Spring 2015

Eating for the Environment: A Demographic Study of Consumer Food Choices and Environmental Knowledge

Rebecca Woythal
Rebecca.Woythal@Colorado.EDU

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By
Rebecca Woythal
University of Colorado at Boulder

A thesis submitted to the
University of Colorado at Boulder
in partial fulfillment
of the requirements to receive
Honors designation in
Environmental Studies
Defended April 6th, 2015

Thesis Advisors:

Liam Downey, Sociology Department, Committee Chair
Dale Miller, Environmental Studies Department
Jill Litt, Environmental Studies Department

Abstract

Agriculture accounts for a large portion of human impact on the environment, making consumer food choices an area to target in order to lower individuals' environmental impacts. To understand how to encourage people to make more sustainable food choices, it is important to understand why individuals make the food choices that they do. In order to better understand consumer behavior, I conducted a survey of 154 respondents to answer the following questions. Is there an association between knowledge of the environmental impacts of food choices and consumption behavior? Is there an association between a consumer's food-related values and consumption behavior? Moreover, is the relationship between knowledge and behavior stronger for those who have certain food-related values? Finally, does the relationship between knowledge and behavior vary according to individuals' demographic characteristics, including age, gender, education level, income level, and political affiliation? I conducted an anonymous online survey of 154 United States citizens and performed ordinary least squares regressions to identify connections between consumers' behavior, knowledge, food-related values, and demographic characteristics. The survey results demonstrate that there is association between consumer knowledge of the environmental impacts of food production and more sustainable food choices. There is also an association between the food-related values of convenience, health, low environmental impact, and organic foods with consumer behavior. This association can be explained partially by a consumer's environmental knowledge for the health, low impact, and organic values. There was no association between consumer behavior and demographic factors.

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Introduction

Agriculture in the United States accounts for a large percentage of the country's total environmental impact from water and land use, greenhouse gas emissions, soil degradation, and pollution from the application of chemical pesticides and fertilizers. To fully obtain a sustainable food system in the United States, it is important to work with both consumers and large agricultural entities to make changes in how food is produced and consumed. Part of the duty of the individual consumer is to use their purchasing power to motivate the agriculture industry to produce foods more sustainable. This purchasing power highlights food consumption as a place where individuals can change their behavior to lower their own personal impacts and aid in creating large scale changes in food production. In an effort to learn how to change human behavior to be more sustainable, it is important to look further into food consumption behaviors and identify what leads people to make environmentally harmful food choices. This study investigates food consumption behavior based on the belief that identifying patterns in human behavior is the first step towards encouraging environmentally conscious food choices throughout the United States. In it, I identify relationships between self-reported food consumption behavior, consumer demographics, individuals' food related values, and personal knowledge of the environmental impacts of food production.

Is there a disconnect between what people know and what choices they make while consuming food? Are those who make environmentally harmful food choices simply less aware than others of the environmental impacts of food production? Are food consumption patterns dictated by what people deem important, such as convenience, health, and cost efficiency? Further, are these connections different across varied demographic categories such as gender, income, political affiliation, education, and age?

To best accomplish an analysis of individuals' food consumption behavior, I examine 154 survey responses from US residents, where individuals reported how often they eat specific foods, what is important to them when making food purchases, and how aware they are of the environmental harms of different agricultural practices. Surveys also include demographic data about each survey respondent regarding their age, gender, income, education, and political affiliation.

The data are then analyzed using Ordinary Least Squares (OLS) regressions to determine whether associations exist between an individual's knowledge of environmental impacts of food production, food related values, and consumption behavior, and if those connections are visible across certain demographic fields.

Since the study's sample size is relatively small, the goal of this research is to conduct a preliminary study on consumer food behavior that informs future research. A sample size of 154 is not generalizable to the American public, so a larger, population-based study with more responses would be beneficial to describing the population with more accuracy. Nevertheless, my thesis serves as a pilot study to determine what associations may be explored further.

Background

Throughout the 20th century, Americans became more aware of the harms of industry and economic development both to human health and the natural environment. Within 100 years, the number of Environmental Movement Organizations grew from very few in 1900 to over 26,000 local, regional, and national organizations in 2000 (Carmichael et al, 2012). Problems with air and water pollution in the 60's and 70's led people to ask government to take action to regulate harm to the environment. These problems also led to Earth Day being established in 1970, and the passing and amendment of legislation such as the Clean Air Act and Clean Water Act

(Cudahy, 2000). This growth signifies the foundation of an era of activism to protect the planet: the environmental movement.

