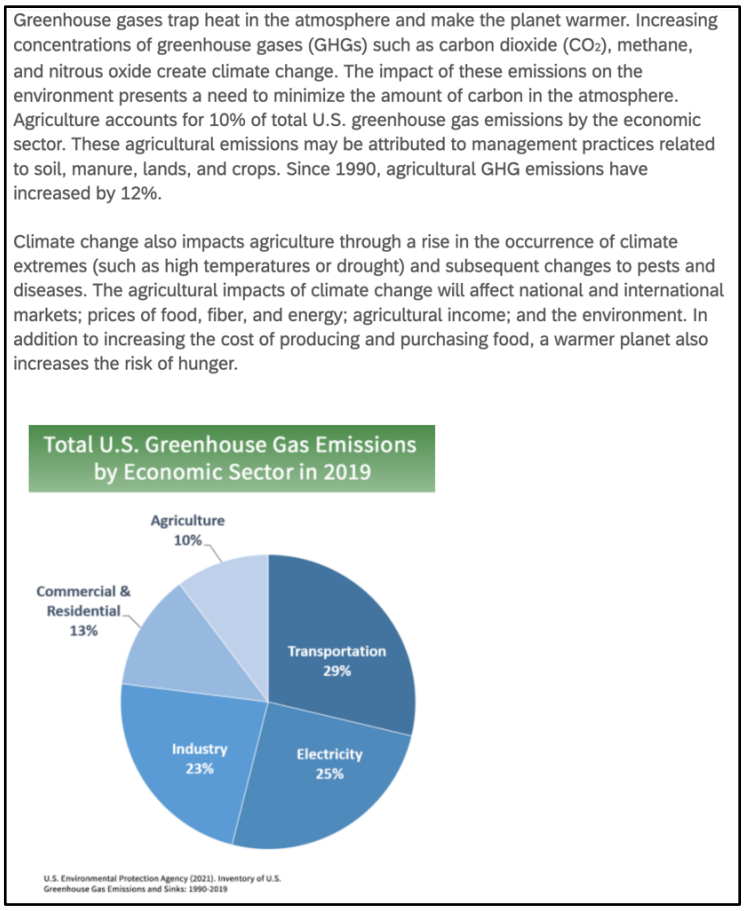

Figure 4. Information Intervention

The figures below display examples of the choice profiles shown to each experimental group. Figure 5 is an example of the meat choice profile seen by respondents in the Control and the Information Intervention groups. The product details included product and price. Neither of these two groups was provided with information about product carbon emissions in the choice experiment. Figure 6 is an example of the meat choice profile seen by respondents in the Carbon Label and Carbon Label & Information Intervention groups. Both groups were provided with product, price, and carbon emissions information.

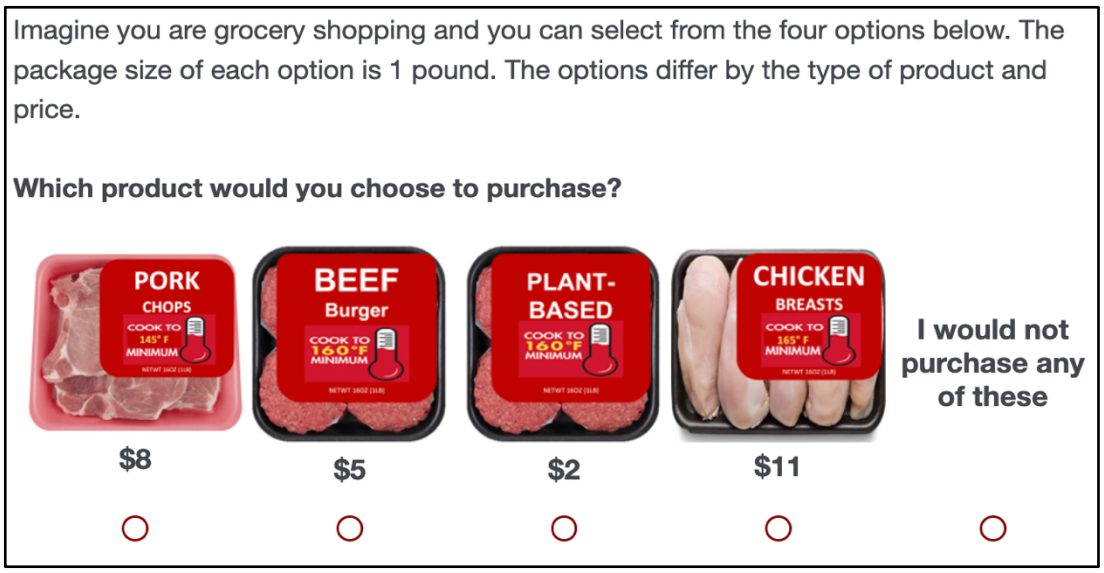

Figure 5. Example of Meat Choice Profile without Emissions

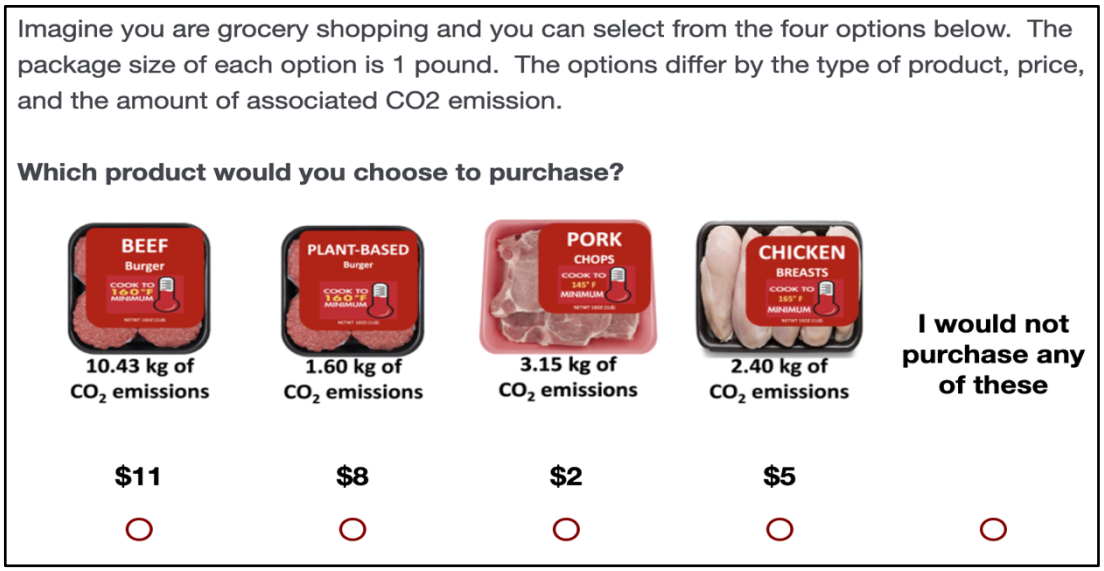

Figure 6. Example of Meat Choice Profile with Emissions

Figure 7 is an example of the milk choice profile seen by respondents in the Control and Information Intervention groups. The provided information included product and price. Neither of these two groups was provided with carbon emissions information. Figure 8 is an example of the milk choice profile seen by respondents in the Carbon Label and Carbon Label & Information Intervention groups. Both groups were provided with product, price, and carbon emissions information.

Figure 7. Example of Beverage Choice Profile without Emissions

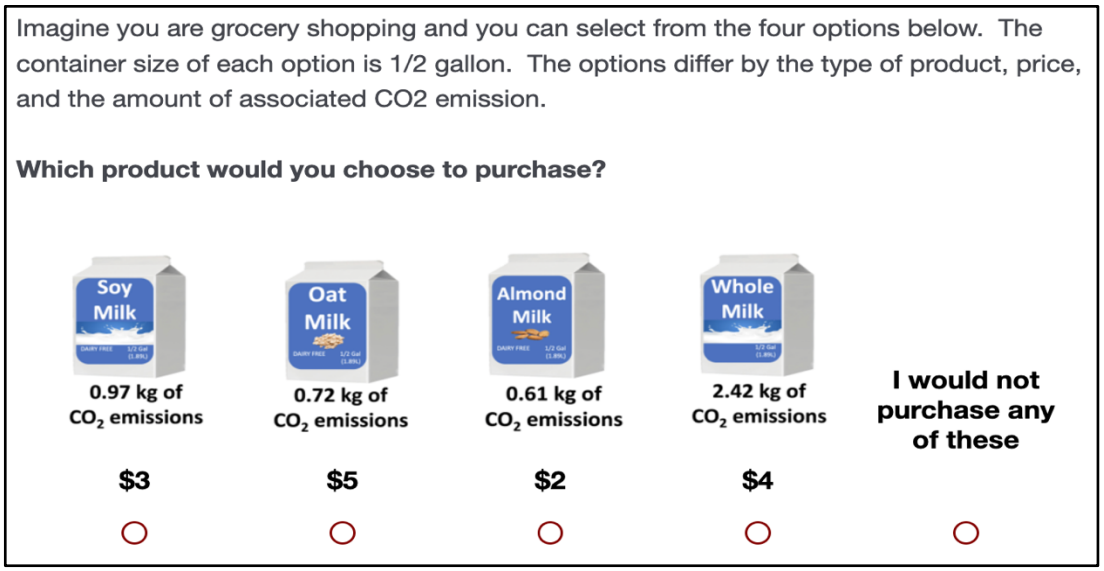

Figure 8. Example of Beverage Choice Profile with Emissions

3.4 Carbon Emissions Calculation Details

Emission estimates for beef, chicken, and pork were obtained from de Vries and de Boer (2010) and are shown in Table 2. These authors compared assessments of the environmental impact of livestock products by analyzing twenty-five peer-reviewed studies that used a LCA to evaluate the impact of pork, chicken, beef, milk, and eggs. LCA is a holistic method of analyzing

a product's environmental impact during its life cycle (de Vries and de Boer 2010). The study found the production of 1 kg of pork resulted in 3.9-10 $kgCO_2e$, 1 kg of chicken resulted in 3.7-6.9 $kgCO_2e$, and 1 kg of beef resulted in 14-32 $kgCO_2e$ (de Vries and de Boer 2010). For our study, each meat type's emission was calculated by taking the midpoints of the estimates from the de Vries and de Boer study and then converting the units from kgs to lbs to obtain the unit for our research, $kgCO_2e$ per lb. For example, the midpoint was 23 $kgCO_2e$ per kg of beef ((14+32)/2). We multiplied 23*0.45 (the number of kg/lb) to find 10.43 $kgCO_2e$ per lb of beef. Following the same calculations, we estimated 2.40 $kgCO_2e$ per lb of chicken and 3.15 $kgCO_2e$ per lb of pork (see Table 2).

Emission estimates were obtained from Heller and Keoleian's (2018) assessment for plant-based meat. In their study, they conducted an LCA of the Beyond Burger, a plant-based $mkgCO_2$ per 4oz. This was multiplied by 4 to find that per 16oz, or 1 lb, of plant-based burger, 1.60 $kgCO_2$ is emitted (see Table 2).

Table 2. Beef & Beef Substitutes – Carbon Emissions

Product	***$kgCO_2e$ per lb of meat***
Beef	10.43
Chicken	2.40
Pork	3.15
Plant-Based Burger	1.60

Note: Emissions for beef, chicken, and pork were calculated by finding midpoints of estimates from Vries and de Boer (2010) and converting to kgCO2e per lb of meat. For plant-based meat, Heller and Keoleian's (2018) estimate was utilized and converted to $kgCO_2e$ per lb of meat.

Carbon emissions data for beef, chicken, and pork products were pulled from the meta-analysis (de Vries and de Boer 2010). The meta-analysis provided estimates for beef emissions from three studies (Williams et al. 2006, Casey and Holden 2006, Cederberg and Darelius 2002);

estimates for chicken emissions from two studies (Williams et al. 2006, Katajajuuri 2008); and estimates for pork emissions from five studies (Zhu-XueQin and Van Ierland 2004, Basset-Mens and Van der Werf 2005, Williams et al. 2006, Cederberg and Darelius 2002, and Blonk et al. 1997). CO_2 emission data for plant-based burgers were pulled from meta-analysis (Heller and Keoleian 2018) that provided one estimate for plant-based emissions.

Emission estimates for all four milk products – dairy, almond, soy, and oat – were obtained from Winans et al. (2019) and are shown in Table 3. Their study used an LCA to calculate the environmental impacts of dairy milk and plant-based alternatives. For our study, each milk type's emission was calculated by averaging the total estimates from the Winans et al. study and then converting the estimates to $kgCO_2e$ per half gallon of milk. Because 48 oz is .375 of one gallon of milk, or 128 ounces, each average was multiplied by 0.5/0.375 to convert the values into $kgCO_2e$ per half gallon of milk. The emissions estimates used in this survey were 2.42 $kgCO_2e$ per half gallon of dairy milk, 0.61 $kgCO_2e$ per half gallon of almond milk, 0.97 $kgCO_2e$ per half gallon of soy milk, and 0.72 $kgCO_2e$ per half gallon of oat milk (see Table 3).

Table 3. Milk and Milk Substitutes – Carbon Emissions

Product	***$kgCO_2e$ per half gallon of milk***
Dairy	2.42
Almond	0.61
Soy	0.97
Oat	0.72

Note: Emissions were calculated from averaging totals found by Winans *et al.* (2019) and converting to $kgCO_2e$ per half gallon of milk

Meta-analysis (Winans et al. 2019) was utilized to derive CO_2 emission data for milk products. The meta-analysis provided four estimates for almond milk emissions (Winans et al. 2019, Clune et al. 2017, Grant and Hick 2017, Henderson and Unnasch 2017); four estimates for

soymilk emissions (Clune et al. 2017, Grant and Hick 2017, Henderson and Unnasch 2017, Granarolo 2016); one estimate for oat milk emissions (Florén et al. 2013), and five estimates for dairy milk emissions (Clune et al. 2017, Florén et al. 2013, Grant and Hick et al. 2017, Henderson and Unnasch et al. 2017, Thoma et al. 2013)

3.5. Most Effective/Least Effective Question Details

After the choice experiment, the survey concluded with a series of most effective/least effective GHG-reducing mechanism questions (example shown in Figure 9 below), food purchasing questions, and final demographics. The figure below displays an example of a most effective/least effective GHG-reducing mechanism question. Respondents were given four options per question and asked to select which they considered the most effective and least effective for reducing GHG emissions from agriculture. This section consisted of six GHG-reducing mechanisms randomly presented two times each throughout three questions. Table 4 below defines the GHG-reducing mechanisms shown to respondents throughout the most effective/least effective GHG-reducing mechanisms question series.

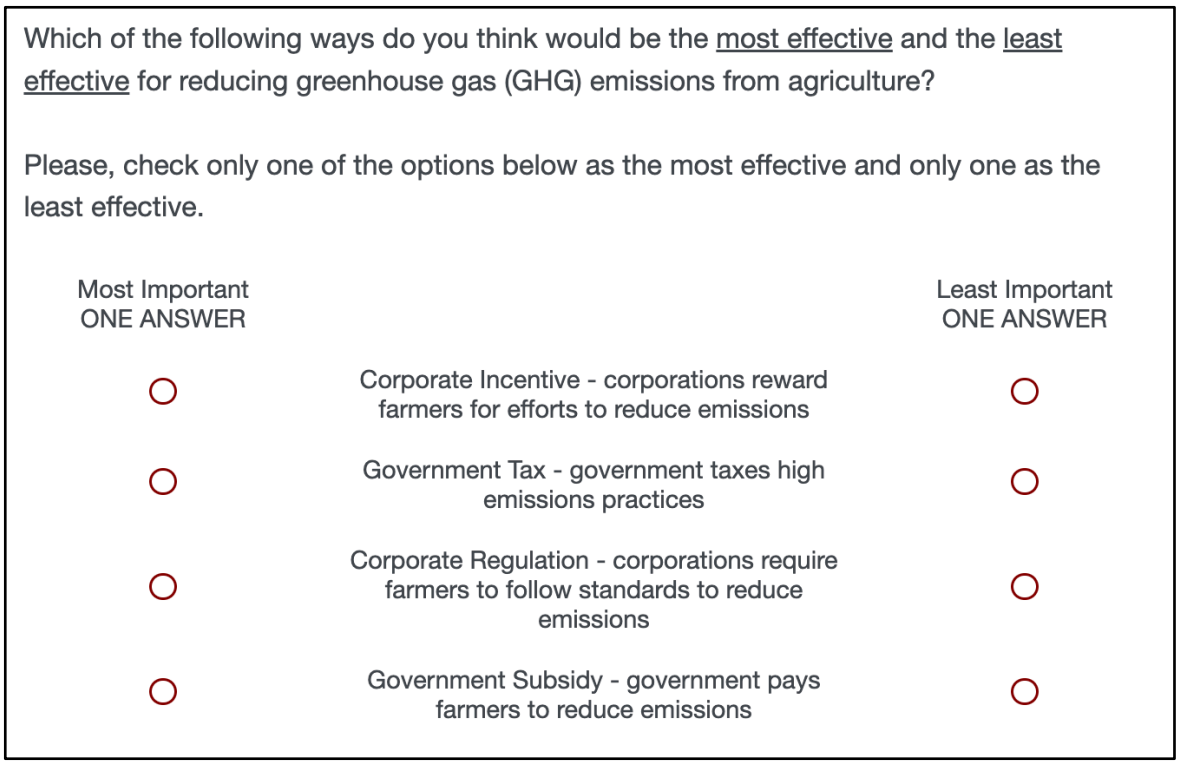

Figure 9. Example of Most Effective/Least Effective GHG Reducing Mechanisms Question

Table 4. GHG-Reducing Mechanisms Defined

Mechanism	***Definition***
Government Subsidy	government pays farmers to reduce emissions
Government Tax	government taxes high emissions practices
Corporate Incentive	corporations reward farmers for efforts to reduce emissions
Corporate Regulation	corporations require farmers to follow standards to reduce emissions
Farmer	farmer chooses to produce in a way that reduces emissions
Consumer	purchaser of food chooses to purchase in a way that reduces emissions

3.6. Food Purchasing Questions & Final Demographics Details

The series of food purchasing questions asked respondents how often they shop for food, purchase milk/meat products, and shop for food in numerous settings including hypermarkets/supermarkets, mini markets/convenience stores, farmer's markets, and online with home delivery. An example is shown below in Figure 10.

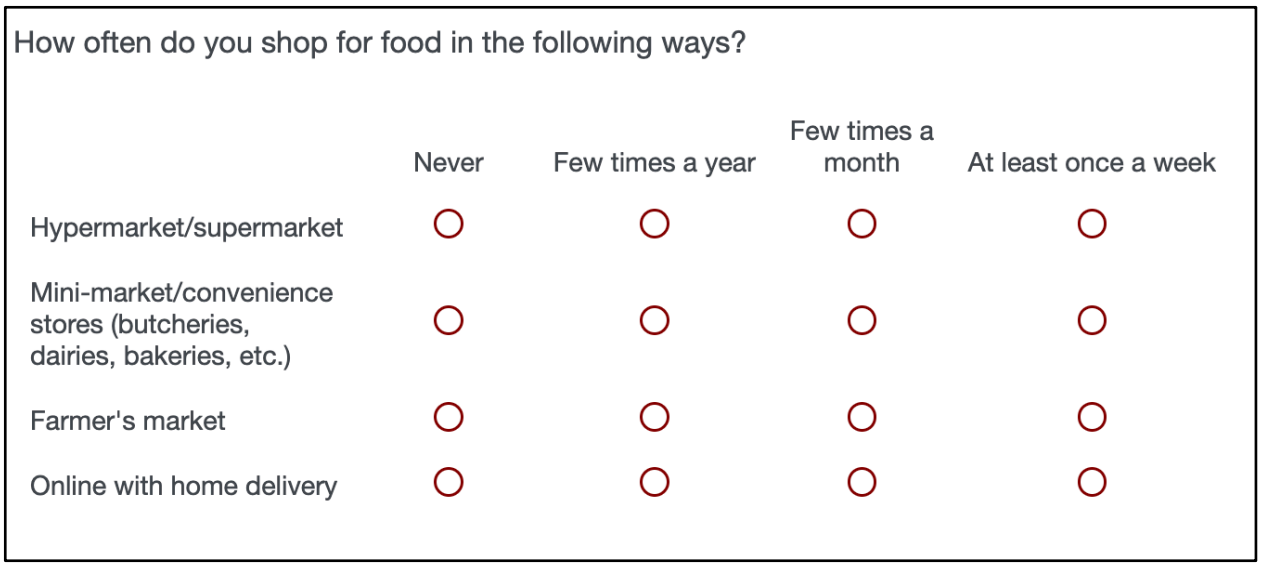

Figure 10. Example 1 of Food Purchasing Question

Respondents were also asked to indicate their level of agreement with three statements (example shown below in Figure 11):

1) "I often purchase food that was produced in an environmentally-friendly way."
2) "I feel it is a moral obligation to avoid wasting food (i.e., food that is not consumed and is wasted)."
3) "I feel that farmers care about the environment."

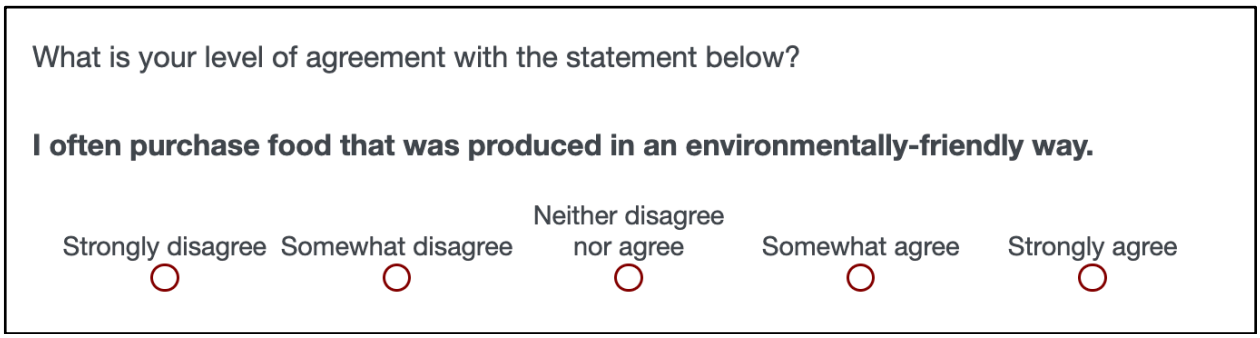

Figure 11. Example 2 of Food Purchasing Question

The final series of demographic questions asked respondents about their place of residence, marital status, number of children, and political affiliation.

3.7. Hypotheses

The experimental design allowed for the testing of the following hypotheses:

H1: Carbon labeling will result in higher substitution effects amongst meat and milk products – relative to the information intervention – due to the information being presented at the time of purchase and the consumer being intrinsically motivated to purchase products with lower emissions. Market share for beef and dairy milk will decrease because of the included products, they are the highest emitters of CO_2.

H2: The information intervention will result in lower substitution effects amongst meat and milk products – relative to carbon labeling – due to the information being presented before the time of purchase and being potentially forgotten or disregarded by the time of purchase.

H3: When comparing meat to milk, there will be higher substitution effects for meat due to the larger variance of carbon emissions amongst the four products (variance of 8.83 kg/lb of meat; variance of 1.81 kg/half gallon of milk).

3.8. Data Analyses

The data analysis in this study is like that of Van Loo et al. (2020). Random utility theory is consistent with discrete choice experiments (McFadden 1973). This framework accounts for the heterogeneity of preferences and assumes consumer *n* derives the following utility from choice alternative, *j:* $U_{nj} = V_{nj} + \varepsilon_{nj}$; where V_{nj} is the systematic component of the utility function, and ε_{nj} is the random or unobservable component. V_{nj} is defined as:

$$V_{njt} = \beta_j + \alpha Price_{njt} \quad (1)$$

where β_j is an alternative-specific constant indicating utility for alternative/product type *j* relative to the opt-out (no purchase) option, normalized to zero for identification purposes, α is the marginal utility of price, and $Price_{nj}$ is the price of alternative *j* faced by consumer *n. t* is representative of the choice set.

A random parameter logit (RPL) model was estimated to analyze the data. The RPL considers the taste variation (for this study, across various meat/milk product types) amongst consumers. The alternative specific constants were identified as random following a normal distribution as a result of the expectation that individuals can exhibit either positive or negative values/preferences for the meat/milk products. The price coefficient is assumed to follow a log-normal distribution. The utilization of a log-normal distribution has been supported by various authors (Caputo and Scarpa 2022) attributing its one-sided distribution that achieves the required negative value and specifies the price variable as negative.

In the RPL, the unconditional choice probabilities of consumer n choosing alternative *j* are expressed as follows:

$$P_{nj} = \int \prod_t^T \frac{e^{\beta'_n x_{njt}}}{\sum_k^J e^{\beta'_n x_{nkt}}} f(\beta_n) d\beta_n \quad (2)$$

Where β_n is the estimated parameter vector for consumer n and *x* is the variable vector. Based on the RPL estimates, the predicted conditional (conditional on not purchasing beef) and unconditional market share for each meat (milk) product or meat (milk) substitute were calculated following Lusk and Tonsor (2016) and Van Loo et al. (2020).

To examine the stability of the symbol effect on indirect utility, two mixed logistic regression model specifications were estimated using 500 Halton draws for each product (Train 2009), and can be specified by:

$$V_1 = ASC_{1j} + \zeta_{1j} P_j \quad (3)$$

$$V_2 = ASC_{2j} + \eta_j (LG_n * ASC_{2j}) + \zeta_2 P_j \quad (4)$$

Where ASC are alternative specific constants for the j^{th} choice option to be estimated, P_j is the price of the j^{th} choice option, and ζ are random coefficients distributed lognormal to relax the independence of irrelevant alternatives property possible in multinomial logistic regression models (Hensher, Rose, and Greene 2015). The main coefficient of interest is η in the second specification, which estimates the Carbon Label Group effect on each choice option. This allows us to test the null hypothesis that indirect utility is similar whether BE is disclosed using a symbol or text (i.e., H_0: $\eta_j \neq 0$). Standard errors were clustered to account for the panel nature of repeated choice decisions made by respondents.

Analysis for the most effective/least effective GHG-reducing mechanisms questions included a difference in proportions test that assessed which mechanisms – of government subsidy, government tax, corporate incentive, and corporate regulation – and which entities – of farmer and consumer – consumers perceived as most effective/least effective in reducing GHG emissions.

4. Results

4.1. Meat Results

Table 5 presents the mixed logistic regression results and analyzes whether there were any effects of the carbon label and information intervention for beef and beef substitutes. For the

carbon label, there were effects overall. For the information intervention, there were not. The carbon label reduced the selection of beef, pork, and chicken. Overall, including the interactions for the carbon label intervention (M2) improved model fit, while the interactions provided information about carbon emissions in agriculture (M3) did not improve model fit. Because the carbon label did have effects, further analysis will focus on this.