In the midst of a multifaceted environmental movement, it becomes increasingly difficult to determine where resources should be pooled to create the biggest impact. Environmentalists disagree over the methods that could be most effective in creating a sustainable way of living. Does efficient change making lie in policy and big business, or do individuals and purchasing power lead to large-scale changes in government and various industries? According to Elena Fraj-Andres and Eva Martinez-Salinas, there are three main fronts where solutions to environmental issues can be found. The fronts are interconnected, and therefore not easily separated, but can be divided into the political, economic, and social fronts (2007). The political front involves changes in policy to protect the environment and natural resources, while the economic front involves business strategies that can either help or hurt progress towards sustainability (Fraj-Andres & Martinez-Salinas, 2007).

The social front is arguably the most important of the three. Social change, for example, can put pressure on legislators and business owners to change how resources flow through the economy, and one way that society can take action and influence such changes is through the purchasing power of the individual. This is possible because of the close connections that exist between the economic, political, and social fronts. If businesses see that customers are favorable of sustainably produced items, they may be motivated to act in more environmentally responsible ways. Motivations work similarly with legislators, as those with political power want to (a) keep up with the demands of their constituents, and (b) create and maintain a thriving economy. In a way, "purchasing power *is* social impact power," (Byrne, 2012).

With this in mind, many environmentalists want sustainability to be a motivation in individuals' purchasing and consumption behavior. Environmentalists therefore urge people to carpool, use public transportation, and buy fuel-efficient vehicles to lower the effects of harmful emissions and natural resource consumption. They also encourage recycling, composting, and reusing old items as part of a solution in creating a sustainable society. Consumers are encouraged to purchase energy efficient and "green" products to decrease the amount of resources and energy used in product packaging and use. However, consumers have been ignoring one of the largest impacts on the environment, the impact of food production for human populations.

This is particularly problematic, because in the United States, for instance, food consumption accounts for up to 30% of the country's total environmental impact, with meat production making up a huge portion of this impact (Tobler et al, 2011). To make matters worse, meat consumption rates go up as people become more financially stable. One report states that doubling the income of an individual is likely to increase their meat consumption by 80% (NTNU, 2010). As a result, changing American's food consumption habits is likely to be an important step towards reducing environmental problems and solving the environmental crisis.

The first step in changing food consumption behavior is to look at why people eat what they do, and to effectively understand why individuals choose to eat in ways that are sustainable or otherwise, it is important to answer questions regarding their knowledge of the environmental impacts of food production, their rood related values, and their consumption behavior. Once this information is obtained, it is then possible to see what connections could be made between behaviors and demographic factors. If empirical relationships can be identified between knowledge, values, and consumption across different demographics, there is an opportunity for future research and outreach to target specific groups in an effort to make sustainable food purchasing more commonplace.

This thesis therefore aims to answer the following questions. Is there an association between knowledge of the environmental impacts of food choices and consumption behavior? Is there an association between a consumer's food-related values and consumption behavior? Moreover, is the relationship between knowledge and behavior stronger for those who have certain food-related values? Finally, does the relationship between knowledge and behavior vary according to individuals' demographic characteristics, including age, gender, education level, income level, and political affiliation?

Environmental Impacts of Agriculture

To understand what purchasing behavior is harmful to the environment, it is first necessary to look at the environmental impacts of agricultural practices. One of these detrimental impacts is the use of fossil fuels and greenhouse gas emissions that lead to climate change, as growing crops creates a direct impact on greenhouse gas emissions and the amount of fossil fuels consumed. For example, production from an average tractor, calculated in a study compiling power and mass for 149 tractor models in New Zealand, results in the equivalent greenhouse gas emissions of 15.8 passenger vehicles, while tilling one hectare with the same tractor uses 30.3 liters of gas (Czarnezki & Prescott, 2013). It also takes fossil fuels to power the pumps that irrigate farmlands, and even more to store, transport, refrigerate, process, and package the crops.

The use of fertilizers also has an effect on greenhouse gas emissions. Fertilizers are often petroleum based and produced with fossil fuels. For instance, producing 5.5 pounds of useable nitrogen requires the energy produced by burning 2,200 pounds of coal (Czarnezki & Prescott, 2013). Moreover, nitrous oxide, a greenhouse gas that has over 300 times the heat-trapping capabilities of CO_2, is emitted at increased levels when fertilizers are applied to soil (Aneja et al, 2009).