Table 5. Beef & Beef Substitutes – Mixed Logistic Regression Results

Product		***M1*** ***Value***	***M2*** ***Value***	***M3*** ***Value***
Beef	Mean Coeff.	4.703*	5.991*	4.852*
	Std. Dev.	2.085*	1.975*	2.066*
Chicken	Mean Coeff.	5.786*	6.541*	6.049*
	Std. Dev.	1.933*	1.984*	1.976*
Pork	Mean Coeff.	4.020*	4.826*	4.171*
	Std. Dev.	1.542*	1.596*	1.584*
Plant-based	Mean Coeff.	2.666*	2.905*	2.736*
	Std. Dev.	2.864*	2.872*	2.965*
Price	Mean of ln(Coeff.)	-1.384*	-1.412*	-1.404*
	Std. Dev.	1.051*	1.033*	1.045*
Beef*Carbon	Coeff.		-2.298*	
Chicken*Carbon	Coeff.		-1.165*	
Pork*Carbon	Coeff.		-1.285*	
Plant-based*Carbon	Coeff.		-0.189	
Beef*Info	Coeff.			-0.107
Chicken*Info	Coeff.			-0.307
Pork*Info	Coeff.			-0.135
Log Likelihood		-9643	-9552	-9613
Simultaneous test for interaction variables (X^2-stat)			-80.81*	2.65

Note: All models were estimated using 49,600 observations with standard errors clustered for 1,240 respondents. * denotes a p-value < 0.01. M1 refers to the overall model (alternative specific constant (ASC)), M2 refers to the interaction effects for the Carbon Label and ASC, and M3 refers to the interaction effects for the Information Intervention and ASC.

Table 6 compares unconditional market shares for beef and beef substitutes with and without carbon labeling. Carbon labeling decreased the market share for beef by 12% and increased the market share for plant-based meat by 6%. It increased the frequency of the "No choice" option by 3%. The decrease in the beef market share supports the initial hypothesis (H1) and previous research that the beef market share decreases likely as a result of beef emissions being the highest relative to beef substitutes. The increase in the plant-based market share is consistent with the understanding that this product emits the lowest amount of CO_2. The "No choice" market share increased by 3% which may be attributed to various reasons associated with uncertainty involving carbon emission information.

Table 6. Beef & Beef Substitutes – Contrast of Unconditional Market Shares

Product	***No Carbon Label***	***With Carbon Label***	***Difference*** *(With – No)*	***Contrast of Margins*** *(X^2-stat)*
Chicken	0.399	0.429	0.030	3.22
Beef	0.316	0.194	-0.122	72.41*
Pork	0.160	0.162	0.002	0.03
Plant-based	0.095	0.157	0.062	27.69*
No choice	0.030	0.058	0.028	18.53*

Note: * and denotes a *p*-values < 0.01.

Figures 12 and 13 display the unconditional market share for beef and beef substitutes 1) without a carbon label (Figure 12) and 2) with a carbon label (Figure 13). Unconditional market shares include the "beef" option and the beef substitutes presented to respondents to analyze the substitution preferences amongst beef/beef substitutes for consumers. When no carbon label is provided beef's market share is 32%, chicken 40%, pork 16%, plant-based 10%, and no choice 3%. Providing a carbon label results in different market shares of 13% less for beef, 3% more for chicken, no change for pork, 6% more for plant-based meat, and 3% more for no choice.

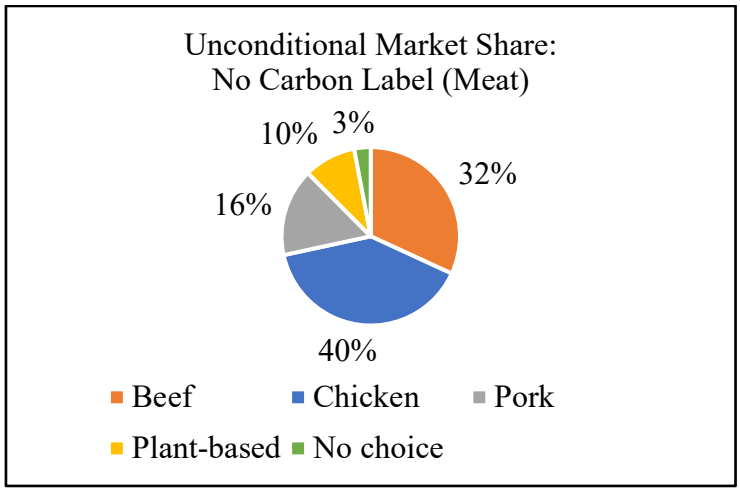

Figure 12. Unconditional Market Share: No Carbon Label (Meat)

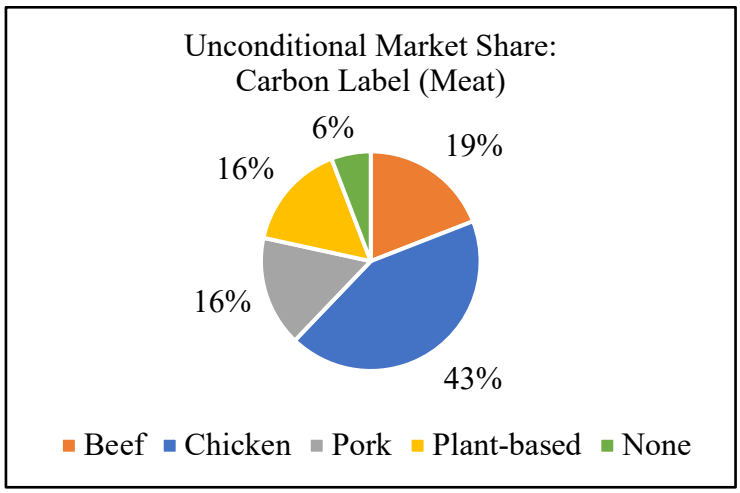

Figure 13. Unconditional Market Share: Carbon Label (Meat)

Figures 14 and 15 illustrate the conditional market share for beef and beef substitutes 1) without a carbon label (Figure 14) and 2) with a carbon label (Figure 15). Conditional market shares remove the "beef" option presented to survey respondents to simulate a beefless market and analyze the substitution preferences amongst beef substitutes for consumers. In the control condition, without a carbon label, the market share for chicken was 58%, pork 23%, plant-based 14%, and no choice 4%. Additionally, when a carbon label is provided, the market shares are

slightly different. The market share for chicken decreases by 5%, pork decreases by 3%, plant-based increases by 6%, and no choice increases by 3%.

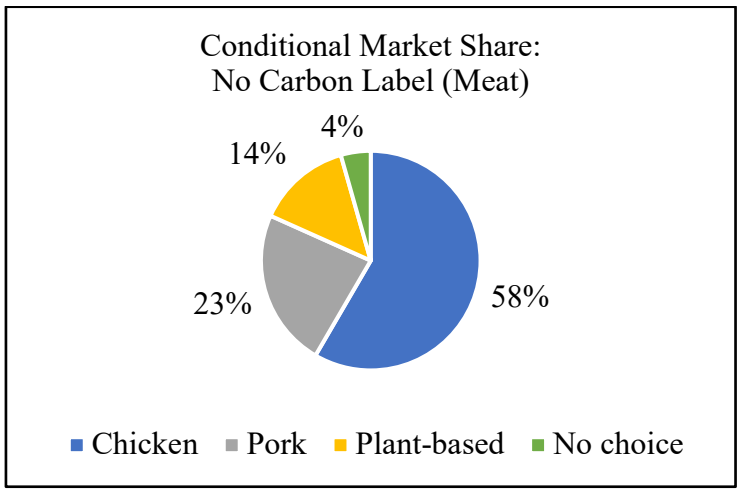

Figure 14. Conditional Market Share: No Carbon Label (Meat)

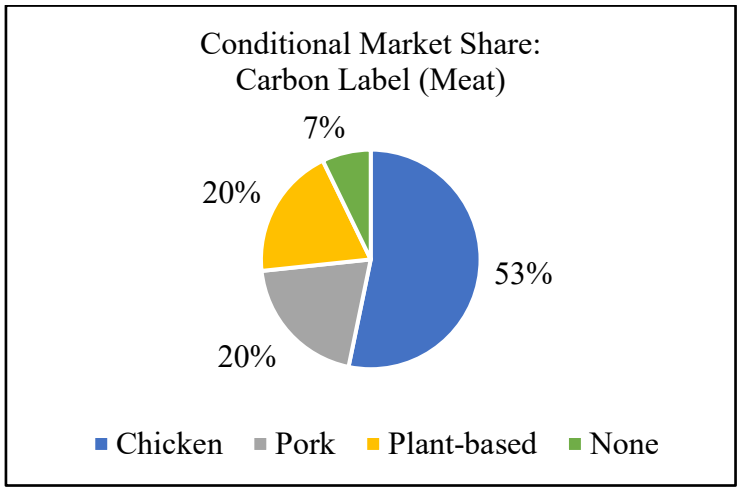

Figure 15. Conditional Market Share: Carbon Label (Meat)

As shown in Table 7, introducing a carbon label would decrease emissions by 22% (1- [3.818/4.910]). If beef were removed from the market without a carbon label, emissions would decrease by 52% (1- [2.358/4.910]). If there were a carbon label, removing beef from the market would decrease by 42% (1- [2.222/3.818]). If no beef was available on the market, introducing a

carbon label would only decrease emissions by 6% (1-[2.222/2.358]). However, the sole reduction in ground beef consumption does not equate this emissions reduction. Ground beef is one of many beef products, so while the results are likely directionally correct, the magnitude of the direction is possibly overstated due to the hypothetical nature of the survey and the complexities associated with meat production and emissions reductions. This consumer behavior highlights a sense of urgency for increasingly sustainable agricultural production.

Table 7. Beef & Beef Substitutes – Carbon Emissions Associated with Unconditional & Conditional Market Shares

		No Carbon Label		***With Carbon Label***	
Product	***CO_2 Emissions (kg/lb)***	***Unconditional***	***Conditional***	***Unconditional***	***Conditional***
Chicken	2.40	0.399	0.584	0.429	0.533
Beef	10.43	0.316		0.194	
Pork	3.15	0.160	0.233	0.162	0.201
Plant-based	1.60	0.095	0.139	0.157	0.195
No choice	-	0.030	0.044	0.058	0.072
Weighted CO_2 Emissions		4.910	2.358	3.818	2.222

Table 8 below shows the meat survey respondent participation relative to various demographic groups. No differences were present in the characteristics of respondents across groups.

Table 8. Meat Survey Demographics

	Control	***Carbon Label***	***Information Intervention***	***Carbon Label & Info. Intervention***
Gender				
Male	0.47	0.44	0.49	0.42
Female	0.52	0.55	0.50	0.57
Prefer not to say	0.01	0.01	0.01	0.01
Education				

Less than high school	0.04	0.01	0.02	0.03
High school/GED	0.25	0.23	0.22	0.23
Some college	0.24	0.25	0.23	0.21
2-Year College Degree (Associate)	0.10	0.16	0.12	0.14
4-Year College Degree (BA, BS)	0.26	0.25	0.26	0.25
Master's Degree	0.09	0.08	0.11	0.12
Doctoral Degree	0.02	0.02	0.02	0.02
Professional Degree	0.02	0.01	0.02	0.01
Prefer not to respond	-	0.01	-	-
Income				
Less than $ 15,000	0.11	0.09	0.09	0.09
$ 15,000 - 29,999	0.17	0.21	0.19	0.17
$ 30,000 - 44,999	0.20	0.14	0.16	0.18
$ 45,000 - 59,999	0.12	0.16	0.16	0.18
$ 60,000 - 74,999	0.11	0.09	0.10	0.11
$ 75,000 - 89,999	0.11	0.09	0.09	0.08
$ 90,000 - 119,999	0.06	0.09	0.10	0.07
$ 120,000 - 149,999	0.05	0.06	0.04	0.06
$ 150,000 or more	0.06	0.04	0.07	0.05
Prefer not to respond	0.01	0.03	0.02	0.02
Region				
Northeast	0.17	0.18	0.18	0.18
Midwest	0.22	0.24	0.20	0.22
South	0.39	0.37	0.40	0.41
West	0.23	0.22	0.22	0.19
Living area				
Urban	0.31	0.30	0.32	0.34
Suburban	0.45	0.48	0.47	0.44
Rural	0.25	0.22	0.21	0.22
Marriage				
Married	0.36	0.40	0.39	0.36
Cohabitant	0.08	0.05	0.07	0.05
Unmarried/ Never been married	0.31	0.26	0.32	0.32
Previously married/ Separated/ Divorced	0.17	0.20	0.14	0.19
Widow/ Widower	0.09	0.08	0.07	0.06
Prefer not to respond	-	0.01	0.01	0.01
Children				
No children	0.70	0.69	0.66	0.66
One child	0.12	0.13	0.14	0.18

Two children	0.14	0.13	0.14	0.10
Three children	0.03	0.04	0.03	0.04
Four children	0.01	0.01	0.02	0.01
More than four children	-	-	0.01	0.02
Farm				
Have not lived on a farm	0.80	0.78	0.81	0.77
Have lived on a farm	0.20	0.22	0.19	0.23
Political Affiliation				
Democrat	0.42	0.35	0.42	0.40
Republican	0.33	0.30	0.30	0.32
Libertarian	0.03	0.05	0.06	0.04
Other	0.14	0.22	0.15	0.15
Prefer not to respond	0.08	0.08	0.07	0.08

Table 9 below shows meat type consumption by demographic. The table reveals that the consumption levels of female versus male versus "prefer not to say" respondents are statistically different ($p<0.001$); urban versus suburban versus rural respondents are statistically different ($p<0.001$); and democrat versus republican versus libertarian versus other versus "prefer not to respond" respondents are statistically different ($p<.01$).