In addition to the greenhouse gas emissions amplified by fertilizer use, there are other harmful environmental impacts from fertilizers as well. Fertilizers are just one of the pollutants that contribute to the large impact of agriculture on the world's resources. According to the EPA, agriculture pollutes or restricts the use of 70% of rivers and 50% of lakes in the United States through water extraction and pollution by pesticides and fertilizers (Lovejoy & Hyde, 1997). This pollution is largely caused by the fact that only around 30% of the nitrogen in fertilizers is utilized by crops (Tenneson, 2009). Phosphorus, which is also important for obtaining large crop yields, is produced by mining phosphate, a process that uses large quantities of fresh water. In central Florida, where most phosphorus is produced in the United States, the Peace River loses 11 million gallons of water per day to sink holes caused by the excess water extraction used to mine and produce usable phosphorus (Tenneson, 2009). The solid waste from the phosphorus separation process also produces a toxic, radioactive waste (Tenneson, 2009).

Excess chemicals from nitrogen and phosphorus fertilizers applied to farm fields runs into nearby waterways and changes ecosystems on both a local and farther-reaching scale. The excess nutrients cause algae to grow rapidly, sink and decompose, and deplete oxygen levels in the polluted area ("The Dead Zone", 2002). Lowered oxygen levels create dead zones, where little to no marine life can survive. One example of this can be seen in the Gulf of Mexico, where there's a dead zone that expands over 8,500 square miles, which the EPA contributes to nitrogen runoff from mid-west farms ("The Dead Zone", 2002).

Aside from polluting freshwater resources, agriculture is responsible for 87% of the world's freshwater withdrawals (Pimental, 1997). Much of the agricultural fresh water is pumped from groundwater resources, which are being pumped beyond their recharge rates, depleting the world's groundwater quicker than it can be replenished (Pimental, 1997).

In addition to greenhouse gasses, natural resource depletion, and fertilizer impacts, chemical pesticide use also has detrimental effects on the earth's natural systems as well as on the health of unintended plants and animals. Much of the impacts related to pesticide use are due to the imprecision of application techniques. Applying pesticides via aircraft technology, for example, only allows between 25-50% of the pesticide to reach the targeted area, while ground based air blasters reach 65% of the target area, and spray booms and rope-wicks allow 70-90% of the pesticide to reach the plant (Pimental, 1995). Overall, of the 2.5 million tons of pesticides applied each year across the globe, less than 0.1% of the chemicals are actually reaching pests due to imprecise application methods, weather, and other factors (Pimental, 1995).

Pesticides that drift or are subject to runoff pollute freshwater sources across the country. A US Geological Survey assessment showed that pesticides or their remnants were found in every stream sampled, as well as in more than 50% of shallow ground water wells sampled in agricultural and urban areas, and 33% of deeper wells (Gilliom et al, 2006). This pollution is problematic, as the dangers of pesticides remain present in the environment long after their application. "Organochlorine pesticides (such as DDT) and their degradates and by-products were found in fish or bed-sediment samples from most streams in agricultural, urban, and mixed land-use settings—and in more than half the fish samples from streams draining undeveloped watersheds," (Gilliom et al, 2006).

Pesticides are harmful for both wildlife and humans through exposure in foods, in animal proteins, and in polluted air, water, and soil (Horrigan et al, 2002). The UN estimates that each year, there are approximately 2 million poisonings and 10,000 deaths due to pesticide use

(Horrigan et al, 2002). Many pesticides are used in agriculture worldwide without being fully tested for their toxicity, leading to certain types of cancers and endocrine disruption in humans (Horrigan et al, 2002). Pesticide use in agriculture also threatens wild pollinators, which support ecosystems by pollinating plants that make up the base to many food chains. Honey bee populations have been declining worldwide, and the European Commissions suspects that neonicotinoid pesticides may be part of the cause due to their ability to suppress immune systems in bees and lead to increased infections, learning problems, and death (Watanabe, 2014).

Unfortunately, the impacts of agriculture do not stop at pollution and resource use, as machinery and farming practices used in agriculture are also harmful to the soil. Topsoil is compacted, which destroys the healthy bacteria and microbes living in the soil, leaving infertile soil (Horrigan et al, 2002). Through heavy tillage and pesticide application, soils are less healthy and more easily eroded from wind and water (Henneron et al, 2015). This presents a negative feedback loop, as conventional agricultural practices degrade the soil in an attempt to make it more fertile.

Moreover, livestock production exacerbates the harmful effects of agriculture on the environment. For example, raising livestock increases the amount of harmful GHG emissions. Globally, livestock production is responsible for emitting somewhere between 4.6 and 7.1 billion tonnes of greenhouse gasses each year. (Fiala, 2006). This accounts for approximately 18% of total global greenhouse gas emissions, partially because of the deforestation and grazing of cattle, as well as the methane and CO2 emitted at feedlot operations (Stehfest et al, 2013; Fiala 2006). In a feedlot operation like those used in the US cattle production, "[Producing] 1 kg of beef in a US feedlot requires the equivalent of 14.8 kg of CO2. As a comparison, 1 gallon of gasoline emits approximately 2.4 kg of CO2. Producing 1 kg beef thus has a similar impact on the environment as 6.2 gallons of gasoline, or driving 160 miles in the average American mid-size car," (Fiala, 2006). In addition to CO_2, methane emissions from livestock account for around 37% of the total amount of methane released into the atmosphere that are originated from human activity (Aneja et al, 2009).

Livestock also has a large impact on water and land resources. For example, it takes approximately 100 times more water to produce one pound of beef versus one pound of vegetable protein (Pimental, 1997). Although livestock production only directly uses 1.3% of total water used in agriculture, accounting for the water needed to grow hay, grain, and other crops used as feed creates a large impact on freshwater resources (Pimental, 1997). 34% of land used for growing crops across the globe is dedicated to producing feed for livestock, and 80% of total global land use is for livestock production (Stehfest et al, 2013). Of all types of livestock, beef has the worst environmental impact. For beef production on average, 157 million metric tons of plant protein produces 28 metric tons of animal protein (Robbins, 1999). "By the time a feedlot steer in the United States is ready for slaughter, it has consumed 2,700 pounds of grain and weighs approximately 1,050 pounds," (Robbins, 1999). In addition, animal waste is subject to runoff, which pollutes local water resources with excess phosphorus, changing the marine ecosystems (Schipanski et al, 2012). Overall, the effects of consuming large amounts of livestock is heavy on the environment, as humans could survive eating more plant matter, and therefore using less resources.

Benefits of Organic Agriculture

Despite the many environmental harms caused by agriculture, organic farming has emerged as a way to counter some of the negative impacts stemming from food production. One example of this is the positive effects of organic farming methods on soil. Using organic compost in fields helps provide food for organisms within soil that help soil become more fertile and produce better yields (Horrigan et al, 2002). In addition, using organic farming methods has been shown to improve soil biota as well as the food-webs within the soil compared to conventional farming methods (Henneron et al, 2015). Soil that is rich in beneficial bacteria and microbes requires less additional fertilizers and allows plants to grow stronger and healthier, reducing the need for pesticides (Henneron et al, 2015).

Organic agriculture also reduces the energy input of crop production. Studies on organic agriculture show that energy use decreased per unit of land and per unit of crop yield compared to conventional farming methods (Gomiero et al, 2008). This is due to the high amount of energy used in chemical fertilizer and pesticide production, which are substituted by natural methods in organic production (Gomiero et al, 2008). However, it is important to note that organic agriculture tends to use more land to produce the same amount of crops as conventional agriculture, so accounting for land can offset the energy gains (Tuomisto et al, 2011).

Organic agriculture also benefits water systems by lowering water pollution levels. For example, using organic farming methods decreases eutrophication caused by fertilizer runoff. Due to the lower amounts of chemical nutrients applied, the eutrophication potential per unit area is lower than in conventionally farmed areas (Tuomisto et al, 2012). In addition, organic agriculture forgoes the use of harmful chemical pesticides, helping to keep freshwater resources free from dangerous endocrine disruptors that can affect humans and wildlife (Horrigan et al, 2002).

Literature Review

As more people become aware of the environmental impacts of food production, more research is being done regarding consumers and their food choices in regards to sustainability.