Table 9. Meat Type Consumption by Demographic

	Beef	***Chicken***	***Pork***	***Plant-Based***
Gender				
Male	0.56	0.40	0.40	0.39
Female	0.44	0.59	0.60	0.58
Prefer not to say	0.01	0.01	-	0.03
Education				
Less than high school	0.02	0.02	0.06	-
High school/GED	0.28	0.22	0.12	0.06
Some college	0.22	0.22	0.31	0.36
2-Year College Degree (Associate)	0.15	0.12	0.12	0.12
4-Year College Degree (BA, BS)	0.20	0.28	0.31	0.24
Master's Degree	0.09	0.11	0.08	0.15
Doctoral Degree	0.01	0.02	0.02	0.03

Professional Degree	0.02	0.02	-	0.03
Prefer not to respond	-	-	-	-
Income				
Less than $ 15,000	0.08	0.09	0.10	0.21
$ 15,000 - 29,999	0.21	0.17	0.25	0.12
$ 30,000 - 44,999	0.17	0.17	0.15	0.12
$ 45,000 - 59,999	0.16	0.16	0.13	0.12
$ 60,000 - 74,999	0.11	0.09	0.12	0.15
$ 75,000 - 89,999	0.08	0.10	0.06	0.06
$ 90,000 - 119,999	0.06	0.09	0.10	0.03
$ 120,000 - 149,999	0.06	0.04	0.04	0.09
$ 150,000 or more	0.04	0.06	0.06	0.06
Prefer not to respond	0.02	0.02	-	0.03
Region				
Northeast	0.15	0.19	0.13	0.24
Midwest	0.24	0.21	0.21	0.18
South	0.38	0.41	0.38	0.27
West	0.23	0.20	0.27	0.30
Living area				
Urban	0.31	0.32	0.25	0.45
Suburban	0.42	0.49	0.38	0.39
Rural	0.27	0.19	0.37	0.15
Marriage				
Married	0.36	0.38	0.46	0.36
Cohabitant	0.07	0.05	0.08	0.09
Unmarried/ Never been married	0.31	0.30	0.23	0.42
Previously married/ Separated/ Divorced	0.19	0.17	0.17	0.09
Widow/ Widower	0.05	0.09	0.06	0.03
Prefer not to respond	0.01	0.01	-	-
Children				
No children	0.63	0.71	0.65	0.73
One child	0.17	0.12	0.13	0.18
Two children	0.15	0.11	0.15	0.09
Three children	0.04	0.03	0.06	-
Four children	0.01	0.02	-	-
More than four children	0.01	0.01	-	-
Farm				
Have not lived on a farm	0.75	0.75	0.73	0.79
Have lived on a farm	0.25	0.25	0.27	0.21
Political Affiliation				
Democrat	0.35	0.35	0.31	0.52

Republican	0.37	0.37	0.35	0.15
Libertarian	0.06	0.06	0.02	0.03
Other	0.14	0.14	0.27	0.24
Prefer not to respond	0.08	0.08	0.06	0.06

4.2. Milk Results

Table 10 presents the mixed logistic regression results and analyzes whether there were any effects of the carbon label and information intervention for dairy milk and dairy milk substitutes. For the carbon label, there were effects overall. For the information intervention, there were not. The carbon label reduced the selection of dairy, oat, soy, and almond milk. Overall, including the interactions for the carbon label intervention (M2) improved model fit, while the interactions provided information about carbon emissions in agriculture (M3) did not improve model fit. Because the carbon label did have effects, further analysis will focus on this. Like meat, the in-purchase information (carbon label) has an effect, while the pre-given information (information intervention) did not.

Table 10. Dairy Milk & Dairy Milk Substitutes – Mixed Logistic Regression Results

		M1	***M2***	***M3***
Product		***Value***	***Value***	***Value***
Dairy	Mean Coeff.	8.034*	9.865*	8.210*
	Std. Dev.	6.359*	6.257*	6.467*
Oat	Mean Coeff.	4.070*	5.036*	3.651*
	Std. Dev.	2.469*	2.634*	2.572*
Soy	Mean Coeff.	3.428*	4.319*	3.012*
	Std. Dev.	2.736*	2.828*	2.746*
Almond	Mean Coeff.	6.056*	7.210*	5.599*
	Std. Dev.	2.901*	2.811*	3.066*
Price	Mean of ln(Coeff.)	-0.321*	-0.333*	-0.279*
	Std. Dev.	0.970*	1.115*	1.087*
Dairy*Carbon	Coeff.		-2.727*	
Oat*Carbon	Coeff.		-1.284**	

Soy*Carbon	Coeff.		-1.435*	
Almond*Carbon	Coeff.		-1.665*	
Dairy*Info	Coeff.			0.442
Oat*Info	Coeff.			1.285**
Soy*Info	Coeff.			0.886
Almond*Info	Coeff.			1.111**
Log Likelihood		-7118	-7076	-7083
Simultaneous test for interaction variables (X^2-stat)			14.07*	8.11

Note: All models were estimated using 48,680 observations with standard errors clustered for 1,217 respondents. * and ** denote *p*-values < 0.01 and 0.05, respectively. M1 refers to the overall model (alternative specific constant (ASC)), M2 refers to the interaction effects for the Carbon Label and ASC, and M3 refers to the interaction effects for the Information Intervention and ASC.

As shown in Table 11, carbon labeling decreased the market share for dairy by 8% and increased the market share for the "None" option by 4%.

Table 11. Dairy Milk & Dairy Milk Substitutes – Contrast of Unconditional Market Shares

Product	***No Carbon Label***	***With Carbon Label***	***Difference*** *(With – No)*	***Contrast of Margins*** *(X^2-stat)*
Dairy	0.530	0.455	-0.075	3.89**
Almond	0.229	0.237	0.007	0.08
Oat	0.088	0.106	0.018	2.11
None	0.085	0.128	0.042	12.36*
Soy	0.068	0.075	0.008	0.43

Note: * and ** denote *p*-values < 0.01 and 0.05, respectively.

The figures below display the unconditional market share for dairy milk substitutes 1) without a carbon label (Figure 17) and 2) with a carbon label (Figure 18). Unconditional market shares include the "dairy" option and the substitutes presented to respondents to analyze the substitution preferences amongst dairy milk substitutes for consumers. When no carbon label is

provided, the market share of dairy milk is 53%, almond 23%, oat 9%, soy 7%, and none 9%. Providing a carbon label results in different market shares of 7% less for dairy, 1% more for almond, 2% more for oat, 1% more for soy, and 4% more for none.

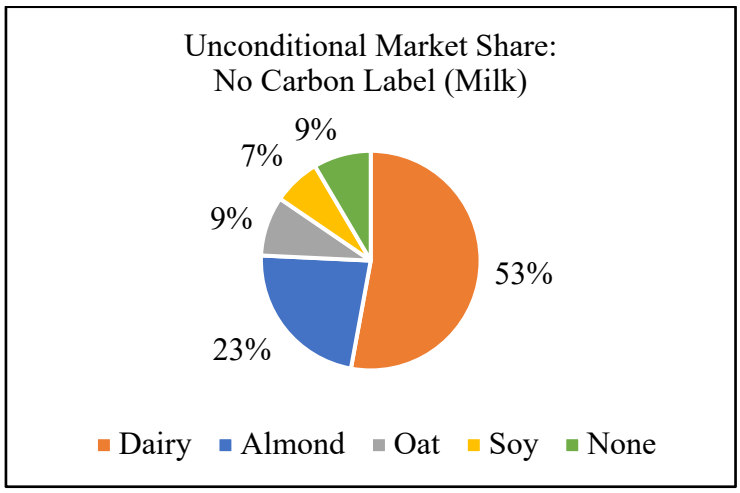

Figure 17. Unconditional Market Share: No Carbon Label (Milk)

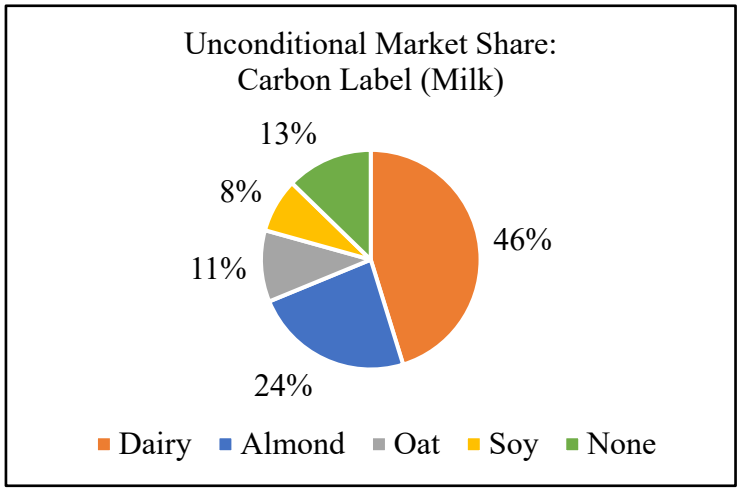

Figure 18. Unconditional Market Share: Carbon Label (Milk)

Figure 19 and Figure 20 display the market shares of the different milk products, conditional on consumers choosing one of the products 1) without a carbon label (Figure 19) and 2) with a carbon label (Figure 20). Conditional market shares remove the "dairy (milk)" option presented to survey respondents to simulate a dairy-less milk market and analyze the substitution

preferences amongst dairy milk substitutes for consumers. In the control condition, without a carbon label, the market share for almond was 49%, oat 19%, soy 14%, and none 18%. Additionally, when a carbon label is provided, the market shares vary somewhat. The market share for almond decreases by 6%, oat remains the same, soy remains the same, and none increases by 5%.

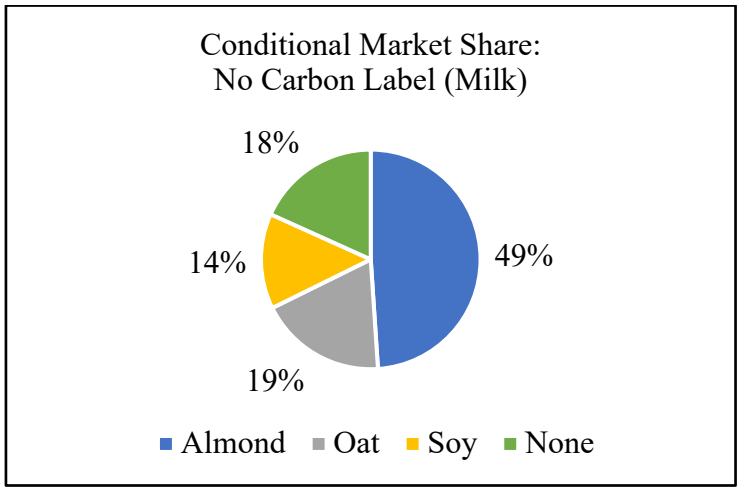

Figure 19. Conditional Market Share: No Carbon Label (Milk)

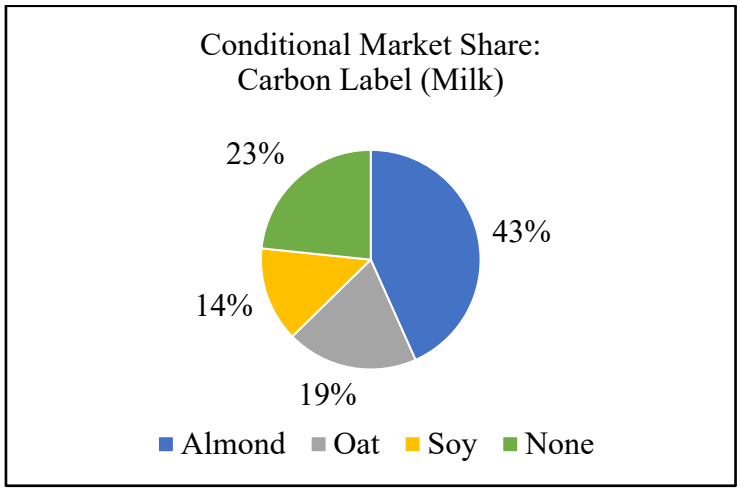

Figure 20. Conditional Market Share: Carbon Label (Milk)

As seen in Table 12, introducing a carbon label would decrease emissions by 10% (1-[1.393/1.552]). If milk were removed from the market without a carbon label, emissions would decrease by 63% (1-[0.571/1.552]). If there were a carbon label, removing milk from the market would decrease by 61% (1-[0.538/1.393]). If no milk was available on the market, introducing a carbon label would only decrease emissions by 6% (1-[0.538/0.571]). However, the sole reduction in dairy milk consumption does not equate this emissions reduction. While the results are likely directionally correct, the magnitude of the direction is possibly overstated due to the hypothetical nature of the survey and the complexities associated with milk production and emissions reductions. This consumer behavior demonstrates a sense of urgency for producers to continue to innovate and find ways to produce in an increasingly sustainable way.