Research on consumer food choice and environmental impacts is a newer field of investigation, and because of this, there are relatively few studies that focus on specific relationships between consumer behavior, knowledge, values, and demographic factors. Moreover, much of the research that has been done takes place outside of the United States, which highlights the need for a countrywide study to look at how relationships may vary in the United States as opposed to other areas of the world. In addition, this research, though looking at various relationships between consumer values, knowledge, behavior, and demographics, does not examine all four at once, and the specific topics of these studies vary from one study to another, making it more difficult to compare the results and draw general conclusions from them. My thesis will thus fill these gaps in the literature by examining all four topics: environmental knowledge, actual consumer behavior, consumer food related values, and demographic factors in a nation-wide study.

Prior research regarding consumer food choices and the environment examines several issues, which I will address in turn. Some research in this field looks solely at consumers' motivations for buying specific foods, or their food related values. For instance, a study conducted in Spain that asks college students to rate the importance of different positive motivations for buying food such as a food's natural content, the individual's ethical concerns, convenience, and more, concluded that consumer choices were based primarily on price concerns and taste (Carrillo et al, 2010). A separate Swiss study questions adults about their food related values such as naturalness, price, and quality, and also asked participants to rate their interest in foods that fell into different categories (Hauser et al, 2013). The study showed that people who value environmental sustainability had higher preferences for organic foods and fair trade products, but that this value was overshadowed when consumers valued low price products as well (Hauser et al, 2013). In a different study, consumers in Serbia reported putting "high quality" as their biggest motivation for buying organic and fair trade products, while a study of community supported agriculture (CSA) programs in Arizona found it difficult to determine whether participation in these programs was a result of environmentally altruistic attitudes, or whether CSA members learned to value the environment through the closer relationship they formed with local farmers (Driouech et al, 2011; MacMillan et al, 2012).

Another area of food choice and environmental research investigates differences in values and knowledge across demographic groups. However, these studies focus mainly on consumer willingness to change their food consumption habits to ones that are more sustainable. One of these studies goes in depth regarding consumers' willingness to adopt new behaviors and what motives can influence them to change their food purchases. Consumers were asked about their food related attitudes, what food purchasing behavior they thought would be less environmentally harmful, as well as different ways in which they would be willing to lower their environmental impacts through food consumption (Tober et al 2011). Participants in this study perceived purchasing organic foods and lowering meat consumption as the least environmentally beneficial options available, which highlights a critical disconnect between consumer knowledge and the environmental impacts of food production. The study also showed that people were least willing to make changes in their food consumption by lowering meat consumption or buying organic meats (Tobler et al, 2011). Looking at demographics, the study shows more willingness among women than men to substitute other foods for meat or to buy local, organic items (Tober, et al. 2011). Finally, a separate Australian study that also looked at the relationships between values, willingness to make changes, and demographics found that in comparison to others, women and those who reported having strong political and ecological values are willing to pay more for foods that have been farmed in a sustainable way (Lockie et al, 2004). However, while providing important information regarding consumers' self reported willingness to make changes in their purchasing behavior, this study provides no information about what consumers actually purchase.

Other studies that examine values, behavior, demographics, and knowledge often look at only one environmental impact at a time. One Flemish online survey asks participants about their knowledge of the concept of an ecological footprint and how it is affected by their food choices, particularly focusing on CO2 and other greenhouse gas emissions through livestock production. The study also asks participants to rank the level of greenhouse gas emissions for different industry sectors, to score their perceived effectiveness of lifestyle changes in lowering their ecological footprint, to record their actual meat consumption patterns, as well as to rank their willingness to pay more for organic meats or meat replacements (Vanhonacker et al, 2012). The Flemish study showed that even those who seemed to make environmentally beneficial changes in their life such as personal waste reduction often underestimated the environmental impacts of their food choices, livestock consumption in particular. However those who perceived their actions as having a large effect on their ecological footprint tended to make more environmentally friendly choices (Vanhonacker et al, 2012). Additionally, participants who were categorized as being "active" or "conscious" in their willingness to adopt environmentally friendly behaviors were generally older and more educated (Vanhonacker, et al, 2012). A different study based out of Finland assessed consumers' understanding of climate change and their concern over it, and if those values were reflected in how often they buy foods that are considered climate friendly (Korkala et al, 2014). In focusing on the impacts of food production on climate change, this study too looks at greenhouse gas emissions as the main factor for scoring climate friendly foods. The study found that females and those who reported a high concern for climate change raised their Climate Friendly Diet Score (CFDS), and those who were unemployed had low CFDS's (Korkala et al, 2014).

An Indian demographic study that highlights important relationships between values and knowledge reviewed the environmental values of consumers and their level of awareness about environmental issues, but focused on green products as a whole, including green-labeled foods (Bhatia & Jain, 2013). This study showed no gendered difference between green consumer values, as well as no statistically significant difference between consumer preferences and purchase intention based on education level (Bhatia & Jain, 2013).

A Midwest-based study showed that the only demographic factor that seemed to influence a person's intention to buy sustainably produced foods was their marital status (Robinson & Smith, 2012). The same study did not find any links between those who were most likely to have purchased sustainable foods and gender, education level, or income, but cites that previous research in the area has mixed results (Robinson & Smith, 2012). This study includes a sample from the US to show an interesting relationship between demographics and purchasing intention, but it is difficult to relate intention to actual purchasing behavior.

In sum, prior research has shown that consumers put the highest value on cost when purchasing foods, that they generally undervalue livestock production as an environmental harm, and that there are varied demographic relationships between willingness to adopt environmentally conscious consumption habits. However, there are several gaps in the literature, and the demographic studies are inconclusive compared to one another. My thesis aims to fill the gaps identified in existing studies. I will be looking not only at an individual's knowledge of the environmental impacts of their food choices and their food related values, but will be looking at this information along with their actual consumption behavior and demographic information.

Based on the previous literature, I predict that those who highly value cost and convenience when purchasing food will have higher environmental harm scores. I also predict that those with more knowledge of the environmental impacts of their food choices will act in less environmentally harmful ways when making food consumption choices. Although demographic results vary, I predict that differences in the relationship between knowledge and behavior will be seen across gender lines, with females having a stronger connection. I also predict that those with higher education levels and higher income levels will act in more environmentally harmful ways when consuming foods, due to the positive relationship between income and meat consumption. Finally, although not based on previous studies, my knowledge of people and the impacts of food productions has led me to predict that those who value health, the environment, buying organic, buying local, and eating humanely raised meat will have lower environmental harm scores.

Methods

Survey Distribution

To obtain information about consumption and consumers' environmental knowledge, I designed a four-part survey with questions directed towards gaining information regarding individuals' food consumption behavior, food related values, environmental knowledge, and demographics information. Using Amazon's Mechanical Turk (MTurk), I allowed 154 registered MTurk respondents to follow a link to the survey, which was created using the survey software Qualtrics. Qualtrics allows researchers to create surveys with many different types of question formats, and provides results in downloadable files that are compatible with data analysis programs.

MTurk allows researchers to pay respondents to complete online tasks, such as surveys. The researcher deposits money into an online account, and is then able to set requirements for potential survey takers. I created an MTurk "task" that was available to MTurk respondents who were registered with the program as living in the United States. The task showed how much the respondents would be compensated upon completion of the survey, and approximately how much time the survey would take to complete. Once the task was posted online, Mechanical Turk respondents were able to preview the task and decide whether or not to accept it. Those who accepted the task were then provided a link to take the survey on Qualtrics, where they received a confirmation code once all questions were answered. The confirmation code then allowed workers to receive payment via MTurk.

Qualtrics comes with a feature known as skip logic, which allows researchers to set certain questions to skip to the end of the survey if the survey taker answers incorrectly. This was used at the beginning of the survey as a way of getting individuals' consent to take the survey, as required by the Institutional Review Board, as well as later in the survey as an attention check. Attention checks are used to identify those who are simply clicking answers without reading the questions in order to disqualify them from receiving a confirmation code.

Concerns have been raised regarding the validity of MTurk in creating results that can be generalizable to the public. However, Princeton University's Survey Research Center named Mechanical Turk a low cost way to attract a diverse survey audience (Survey Research Center, 2014). One study revealed that MTurk provides more diverse participants than college survey samples or standard online samples, and that the data are just as reliable as traditional survey distribution methods (Buhrmester, 2011). As the goal of this thesis is to conduct preliminary research to guide further studies, I decided that MTurk would provide a better sample population than surveying on the CU Boulder Campus or the surrounding community, and that it would be an appropriate method to recruit survey participants.

Survey Design

The survey was designed in four separate sections. The first part of the survey aimed at identifying the actual consumption behavior of individuals. Participants were shown a list of common foods, and were asked to rate the frequency of consumption on a 5-point Likert scale. The Likert scale ranged from less than once per month, 1-3 times per month, 1-3 times per week, almost daily, and once or more per day. The foods included were organic beef, nonorganic beef, organic chicken, nonorganic chicken, organic pork, nonorganic pork, organic dairy, nonorganic dairy, organic vegetables, nonorganic vegetables, and eggs.