Table 12. Dairy Milk & Dairy Milk Substitutes – Carbon Emissions Associated with Unconditional & Conditional Market Shares

		No Carbon Label		***With Carbon Label***	
	CO_2 Emissions (kg/lb)	***Unconditional***	***Conditional***	***Unconditional***	***Conditional***
Dairy	2.42	0.530		0.455	
Almond	0.61	0.229	0.488	0.237	0.434
Oat	0.72	0.088	0.187	0.106	0.194
None	-	0.085	0.182	0.128	0.234
Soy	0.97	0.068	0.144	0.075	0.138
Weighted CO_2 Emissions		1.552	0.571	1.393	0.538

Table 13 shows the milk survey respondent participation relative to various demographic groups. No differences were present in the characteristics of respondents across groups.

Table 13. Milk Survey Demographics

	Control	***Carbon Label***	***Information Intervention***	***Carbon Label & Info. Intervention***
Gender				
Male	0.47	0.49	0.47	0.47
Female	0.53	0.51	0.52	0.52
Prefer not to say	-	0.01	-	0.01
Education				
Less than high school	0.03	0.02	0.02	0.02
High school/GED	0.25	0.22	0.23	0.25
Some college	0.24	0.22	0.29	0.25
2-Year College Degree (Associate)	0.13	0.14	0.12	0.17
4-Year College Degree (BA, BS)	0.23	0.23	0.21	0.21
Master's Degree	0.09	0.12	0.09	0.08
Doctoral Degree	0.02	0.03	0.01	-
Professional Degree	0.01	0.02	0.02	0.01
Prefer not to respond	0.01	-	-	-
Income				
Less than $ 15,000	0.12	0.12	0.11	0.13
$ 15,000 - 29,999	0.20	0.14	0.18	0.17
$ 30,000 - 44,999	0.18	0.16	0.18	0.17
$ 45,000 - 59,999	0.15	0.15	0.18	0.17
$ 60,000 - 74,999	0.09	0.12	0.11	0.09
$ 75,000 - 89,999	0.06	0.09	0.06	0.09
$ 90,000 - 119,999	0.08	0.09	0.06	0.06
$ 120,000 - 149,999	0.04	0.05	0.06	0.07
$ 150,000 or more	0.05	0.06	0.05	0.04
Prefer not to respond	0.03	0.03	0.02	0.02
Region				
Northeast	0.15	0.19	0.20	0.15
Midwest	0.23	0.21	0.23	0.20
South	0.37	0.36	0.39	0.41
West	0.25	0.25	0.17	0.24
Living area				
Urban	0.31	0.31	0.30	0.33
Suburban	0.48	0.50	0.48	0.44
Rural	0.21	0.19	0.22	0.22
Marriage				
Married	0.32	0.37	0.32	0.33
Cohabitant	0.06	0.08	0.06	0.10

Unmarried/ Never been married	0.35	0.32	0.38	0.35
Previously married/ Separated/ Divorced	0.19	0.18	0.17	0.15
Widow/ Widower	0.08	0.04	0.06	0.06
Prefer not to respond	-	0.02	0.01	0.01
Children				
No children	0.72	0.68	0.71	0.70
One child	0.13	0.17	0.14	0.13
Two children	0.09	0.09	0.11	0.10
Three children	0.03	0.04	0.01	0.03
Four children	0.02	0.02	0.01	0.02
More than four children	0.01	-	0.02	0.01
Farm				
Have not lived on a farm	0.82	0.79	0.79	0.80
Have lived on a farm	0.18	0.21	0.21	0.20
Political Affiliation				
Democrat	0.39	0.39	0.44	0.40
Republican	0.31	0.29	0.24	0.30
Libertarian	0.06	0.05	0.07	0.04
Other	0.16	0.21	0.21	0.19
Prefer not to respond	0.07	0.06	0.04	0.06

Table 14 below shows milk type consumption by demographic. The table reveals that the consumption levels of respondents by region (northeast versus midwest versus south versus west) are statistically different ($p<0.001$), and respondents by number of children (no children versus one child versus two children versus three children versus four children versus more than four children) are statistically different ($p<.01$).

Table 14. Milk Type Consumption by Demographic

	Dairy Milk	***Oat Milk***	***Soy Milk***	***Almond Milk***
Gender				
Male	0.49	0.48	0.39	0.42
Female	0.50	0.5	0.59	0.58
Prefer not say	-	0.02	0.02	0.01
Education				
Less than high school	0.03	-	-	0.03
High school/GED	0.25	0.18	0.14	0.18
Some college	0.26	0.18	0.25	0.24
2-Year College Degree (Associate)	0.15	0.1	0.11	0.13
4-Year College Degree (BA, BS)	0.20	0.38	0.27	0.29
Master's Degree	0.09	0.14	0.11	0.09
Doctoral Degree	0.01	-	0.07	0.02
Professional Degree	0.01	0.02	0.05	0.02
Prefer not to respond	-	-	-	0.01
Income				
Less than $ 15,000	0.12	0.14	0.20	0.09
$ 15,000 - 29,999	0.18	0.12	0.16	0.15
$ 30,000 - 44,999	0.18	0.16	0.09	0.18
$ 45,000 - 59,999	0.16	0.18	0.11	0.18
$ 60,000 - 74,999	0.10	0.08	0.07	0.10
$ 75,000 - 89,999	0.07	0.08	0.14	0.07
$ 90,000 - 119,999	0.06	0.1	0.07	0.10
$ 120,000 - 149,999	0.05	0.06	0.02	0.05
$ 150,000 or more	0.04	0.08	0.11	0.06
Prefer not to respond	0.03	-	0.02	0.02
Region				
Northeast	0.17	0.18	0.09	0.22
Midwest	0.24	0.1	0.09	0.16
South	0.38	0.46	0.32	0.38
West	0.21	0.26	0.50	0.25
Living area				
Urban	0.30	0.34	0.45	0.35
Suburban	0.48	0.44	0.36	0.49
Rural	0.22	0.22	0.18	0.16
Marriage				
Married	0.34	0.26	0.25	0.35
Cohabitant	0.07	0.12	0.11	0.07

Unmarried/ Never been married	0.35	0.42	0.43	0.33
Previously married/ Separated/ Divorced	0.17	0.18	0.18	0.18
Widow/ Widower	0.07	0.02	0.02	0.05
Prefer not to respond	0.01	-	-	0.02
Children				
No children	0.70	0.54	0.82	0.75
One child	0.14	0.3	0.09	0.14
Two children	0.11	0.12	0.05	0.06
Three children	0.03	0.04	-	0.03
Four children	0.02	-	-	0.01
More than four children	0.01	-	0.05	0.02
Farm				-
Have not lived on a farm	0.79	0.88	0.89	0.82
Have lived on a farm	0.21	0.12	0.11	0.18
Political Affiliation				-
Democrat	0.41	0.38	0.39	0.39
Republican	0.30	0.28	0.11	0.30
Libertarian	0.05	0.04	0.09	0.10
Other	0.19	0.24	0.34	0.16
Prefer not to respond	0.06	0.06	0.07	0.05

Figure 21 below displays the frequencies in which survey respondents selected each of the six mechanisms. Overall, respondents favored the "carrot," corporate incentive and government subsidy, more than the "stick," corporate regulation and government tax. Also, respondents favored the farmer over the consumer. The farmer was selected as most effective by 15% more of the sample than it was chosen as least effective, whereas the consumer was selected as most effective by 10% less of the sample than it was selected as least effective.

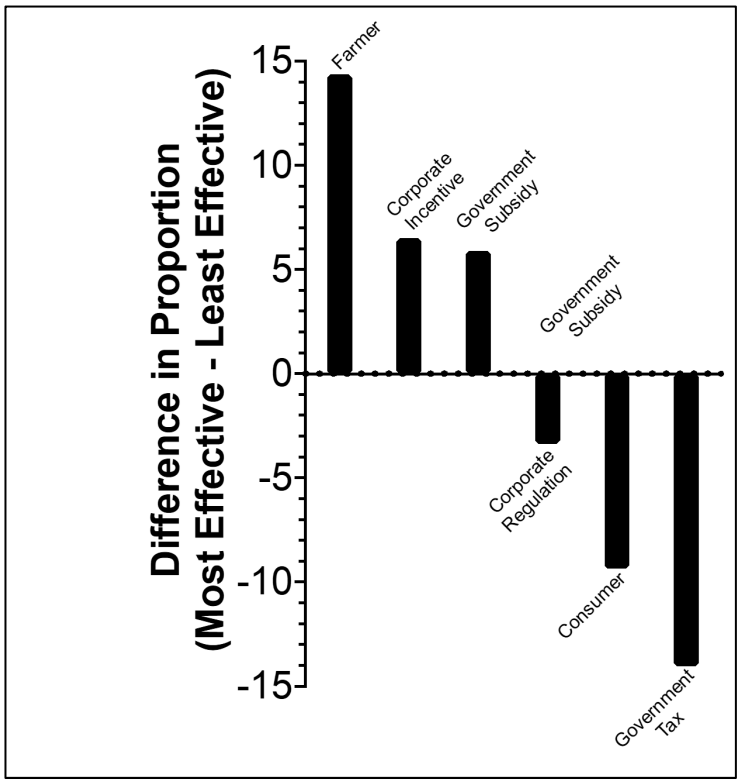

Figure 21. Difference in Proportions – Most Effective/Least Effective GHG-Reducing Mechanisms

5. Conclusions

Overall, this study shows that consumers care about the environmental impact of their food purchasing decisions with regard to meat and milk. Sustainability-related food labeling demonstrates the potential to reduce emissions, thus, the study suggests a continued focus on in-store nudges, such as through food labels, for supermarket consumers and urges creativity in approaching how to educate and inspire customers within the walls of a grocery store and even in the context of online grocery shopping (Bauer et al. 2022). This builds upon research that has assessed related food labeling in restaurant settings (Wolfson et al. 2022). Continuing consumer-oriented research is critical to understanding their attitudes, not just regarding sustainability, but concerning purchasing behavior and decision-making on a holistic scale. Research must evolve accordingly as consumer demands shift and alternative food products emerge to meet evolving wants and needs (Sethi et al. 2016). Also, producer-focused studies should be emphasized to ensure holistic understanding. However, it is vital to note that no silver bullet exists to reduce emissions or shape a sustainable future.

This study has the potential to generate substantive discussion regarding substitution effects and sustainable agriculture. While research has been done on the carbon emissions associated with beef and dairy milk substitutes, this study fills the gap by considering the substitution effects associated with this consumption. Conversations can be stimulated around the magnitude of these substitution effects discovered in this study and the potential for future research to further understand substitution effects associated with other areas of agricultural consumption.

Further discussion may be generated by the survey's findings about which CO_2-reducing mechanisms consumers consider most effective and least effective. These results can inspire

conversations regarding potential approaches from a private-sector and public-sector standpoint to enhance sustainable agricultural production. Additionally, this study may foster dialogue around how farmers and ranchers practice climate-smart practices that decrease emissions while feeding a growing population (AFBF 2022, Farmers for a Sustainable Future 2022). Many conversations regarding sustainability target farmers and ranchers while remising the fact that these agriculturalists are environmental stewards who care deeply for the land and natural resources where they produce. This study hopes to spur conversations involving consumer-producer partnerships to practice sustainability, protect natural resources, and spur communities forward.

Survey limitations involve sample and product selection. The sample only consists of US consumers, serving as a nationally representative sample, so global conclusions cannot be drawn from this study. Survey findings are relevant to the US but hope to inspire further research on a global scale. Another limitation involves product selection. Only four meat/milk products were included. The plant-based meat option alludes to a plant-based burger, so other plant-based meat, i.e. chicken, were not included. The survey also does not include vegetable proteins such as tofu or other fresh produce items. From a dairy perspective, only beverage products are included, so while assumptions can be made for value-added products, conclusions cannot be drawn beyond milk. Also, the types of dairy milk alternatives extend beyond those included in the survey. Further studies could test the robustness of results for other products. Another limitation is that this study is consumer-oriented rather than producer-focused, thus, the findings pertain solely to the purchasing of these products rather than the production of them. Further research could focus on producers and identify ways to partner with them in sustainability efforts. Finally, although the cheap talk section was to mitigate potential hypothetical bias, the results still only capture

situations rather than trends. The direction of results is likely correct, but the magnitude of the direction is possibly overestimated due to the hypothetical nature of the survey. These limitations highlight opportunities to advance this research beyond the scope of this research.

The implications of this study pertain to shaping a sustainable future for the environment not only in the U.S. but also in other countries. The growth of agricultural productivity has played a key role in alleviating poverty and improving food security (USDA), thus future innovation is critical. The advancement of GHG-reduction efforts, including research and innovation, will require the cooperation and engagement of agriculturalists, industries, and many individuals. Farmers and ranchers face challenges to feed a growing population coupled with an increased need to do so in a way that reduces emissions. Understanding consumer perceptions of carbon emissions in agriculture is vital to enhancing agricultural sustainability.

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7. Appendices

7.1. Appendix A. Survey Questions

7.2. Appendix A1. Meat Survey Questions

Carbon Credit Survey - Meat

intro **INVITATION TO PARTICIPATE** You are invited to participate in a research study about consumer purchasing behavior for meat and milk products. Please read through the following information and indicate your consent below to begin the survey. **INFORMATION ABOUT THE RESEARCH STUDY** The survey should take approximately 15 minutes. **You must be 18 years of age or older to participate** Risks and Benefits: Your participation will assist in advancement of knowledge of U.S. consumer's choice behavior. There are no anticipated risks to participating in this study. Your responses are completely anonymous Voluntary Participation: Your participation in the research is completely voluntary. Confidentiality: Your responses on the survey will be recorded anonymously. No identifying personal information will be collected in the survey. Only basic demographic information (age, gender, education etc.) will be collected. Right to Withdraw: You are free to refuse to participate in the research and to stop filling out the survey at any time. If you have questions or concerns about this study, you may contact Dr. Brandon McFadden at mcfadden@uark.edu. For questions or concerns about your rights as a research participant, please contact Ro Windwalker, the University's Compliance Coordinator, at 1+ (479) 575-2208 or by e-mail at irb@uark.edu.