Based on the results of this section, each participant was given an eco-score using the weighted environmental impact scores from Table 1. This eco-score was calculated by multiplying participants' responses regarding the frequency consumption of each food with the food's weighted environmental impact score. The goal of this thesis is to include multiple environmental impacts in the participants' environmental scores, as opposed to focusing on just one impact like many previous studies. However, a complete Life Cycle Analysis database for the environmental impacts of foods in the United States is incomplete, so the environmental impact of each of the foods was determined by creating a scale based on two existing studies.

One of the studies explored land use, water use, nitrogen burdens and greenhouse gas emissions resulting from the production of beef, poultry, pork, dairy, and egg products in the United States (Eshel et al, 2014). The other study, based in Switzerland, created an eco-indicator score for organic and integrated meats and vegetables (integrated agriculture combines conventional and organic methods) (Jungbluth et al, 2000). The Swiss study notes that the least sustainable meats are about seven times more harmful for the environment than the most sustainable meats, a difference that matched the numbers in the first study. The two studies combined thus allowed a comparison of the relative environmental impact of beef, poultry, pork, dairy, egg, and vegetable production. Due to the high seasonal variability of fruits, LCA data on fruit production was not included in the survey.

The Swiss study only looked at organic and integrated farming methods, so an assumption was made that the difference in environmental impacts between organic and integrated farming were the same as between integrated and conventional farming. Then, comparing those numbers to the American study, environmental impact scores were created for nonorganic beef, organic beef, nonorganic chicken, organic chicken, nonorganic pork, organic pork, nonorganic dairy, organic dairy, nonorganic vegetables, organic vegetables, and eggs. The scores were then weighted so that the lowest impact score would equal 1, with additional scores created for the other five categories. The scoring is shown in Table 1.

Table 1:

Type of Food	Eco-Score (Eco-Points/kg)	Weighted Score
Nonorganic Beef	0.12	80
Organic Beef	0.043	28.667
Nonorganic Poultry, Pork, Dairy	0.017	11.334
Nonorganic Veggies and Eggs	0.01	6.667
Organic Poultry, Pork, Dairy	0.007	4.667
Organic Veggies	0.0015	1

Each survey participant was then given an overall score for how environmentally conscious their consumption behaviors were reported to be. The frequency of consumption responses, ranging from less than once per month, one to three times per month, one to three times per week, almost daily, and once or more per day, were weighted on a scale from 1-5. The scale assigned 1 for the lowest frequency, representing a consumption of less than once per month, and 5 for the highest frequency, representing once per day or more. Then, the scores were multiplied with the food's environmental impact scores (Table 1) for organic beef, nonorganic beef, organic chicken, nonorganic chicken, organic pork, nonorganic pork, organic dairy, nonorganic dairy, organic vegetables, nonorganic vegetables, and eggs for each individual who took the survey. These numbers were summed to create one overarching eco-score for each participant.

The second section of the survey was designed to measure the respondents' knowledge regarding the environmental impacts of food production. The participants were shown a series of true facts and were asked to rate their awareness of the issues on a Likert scale with three possible responses. The available choices were; "Never heard of this concept", "Know of this concept, unsure if true", and "Am fully aware of this concept". The choices were weighted as 1, 2, and 3, respectively. The facts that were chosen for the knowledge section were all found from preliminary research about the ecological impacts of food production. Therefore, if a participant responds with "Am fully aware of this concept", that answer represents their knowledge of that particular impact. The facts included in the survey were as follows: The food we purchase has a large impact on our ecological footprint (Tobler et al, 2011). Organic farming decreases soil degradation (Henneron et al, 2015). Organic fruits and vegetables use less energy to produce than conventional fruits and vegetables because of the energy intensive pesticide production process (Gomiero et al, 2008). Organic farming decreases water pollution (Tuomisto et al, 2012). Producing one pound of beef requires 100 times more water than producing one pound of wheat

(Pimental, 1997). Nonorganic beef has approximately an 80 times greater environmental impact than organic vegetables (Eshel et al, 2014; Jungbluth et al, 2000).