Thank you for your participation!

By clicking the button below and taking the survey, you acknowledge that you have read the above statement and have been able to ask questions and express concerns, which have been satisfactorily answered by the investigator. You understand the purpose of the study as well as the potential risks and benefits that are involved. You understand that your participation is voluntary and that no rights have been waived in giving your consent. You acknowledge that you are 18 years of age or older and that you may choose to terminate your participation in the study at any time for any reason.

- ○ I consent, begin the study (1)
- ○ I do not consent, I do not wish to participate (0)

Age_screen Are you 18 years old or older?

- ○ Yes (1)
- ○ No (0)

Sex What is your sex?

- ○ Male (1)
- ○ Female (2)
- ○ Prefer not to respond (3)

Age_screen
What is your age? Please provide your age in years below.

_____

Edu What is the highest level of education you have completed?

- ○ Less than high school (1)
- ○ High school/GED (2)
- ○ Some college (3)
- ○ 2-Year College Degree (Associate) (4)
- ○ 4-Year College Degree (BA, BS) (5)
- ○ Master's Degree (6)
- ○ Doctoral Degree (7)
- ○ Professional Degree (8)
- ○ Prefer not to respond (9)

Income_screen What do you estimate your household gross income to be this year? Gross income is your total income before taxes and deductions.

- ○ Less than $ 15,000 (1)
- ○ $ 15,000 - 29,999 (2)
- ○ $ 30,000 - 44,999 (3)
- ○ $ 45,000 - 59,999 (4)
- ○ $ 60,000 - 74,999 (5)
- ○ $ 75,000 - 89,999 (6)
- ○ $ 90,000 - 119,999 (7)
- ○ $ 120,000 - 149,999 (8)
- ○ $ 150,000 or more (9)
- ○ Prefer not to respond (10)

C3 In which region do you live?

- ○ Northeast (1)
- ○ Midwest (2)
- ○ South (3)
- ○ West (5)
- ○ Outside the U.S. (6)

FoodPurch_Screen Are you the main food purchaser in your household?

- ○ Yes (1)
- ○ No (0)

Honest_screen Do you commit to carefully reading and providing thoughtful and accurate answers to the questions in this survey?

- ○ I will read carefully and provide my best answers (1)
- ○ I will not read carefully and provide my best answers (2)
- ○ I cannot promise either way (3)

Intro5 The survey will consist of four parts:

In part 1, you will make hypothetical purchasing decisions for meat products.

In part 2, you will be asked a few questions about what is important to you when shopping for food and how to best reduce greenhouse gas (GHG) emissions from agriculture.

In part 3, you will be asked few questions regarding your food purchasing behavior.

In part 4, you will be asked a few questions regarding your socio-demographic status.

Meat_screen Would you be willing to consume beef, chicken, pork, and plant-based meat?

- ○ Yes (1)
- ○ No (0)

Q425 Which type of meat do you **primarily** consume?

- ○ Beef (1)
- ○ Chicken (2)
- ○ Pork (3)
- ○ Plant-based (4)

Q244 Next, you will be asked to make hypothetical purchasing decisions. Below is important information about making hypothetical purchasing decisions in surveys. Please read the information below.

Studies show that people tend to act differently when they face hypothetical decisions. In other words, they say one thing and do something different. For example, some people would say they would choose an item in a hypothetical situation, but when faced with non-hypothetical or real choices (e.g., in a supermarket), they will not actually choose the item that they said they would choose. We want you to behave in the same way that you would if you really had to choose between food options in a supermarket.

Now imagine you are grocery shopping while making the following purchasing decisions. Thank you.

Q387 CO_2 is the primary method for measuring Greenhouse Gas Emissions, and for comparison across industries, CO_2-equivalent is provided based on the CO_2 emissions per unit of an item produced. For the purposes of this survey, you are presented CO_2 equivalent emissions on the basis of one pound or one gallon of food produced.

Intro5 Greenhouse gases trap heat in the atmosphere and make the planet warmer. Increasing concentrations of greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane, and nitrous oxide create climate change. The impact of these emissions on the environment presents a need to minimize the amount of carbon in the atmosphere. Agriculture accounts for 10% of total U.S. greenhouse gas emissions by the economic sector. These agricultural emissions may be attributed to management practices related to soil, manure, lands, and crops. Since 1990, agricultural GHG emissions have increased by 12%.

Climate change also impacts agriculture through a rise in the occurrence of climate extremes (such as high temperatures or drought) and subsequent changes to pests and diseases. The agricultural impacts of climate change will affect national and international markets; prices of food, fiber, and energy; agricultural income; and the environment. In addition to increasing the cost of producing and purchasing food, a warmer planet also increases the risk of hunger.

Q389 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- ○ **$5** (1)
- ○ **$11** (2)
- ○ **$8** (3)
- ○ **$2** (4)
- ○ **I would not purchase any of these** (5)

Q408 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- ○ **$11** (1)
- ○ **$5** (2)
- ○ **$2** (3)
- ○ **$8** (4)
- ○ **I would not purchase any of these** (5)

Q409 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- **$2** (1)
- **$8** (2)
- **$5** (3)
- **$11** (4)
- **I would not purchase any of these** (5)

Q410 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- **$11** (1)
- **$2** (2)
- **$8** (3)
- **$5** (4)
- **I would not purchase any of these** (5)

Q411 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- ○ **$8** (1)
- ○ **$11** (2)
- ○ **$5** (3)
- ○ **$2** (4)
- ○ **I would not purchase any of these** (5)

Q412 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- ○ **$5** (1)
- ○ **$8** (2)
- ○ **$2** (3)
- ○ **$11** (4)
- ○ **I would not purchase any of these** (5)

Q413 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product, price, and the

amount of associated CO_2 emission.

Which product would you choose to purchase?

- **$8** (1)
- **$2** (2)
- **$11** (3)
- **$5** (4)
- **I would not purchase any of these** (5)

Q414 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- **$2** (1)
- **$5** (2)
- **$11** (3)
- **$8** (4)
- **I would not purchase any of these** (5)

Meat1 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product and price.

Which product would you choose to purchase?

- **$5** (1)
- **$11** (2)
- **$8** (3)
- **$2** (4)
- **I would not purchase any of these** (5)

Q328 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product and price.

Which product would you choose to purchase?

- **$11** (1)
- **$5** (2)
- **$2** (3)
- **$8** (4)
- **I would not purchase any of these** (5)

Q337 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product and price.
Which product would you choose to purchase?

- **$2** (1)
- **$8** (2)
- **$5** (3)
- **$11** (4)
- **I would not purchase any of these** (5)

Q346 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product and price.

Which product would you choose to purchase?

- **$11** (1)
- **$2** (2)
- **$8** (3)
- **$5** (4)
- **I would not purchase any of these** (5)

Q355 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product and price.

Which product would you choose to purchase?

- **$8** (1)
- **$11** (2)
- **$5** (3)
- **$2** (4)
- **I would not purchase any of these** (5)

Q364 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product and price.

Which product would you choose to purchase?

- ○ **$5** (1)
- ○ **$8** (2)
- ○ **$2** (3)
- ○ **$11** (4)
- ○ **I would not purchase any of these** (5)

Q373 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product and price.

Which product would you choose to purchase?

- ○ **$8** (1)
- ○ **$2** (2)
- ○ **$11** (3)
- ○ **$5** (4)
- ○ **I would not purchase any of these** (5)

Q382 Imagine you are grocery shopping and you can select from the four options below. The package size of each option is 1 pound. The options differ by the type of product and price.

Which product would you choose to purchase?

- ○ **$2** (1)
- ○ **$5** (2)
- ○ **$11** (3)
- ○ **$8** (4)
- ○ **I would not purchase any of these** (5)

Q388 In this section, you will be asked questions that will provide information regarding the relative importance that you place on different food attributes and the relative effectiveness of ways to reduce gas emissions (GHG) emissions.

For each question below, we ask you to indicate which option you consider to be the most important/effective and which option you consider to be the least important/effective.

Here is an example of a choice question to show how these questions are answered.

The 4 options provided below represent the characteristics of an apple: appearance, production place, price, and degree of sweetness. Assuming that price is the most important characteristic and production place is the least important characteristic, the response to this question would look like this:

Please carefully and truthfully answer each of the questions below.

B1 Which of the following options below is <u>most important</u> and which option is the <u>least important</u> when you purchase food?

Please, check only one of the options below as the most important and only one as the least important.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)

○	⊗Safety - eating the food will not make you sick (1)	○
○	⊗Taste - flavor of the food in your mouth (5)	○
○	⊗Price - price you pay for the food (4)	○
○	⊗Naturalness - made without modern food technologies like genetic engineering, hormone treatment, and food irradiation (3)	○

B2 Which of the following options is the most important and which is the least important when you purchase food?

Please, check only one of the options below as the most important and only one as the least important.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)

○	⊗Nutrition - amount and type of fat, protein, etc. (1)	○
○	⊗Taste - taste of food in your mouth (2)	○
○	⊗Price - price you pay for the food (3)	○
○	⊗Environmental Impact - effects of food production on the environment (4)	○

B3 Which of the following options is the most important and which is the least important when you purchase food?

Please, check only one of the options below as the most important and only one as the least important.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)

○	⊗Safety - eating the food will not make you sick (1)	○
○	⊗Nutrition - amount and type of fat, protein, etc. (2)	○
○	⊗Naturalness - made without modern food technologies like genetic engineering, hormone treatment, and food irradiation (3)	○
○	⊗Environmental Impact - effects of food production on the environment (4)	○

Q199 In this section, you will be asked questions that will provide information regarding the relative importance that you place on different mechanisms for reducing greenhouse gas emissions in agriculture. For each question below, we ask you to indicate which mechanism you consider to be the most important and which attribute you consider to be the least important when addressing environmental impacts of agriculture. Please, check for each question just one attribute that you consider as the most important and just one attribute that you consider as the least important.

Please carefully and truthfully answer each of the questions below since your responses are important to us and can help communities, companies, and policymakers in reducing GHG emissions in agriculture. Thank you.

Which of the following ways do you think would be the most effective and the least effective for reducing greenhouse gas (GHG) emissions from agriculture?

Please, check only one of the options below as the most effective and only one as the least effective.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)
○	⊗Government Subsidy - government pays farmers to reduce emissions (1)	○
○	⊗Government Tax - government taxes high emissions practices (5)	○
○	⊗Corporate Incentive - corporations reward farmers for efforts to reduce emissions (4)	○
○	⊗Corporate Regulation - corporations require farmers to follow standards to reduce emissions (3)	○

Q175 Which of the following options do you think is the most effective and which is the least effective for reducing greenhouse gas emissions (GHG) from agriculture?

Please, check only one of the options below as the most effective and only one as the least effective.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)
○	⊗Farmer - farmer chooses to produce in a way that reduces emissions (1)	○
○	⊗Government Tax - government taxes high emissions practices (2)	○
○	⊗Corporate Incentive - corporations reward farmers for efforts to reduce emissions (3)	○
○	⊗Consumer - purchaser of food chooses to purchase in a way that reduces emissions (4)	○

Which of the following options do you think is the most effective and which is the least effective for reducing greenhouse gas emissions (GHG) from agriculture?

Please, check only one of the options below as the most effective and only one as the least effective.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)
○	⊗Government Subsidy - government pays farmers to reduce emissions (1)	○
○	⊗Farmer - farmer chooses to produce in a way that reduces emissions (2)	○
○	⊗Corporate Regulation - corporations require farmers to follow standards to reduce emissions (3)	○
○	⊗Consumer - purchaser of food chooses to purchase in a way that reduces emissions (4)	○

How often do you shop for food? (choose only one answer)

- ○ At least once a week (3)
- ○ Few times a month (2)
- ○ Few times a year (1)
- ○ Never (0)

Display This Question:
If milk = 0

X→

Q391 How often do you purchase meat products? (choose only one answer)

- ○ At least once a week (3)
- ○ Few times a month (2)
- ○ Few times a year (1)
- ○ Never (0)

Display This Question:
If milk = 1

X→

Q392 How often do you purchase milk products? (choose only one answer)

- ○ At least once a week (3)
- ○ Few times a month (2)
- ○ Few times a year (1)
- ○ Never (0)

How often do you shop for food in the following ways?

	Never (0)	Few times a year (1)	Few times a month (2)	At least once a week (3)
Hypermarket/supermarket (1)	○	○	○	○
Mini-market/convenience stores (butcheries, dairies, bakeries, etc.) (2)	○	○	○	○
Farmer's market (4)	○	○	○	○
Online with home delivery (3)	○	○	○	○

What is your level of agreement with the statement below?

I often purchase food that was produced in an environmentally-friendly way.

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither disagree nor agree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

What is your level of agreement with the statement below?

I feel it is a moral obligation to avoid wasting food (i.e., food that is not consumed and is wasted).

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither disagree nor agree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

What is your level of agreement with the statement below?

I feel that farmers care about the environment.

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither disagree nor agree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Finally, we would like some background information about you. This is an important part of our analysis. The survey is anonymous, and your name is in no way linked to the responses.

Please carefully and truthfully answer each of the questions below since your responses are important to us and can help policy makers, communities, and companies in emergency management efforts. Thank you.

Do you live in an urban, suburban, or rural area?

- ○ Urban (1)
- ○ Suburban (2)
- ○ Rural (3)

What is your marital status?

- ○ Married (1)
- ○ Cohabitant (2)
- ○ Unmarried/ Never been married (3)
- ○ Previously married/ Separated/ Divorced (4)
- ○ Widow/ Widower (5)
- ○ Prefer not to respond (6)

C6 How many children who are 18 years old or younger live in your household?

- ○ No children (1)
- ○ One child (2)
- ○ Two children (3)
- ○ Three children (4)
- ○ Four children (5)
- ○ More than four children (6)

C8 Do you live or have you ever lived on a farm?

- ○ Yes (1)
- ○ No (0)

Q184 What is your political affiliation?

- ○ Democrat (1)
- ○ Republican (2)
- ○ Libertarian (3)
- ○ Other (4)
- ○ Prefer not to respond (5)

7.3. Appendix A2. Milk Survey Questions

INVITATION TO PARTICIPATE You are invited to participate in a research study about consumer purchasing behavior for meat and milk products. Please read through the following information and indicate your consent below to begin the survey. **INFORMATION ABOUT THE RESEARCH STUDY** The survey should take approximately 15 minutes. **You must be 18 years of age or older to participate** Risks and Benefits: Your participation will assist in advancement of knowledge of U.S. consumer's choice behavior. There are no anticipated risks to participating in this study. Your responses are completely anonymous

Voluntary Participation: Your participation in the research is completely voluntary. Confidentiality: Your responses on the survey will be recorded anonymously. No identifying personal information will be collected in the survey. Only basic demographic information (age, gender, education etc.) will be collected. Right to Withdraw: You are free to refuse to participate in the research and to stop filling out the survey at any time. If you have questions or concerns about this study, you may contact Dr. Brandon McFadden at mcfadden@uark.edu. For questions or concerns about your rights as a research participant, please contact Ro Windwalker, the University's Compliance Coordinator, at 1+ (479) 575-2208 or by e-mail at irb@uark.edu.

Thank you for your participation!

By clicking the button below and taking the survey, you acknowledge that you have read the above statement and have been able to ask questions and express concerns, which have been satisfactorily answered by the investigator. You understand the purpose of the study as well as the potential risks and benefits that are involved. You understand that your participation is voluntary and that no rights have been waived in giving your consent. You acknowledge that you are 18 years of age or older and that you may choose to terminate your participation in the study at any time for any reason.

- ○ I consent, begin the study (1)
- ○ I do not consent, I do not wish to participate (0)

Age_screen Are you 18 years old or older?

- ○ Yes (1)
- ○ No (0)

What is your sex?

- ○ Male (1)
- ○ Female (2)
- ○ Prefer not to respond (3)

Age_screen
What is your age? Please provide your age in years below.

Edu What is the highest level of education you have completed?

- ○ Less than high school (1)
- ○ High school/GED (2)
- ○ Some college (3)
- ○ 2-Year College Degree (Associate) (4)
- ○ 4-Year College Degree (BA, BS) (5)
- ○ Master's Degree (6)
- ○ Doctoral Degree (7)
- ○ Professional Degree (8)
- ○ Prefer not to respond (9)

What do you estimate your household gross income to be this year? Gross income is your total income before taxes and deductions.

- ○ Less than $ 15,000 (1)
- ○ $ 15,000 - 29,999 (2)
- ○ $ 30,000 - 44,999 (3)
- ○ $ 45,000 - 59,999 (4)
- ○ $ 60,000 - 74,999 (5)
- ○ $ 75,000 - 89,999 (6)
- ○ $ 90,000 - 119,999 (7)
- ○ $ 120,000 - 149,999 (8)
- ○ $ 150,000 or more (9)
- ○ Prefer not to respond (10)

In which region do you live?

- ○ Northeast (1)
- ○ Midwest (2)
- ○ South (3)
- ○ West (4)
- ○ Outside the U.S. (5)

Are you the main food purchaser in your household?

- ○ Yes (1)
- ○ No (0)

Do you commit to carefully reading and providing thoughtful and accurate answers to the questions in this survey?

- ○ I will read carefully and provide my best answers (1)
- ○ I will not read carefully and provide my best answers (2)
- ○ I cannot promise either way (3)

The survey will consist of four parts:

In part 1, you will make hypothetical purchasing decisions for milk products.

In part 2, you will be asked a few questions about what is important to you when shopping for food and how to best reduce greenhouse gas (GHG) emissions from agriculture.

In part 3, you will be asked few questions regarding your food purchasing behavior.

In part 4, you will be asked a few questions regarding your socio-demographic status.

Would you be willing to consume dairy milk, oat milk, soy milk, and almond milk?

- ○ Yes (1)
- ○ No (0)

Q424 Which type of milk do you **primarily** consume?

- ○ Dairy milk (1)
- ○ Oat milk (2)
- ○ Soy milk (3)
- ○ Almond milk (4)

Next, you will be asked to make hypothetical purchasing decisions. Below is important information about making hypothetical purchasing decisions in surveys. Please read the information below.

Studies show that people tend to act differently when they face hypothetical decisions. In other words, they say one thing and do something different. For example, some people would say they would choose an item in a hypothetical situation, but when faced with non-hypothetical or real choices (e.g., in a supermarket), they will not actually choose the item that they said they would choose. We want you to behave in the same way that you would if you really had to choose between food options in a supermarket.

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CO_2 is the primary method for measuring Greenhouse Gas Emissions, and for comparison across industries, CO_2-equivalent is provided based on the CO_2 emissions per unit of an item produced. For the purposes of this survey, you are presented CO_2 equivalent emissions on the basis of one pound or one gallon of food produced.

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agricultural impacts of climate change will affect national and international markets; prices of food, fiber, and energy; agricultural income; and the environment. In addition to increasing the cost of producing and purchasing food, a warmer planet also increases the risk of hunger.

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- **$3** (1)
- **$5** (2)
- **$4** (3)
- **$2** (4)
- **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- **$5** (1)
- **$3** (2)
- **$2** (3)
- **$4** (4)
- **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- **$2** (1)
- **$4** (2)
- **$3** (3)
- **$5** (4)
- **I would not purchase any of these** (5)

Q417 Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- **$5** (1)
- **$2** (2)
- **$4** (3)
- **$3** (4)
- **I would not purchase any of these** (5)

Q418 Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- ○ **$4** (1)
- ○ **$5** (2)
- ○ **$3** (3)
- ○ **$2** (4)
- ○ **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- ○ **$3** (1)
- ○ **$4** (2)
- ○ **$2** (3)
- ○ **$5** (4)
- ○ **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- ○ **$4** (1)
- ○ **$2** (2)
- ○ **$5** (3)
- ○ **$3** (4)
- ○ **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product, price, and the amount of associated CO_2 emission.

Which product would you choose to purchase?

- ○ **$2** (1)
- ○ **$3** (2)
- ○ **$5** (3)
- ○ **$4** (4)
- ○ **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product and price.

Which product would you choose to purchase?

- ○ **$3** (1)
- ○ **$5** (2)
- ○ **$4** (3)
- ○ **$2** (4)
- ○ **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product and price.

Which product would you choose to purchase?

- ○ **$5** (1)
- ○ **$3** (2)
- ○ **$2** (3)
- ○ **$4** (4)
- ○ **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product and price.

Which product would you choose to purchase?

- ○ **$2** (1)
- ○ **$4** (2)
- ○ **$3** (3)
- ○ **$5** (4)
- ○ **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product and price.

Which product would you choose to purchase?

- **$5** (1)
- **$2** (2)
- **$4** (3)
- **$3** (4)
- **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product and price.

Which product would you choose to purchase?

- **$4** (1)
- **$5** (2)
- **$3** (3)
- **$2** (4)
- **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product and price.

Which product would you choose to purchase?

- **$3** (1)
- **$4** (2)
- **$2** (3)
- **$5** (4)
- **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product and price.

Which product would you choose to purchase?

- **$4** (1)
- **$2** (2)
- **$5** (3)
- **$3** (4)
- **I would not purchase any of these** (5)

Imagine you are grocery shopping and you can select from the four options below. The container size of each option is 1/2 gallon. The options differ by the type of product and price.

Which product would you choose to purchase?

- ○ **$2** (1)
- ○ **$3** (2)
- ○ **$5** (3)
- ○ **$4** (4)
- ○ **I would not purchase any of these** (5)

In this section, you will be asked questions that will provide information regarding the relative importance that you place on different food attributes and the relative effectiveness of ways to reduce gas emissions (GHG) emissions.

For each question below, we ask you to indicate which option you consider to be the most important/effective and which option you consider to be the least important/effective.

Here is an example of a choice question to show how these questions are answered.

The 4 options provided below represent the characteristics of an apple: appearance, production place, price, and degree of sweetness. Assuming that price is the most important characteristic and production place is the least important characteristic, the response to this question would look like this:

Please carefully and truthfully answer each of the questions below.

Which of the following options below is <u>most important</u> and which option is the <u>least important</u> when you purchase food?

Please, check only one of the options below as the most important and only one as the least important.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)

○	⊗Safety - eating the food will not make you sick (1)	○
○	⊗Taste - flavor of the food in your mouth (5)	○
○	⊗Price - price you pay for the food (4)	○
○	⊗Naturalness - made without modern food technologies like genetic engineering, hormone treatment, and food irradiation (3)	○

Which of the following options is the most important and which is the least important when you purchase food?

Please, check only one of the options below as the most important and only one as the least important.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)

○	⊗Nutrition - amount and type of fat, protein, etc. (1)	○
○	⊗Taste - taste of food in your mouth (2)	○
○	⊗Price - price you pay for the food (3)	○
○	⊗Environmental Impact - effects of food production on the environment (4)	○

Which of the following options is the most important and which is the least important when you purchase food?

Please, check only one of the options below as the most important and only one as the least important.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)

○	⊗Safety - eating the food will not make you sick (1)	○
○	⊗Nutrition - amount and type of fat, protein, etc. (2)	○
○	⊗Naturalness - made without modern food technologies like genetic engineering, hormone treatment, and food irradiation (3)	○
○	⊗Environmental Impact - effects of food production on the environment (4)	○

In this section, you will be asked questions that will provide information regarding the relative importance that you place on different mechanisms for reducing greenhouse gas emissions in agriculture. For each question below, we ask you to indicate which mechanism you consider to be the most important and which attribute you consider to be the least important when addressing environmental impacts of agriculture. Please, check for each question just one attribute that you consider as the most important and just one attribute that you consider as the least important.

Please carefully and truthfully answer each of the questions below since your responses are important to us and can help communities, companies, and policymakers in reducing GHG emissions in agriculture. Thank you.

Which of the following ways do you think would be the most effective and the least effective for reducing greenhouse gas (GHG) emissions from agriculture?

Please, check only one of the options below as the most effective and only one as the least effective.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)
○	⊗Government Subsidy - government pays farmers to reduce emissions (1)	○
○	⊗Government Tax - government taxes high emissions practices (5)	○
○	⊗Corporate Incentive - corporations reward farmers for efforts to reduce emissions (4)	○
○	⊗Corporate Regulation - corporations require farmers to follow standards to reduce emissions (3)	○

Which of the following options do you think is the most effective and which is the least effective for reducing greenhouse gas emissions (GHG) from agriculture?

Please, check only one of the options below as the most effective and only one as the least effective.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)
○	⊗Farmer - farmer chooses to produce in a way that reduces emissions (1)	○
○	⊗Government Tax - government taxes high emissions practices (2)	○
○	⊗Corporate Incentive - corporations reward farmers for efforts to reduce emissions (3)	○
○	⊗Consumer - purchaser of food chooses to purchase in a way that reduces emissions (4)	○

Which of the following options do you think is the most effective and which is the least effective for reducing greenhouse gas emissions (GHG) from agriculture?

Please, check only one of the options below as the most effective and only one as the least effective.

Most Important ONE ANSWER (1)		Least Important ONE ANSWER (2)
○	⊗Government Subsidy - government pays farmers to reduce emissions (1)	○
○	⊗Farmer - farmer chooses to produce in a way that reduces emissions (2)	○
○	⊗Corporate Regulation - corporations require farmers to follow standards to reduce emissions (3)	○
○	⊗Consumer - purchaser of food chooses to purchase in a way that reduces emissions (4)	○

How often do you shop for food? (choose only one answer)

- ○ At least once a week (3)
- ○ Few times a month (2)
- ○ Few times a year (1)
- ○ Never (0)

Display This Question:
If milk = 0

Q391 How often do you purchase meat products? (choose only one answer)

- ○ At least once a week (3)
- ○ Few times a month (2)
- ○ Few times a year (1)
- ○ Never (0)

Display This Question:
If milk = 1

Q392 How often do you purchase milk products? (choose only one answer)

- ○ At least once a week (3)
- ○ Few times a month (2)
- ○ Few times a year (1)
- ○ Never (0)

How often do you shop for food in the following ways?

	Never (0)	Few times a year (1)	Few times a month (2)	At least once a week (3)
Hypermarket/supermarket (1)	○	○	○	○
Mini-market/convenience stores (butcheries, dairies, bakeries, etc.) (2)	○	○	○	○
Farmer's market (4)	○	○	○	○
Online with home delivery (3)	○	○	○	○

What is your level of agreement with the statement below?

I often purchase food that was produced in an environmentally-friendly way.

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither disagree nor agree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

What is your level of agreement with the statement below?

I feel it is a moral obligation to avoid wasting food (i.e., food that is not consumed and is wasted).

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither disagree nor agree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

What is your level of agreement with the statement below?

I feel that farmers care about the environment.

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither disagree nor agree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Finally, we would like some background information about you. This is an important part of our analysis. The survey is anonymous, and your name is in no way linked to the responses.

Please carefully and truthfully answer each of the questions below since your responses are important to us and can help policymakers, communities, and companies in emergency management efforts. Thank you.

Do you live in an urban, suburban, or rural area?

- ○ Urban (1)
- ○ Suburban (2)
- ○ Rural (3)

What is your marital status?

- ○ Married (1)
- ○ Cohabitant (2)
- ○ Unmarried/ Never been married (3)
- ○ Previously married/ Separated/ Divorced (4)
- ○ Widow/ Widower (5)
- ○ Prefer not to respond (6)

How many children who are 18 years old or younger live in your household?

- ○ No children (1)
- ○ One child (2)
- ○ Two children (3)
- ○ Three children (4)
- ○ Four children (5)
- ○ More than four children (6)

Do you live or have you ever lived on a farm?

- ○ Yes (1)
- ○ No (0)

What is your political affiliation?

- ○ Democrat (1)
- ○ Republican (2)
- ○ Libertarian (3)
- ○ Other (4)
- ○ Prefer not to respond (5)

7.4. Appendix B. IRB Approval Document

UNIVERSITY OF ARKANSAS

To:	Sara M Gardner
From:	Douglas J Adams, Chair IRB Expedited Review
Date:	07/01/2022
Action:	**Exemption Granted**
Action Date:	07/01/2022
Protocol #:	2206405805
Study Title:	carbon credit market

The above-referenced protocol has been determined to be exempt.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

If you have any questions or need any assistance from the IRB, please contact the IRB Coordinator at 109 MLKG Building, 5-2208, or irb@uark.edu.

cc: Aaron M Shew, Investigator
Wei Yang, Investigator
Alvaro Durand-Morat, Investigator
Lawton L Nalley, Investigator

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7.5. Appendix C. Consumer Price Index Average Price Data

CPI Average Price Data, U.S. city average (AP)

Series Title	Ground beef, 100% beef, per lb. (453.6 gm) in U.S. city average, average price, not seasonally adjusted
Series ID	APU0000703112
Survey Name	CPI Average Price Data, U.S. city average (AP)
Measure Data Type	Ground beef, 100% beef, per lb. (453.6 gm)
Area	U.S. city average
Item	Ground beef, 100% beef, per lb. (453.6 gm)

Year	Period	Label	Observation Value									
2020	M01	2020 Jan	3.886									
2020	M02	2020 Feb	3.865									
2020	M03	2020 Mar	3.881									
2020	M04	2020 Apr	4.052									
2020	M05	2020 May	4.461									
2020	M06	2020 Jun	4.737									
2020	M07	2020 Jul	4.264									
2020	M08	2020 Aug	4.177									
2020	M09	2020 Sep	4.076									
2020	M10	2020 Oct	4.008									
2020	M11	2020 Nov	4.027									
2020	M12	2020 Dec	3.951									
2021	M01	2021 Jan	3.965		2021	M01	2021 Jan	3.965				
2021	M02	2021 Feb	3.987		2021	M02	2021 Feb	3.987				
2021	M03	2021 Mar	4.042		2021	M03	2021 Mar	4.042				
2021	M04	2021 Apr	4.096		2021	M04	2021 Apr	4.096				
2021	M05	2021 May	4.101		2021	M05	2021 May	4.101				
2021	M06	2021 Jun	4.357		2021	M06	2021 Jun	4.357				
2021	M07	2021 Jul	4.388		2021	M07	2021 Jul	4.388				
2021	M08	2021 Aug	4.468		2021	M08	2021 Aug	4.468				
2021	M09	2021 Sep	4.504		2021	M09	2021 Sep	4.504				
2021	M10	2021 Oct	4.719		2021	M10	2021 Oct	4.719				
2021	M11	2021 Nov	4.716		2021	M11	2021 Nov	4.716				
2021	M12	2021 Dec	4.604		2021	M12	2021 Dec	4.604				
2022	M01	2022 Jan	4.554									
							Max	4.719				
							Min	3.965				
							Average	4.329				

CPI Average Price Data, U.S. city average (AP)

Series Title	Chicken breast, boneless, per lb. (453.6 gm) in U.S. city average, average price, not seasonally adjusted
Series ID	APU0000FF1101
Survey Name	CPI Average Price Data, U.S. city average (AP)
Measure Data Type	Chicken breast, boneless, per lb. (453.6 gm)
Area	U.S. city average
Item	Chicken breast, boneless, per lb. (453.6 gm)

Year	Period	Label	Observation Value									
2020	M01	2020 Jan	3.059									
2020	M02	2020 Feb	3.013									
2020	M03	2020 Mar	2.956									
2020	M04	2020 Apr	3.158									
2020	M05	2020 May	3.348									
2020	M06	2020 Jun	3.349									
2020	M07	2020 Jul	3.221									
2020	M08	2020 Aug	3.276									
2020	M09	2020 Sep	3.302									
2020	M10	2020 Oct	3.290									
2020	M11	2020 Nov	3.412									
2020	M12	2020 Dec	3.293									
2021	M01	2021 Jan	3.260		2021	M01	2021 Jan	3.260				
2021	M02	2021 Feb	3.239		2021	M02	2021 Feb	3.239				
2021	M03	2021 Mar	3.291		2021	M03	2021 Mar	3.291				
2021	M04	2021 Apr	3.406		2021	M04	2021 Apr	3.406				
2021	M05	2021 May	3.371		2021	M05	2021 May	3.371				
2021	M06	2021 Jun	3.353		2021	M06	2021 Jun	3.353				
2021	M07	2021 Jul	3.500		2021	M07	2021 Jul	3.500				
2021	M08	2021 Aug	3.536		2021	M08	2021 Aug	3.536				
2021	M09	2021 Sep	3.517		2021	M09	2021 Sep	3.517				
2021	M10	2021 Oct	3.589		2021	M10	2021 Oct	3.589				
2021	M11	2021 Nov	3.618		2021	M11	2021 Nov	3.618				
2021	M12	2021 Dec	3.725		2021	M12	2021 Dec	3.725				
2022	M01	2022 Jan	3.726									
							Max	3.725				
							Min	3.239				
							Average	3.450				

CPI Average Price Data, U.S. city average (AP)

Series Title	Milk, fresh, whole, fortified, per gal. (3.8 lit) in U.S. city average, average price, not seasonally adjusted
Series ID	APU0000709112
Survey Name	CPI Average Price Data, U.S. city average (AP)
Measure Data Type	Milk, fresh, whole, fortified, per gal. (3.8 lit)
Area	U.S. city average
Item	Milk, fresh, whole, fortified, per gal. (3.8 lit)

Year	Period	Label	Observation Value									
2020	M01	2020 Jan	3.253									
2020	M02	2020 Feb	3.196									
2020	M03	2020 Mar	3.248									
2020	M04	2020 Apr	3.267									
2020	M05	2020 May	3.210									
2020	M06	2020 Jun	3.198									
2020	M07	2020 Jul	3.255									
2020	M08	2020 Aug	3.406									
2020	M09	2020 Sep	3.448									
2020	M10	2020 Oct	3.380									
2020	M11	2020 Nov	3.425									
2020	M12	2020 Dec	3.535									
2021	M01	2021 Jan	3.468		2021	M01	2021 Jan	3.468				
2021	M02	2021 Feb	3.368		2021	M02	2021 Feb	3.368				
2021	M03	2021 Mar	3.348		2021	M03	2021 Mar	3.348				
2021	M04	2021 Apr	3.447		2021	M04	2021 Apr	3.447				
2021	M05	2021 May	3.497		2021	M05	2021 May	3.497				
2021	M06	2021 Jun	3.557		2021	M06	2021 Jun	3.557				
2021	M07	2021 Jul	3.627		2021	M07	2021 Jul	3.627				
2021	M08	2021 Aug	3.560		2021	M08	2021 Aug	3.560				
2021	M09	2021 Sep	3.585		2021	M09	2021 Sep	3.585				
2021	M10	2021 Oct	3.663		2021	M10	2021 Oct	3.663				
2021	M11	2021 Nov	3.671		2021	M11	2021 Nov	3.671				
2021	M12	2021 Dec	3.743		2021	M12	2021 Dec	3.743				
2022	M01	2022 Jan	3.787									
							Max	3.743				
							Min	3.348				
							Average	3.545				

CPI for All Urban Consumers (CPI-U)

Series Title	Pork chops in U.S. city average, all urban consumers, not seasonally adjusted
Series ID	CUUR0000SEFD03
Seasonality	Not Seasonally Adjusted
Survey Name	CPI for All Urban Consumers (CPI-U)
Measure Data Type	Pork chops
Area	U.S. city average
Item	Pork chops

Year	Period	Label	Observation Value
2020	M01	2020 Jan	188.587
2020	M02	2020 Feb	193.058
2020	M03	2020 Mar	190.618
2020	M04	2020 Apr	204.752
2020	M05	2020 May	221.889
2020	M06	2020 Jun	231.435
2020	M07	2020 Jul	218.186
2020	M08	2020 Aug	211.034
2020	M09	2020 Sep	212.637
2020	M10	2020 Oct	204.053
2020	M11	2020 Nov	210.221
2020	M12	2020 Dec	208.335
2021	M01	2021 Jan	203.256
2021	M02	2021 Feb	205.226
2021	M03	2021 Mar	208.450
2021	M04	2021 Apr	212.226
2021	M05	2021 May	214.056
2021	M06	2021 Jun	224.766
2021	M07	2021 Jul	228.531
2021	M08	2021 Aug	228.555
2021	M09	2021 Sep	225.262
2021	M10	2021 Oct	236.503
2021	M11	2021 Nov	236.883
2021	M12	2021 Dec	234.362
2022	M01	2022 Jan	232.720

					2021	M01	2021 Jan	203.256	2.03256			
					2021	M02	2021 Feb	205.226	2.05226			
					2021	M03	2021 Mar	208.450	2.0845			
					2021	M04	2021 Apr	212.226	2.12226			
					2021	M05	2021 May	214.056	2.14056			
					2021	M06	2021 Jun	224.766	2.24766			
					2021	M07	2021 Jul	228.531	2.28531			
					2021	M08	2021 Aug	228.555	2.28555			
					2021	M09	2021 Sep	225.262	2.25262			
					2021	M10	2021 Oct	236.503	2.36503			
					2021	M11	2021 Nov	236.883	2.36883			
					2021	M12	2021 Dec	234.362	2.34362			
							Max	236.883	2.36883			
							Min	203.256	2.03256			
							Average	221.506	2.215063333			

CPI Average Price Data, U.S. city average (AP)

Series Title	Milk, fresh, whole, fortified, per gal. (3.8 lit) in U.S. city average, average price, not seasonally adjusted
Series ID	APU0000709112
Survey Name	CPI Average Price Data, U.S. city average (AP)
Measure Data Type	Milk, fresh, whole, fortified, per gal. (3.8 lit)
Area	U.S. city average
Item	Milk, fresh, whole, fortified, per gal. (3.8 lit)

Year	Period	Label	Observation Value
2020	M01	2020 Jan	3.253
2020	M02	2020 Feb	3.196
2020	M03	2020 Mar	3.248
2020	M04	2020 Apr	3.267
2020	M05	2020 May	3.210
2020	M06	2020 Jun	3.198
2020	M07	2020 Jul	3.255
2020	M08	2020 Aug	3.406
2020	M09	2020 Sep	3.448
2020	M10	2020 Oct	3.380
2020	M11	2020 Nov	3.425
2020	M12	2020 Dec	3.535
2021	M01	2021 Jan	3.468
2021	M02	2021 Feb	3.368
2021	M03	2021 Mar	3.348
2021	M04	2021 Apr	3.447
2021	M05	2021 May	3.497
2021	M06	2021 Jun	3.557
2021	M07	2021 Jul	3.627
2021	M08	2021 Aug	3.560
2021	M09	2021 Sep	3.585
2021	M10	2021 Oct	3.663
2021	M11	2021 Nov	3.671
2021	M12	2021 Dec	3.743
2022	M01	2022 Jan	3.787

2021	M01	2021 Jan	3.468	2021	M01	2021 Jan	3.468					
2021	M02	2021 Feb	3.368	2021	M02	2021 Feb	3.368					
2021	M03	2021 Mar	3.348	2021	M03	2021 Mar	3.348					
2021	M04	2021 Apr	3.447	2021	M04	2021 Apr	3.447					
2021	M05	2021 May	3.497	2021	M05	2021 May	3.497					
2021	M06	2021 Jun	3.557	2021	M06	2021 Jun	3.557					
2021	M07	2021 Jul	3.627	2021	M07	2021 Jul	3.627					
2021	M08	2021 Aug	3.560	2021	M08	2021 Aug	3.560					
2021	M09	2021 Sep	3.585	2021	M09	2021 Sep	3.585					
2021	M10	2021 Oct	3.663	2021	M10	2021 Oct	3.663					
2021	M11	2021 Nov	3.671	2021	M11	2021 Nov	3.671					
2021	M12	2021 Dec	3.743	2021	M12	2021 Dec	3.743					
2022	M01	2022 Jan	3.787									
						Max	3.743					
						Min	3.348					
						Average	3.545					