Participants were then assigned a score to represent their environmental knowledge. This was done by adding the sum of their answers, ranged one through three, and averaging them. This resulted in each participant having a knowledge score between one and three, with three representing the highest level of environmental impact knowledge.

The third section in the survey was designed to gain information about the participants' food related values. Respondents were shown a list of values regarding the food they consume, and were asked to rate the level of personal importance of each of the values on a Likert scale of 1= Very important, 2=Neutral, and 3=Unimportant. This section included the following values: The food I consume should be convenient to purchase and prepare; The food I eat should be low cost; The food I eat should be healthy; The food I eat should be locally grown, when possible; The food I eat should have a low environmental impact; The food I eat should be organic; The meat I consume should be humanely raised; I don't care how it's produced, it should taste good.

The last part of the survey asked a series of questions related to respondent demographics. Participants were asked about their age, and were able to select a choice from specific age categories. They were then asked to pick their gender out of a selection of three choices: male, female, and not specified. Participants then chose the highest level of education completed from the list provided. The next question asked about their income level, with participants given different income ranges to choose from. The last question of the survey asked participants to choose their political affiliation, with respondents given the choices of republican, independent, democratic, and not specified. The complete survey can be found in the appendix.

Data Analyses

Once the data were collected, data were cleaned to eliminate missing values and incomplete responses. For example, survey responses that failed the attention checks, came from IP addresses outside the United States, or clearly answered questions dishonestly by choosing all answers within one path down the survey were deleted. The data were then uploaded via a CSV file to Stata, a statistical software package compatible with the results downloaded from Qualtrics.

Then I determined which type of analyses would be useful for each of my research questions. The first question to be answered is as follows: Is there an association between knowledge of the environmental impacts of food choices and consumption behavior? To test this relationship, I created two variables, one for behavior and one for knowledge. The behavior variable was the summed eco-score for each individual survey, which was determined by multiplying respondents' consumption frequencies from section one of the survey with the calculated eco-scores of each food found in Table 1. The knowledge variable consisted of the responses from section two of the survey averaged for each individual, resulting in a number between one and three. The knowledge score was recoded to range from zero to two instead of one to three. Ordinary Least Squares (OLS) regressions were then used to determine the relationship between behavior and knowledge.

The second research question looked for an association between a consumer's food-related values and consumption behavior. To determine whether significant associations between these factors exist, each of the eight values (excluding the attention check question) were regressed separately with behavior. Before they were regressed, each of the variables were recoded to be dummy variables, with the environmentally favorable answer given a value of 1, and the neutral and environmentally harmful answers given a value of zero. The answers of "unimportant" for the values of convenience, low cost, and emphasis on taste were considered environmentally friendly and coded to be equal to 1. The answers of "very important" for the values of health, locally grown, low environmental impact, organic, and humanely raised were considered environmentally friendly and also coded equal to 1.

My third research question asks whether the relationship between knowledge and behavior is stronger for those with specific food-related values than for those without these values. To answer this question, I regressed behavior on knowledge and each of the eight food-related values, running a separate regression model for each food related value. I then determined which results were either statistically significant (p value of less than .05) or marginally significant ($.05 < p < .1$). From there, statistically significant or marginally significant results were then analyzed using interaction terms, allowing me to determine whether the association between behavior and knowledge differs for respondents with different food-related values.

Finally, my last research question asks whether the association between knowledge and behavior varies according to an individual's demographic characteristics, including age, gender, education level, income level, and political affiliation. To answer this question, I recoded the "education" variable to have only four categories: No high school, High School, Some College/Undergraduate Degree, and Master's/Ph.D/Advanced Degree. I then ran a series of OLS regression models that examined the relationship between behavior and each of the demographic factor questions. For those results that were either statistically or marginally significant, I then ran OLS models with interaction terms to determine whether the association between behavior and knowledge varies according to respondents' demographic characteristics.

Results

Table 2 below shows the descriptive statistics of the survey respondents. A slight majority of respondents (55.2%) were male, and 44.8% of respondents were female. There were 23 respondents between the ages of 18–22 (14.9%), 50 respondents between the ages of 23–30 (32.5%), 53 respondents between the ages of 31–40 (34.4%), 20 respondents between the ages of 41–55 (13%), 7 respondents between the ages of 55-65 (4.6%), and one respondent over the age of 65 (0.7%). The most common education level completed was an undergraduate degree (44.2% of respondents), with 13.6% of respondents having completed high school or an equivalent, 32.5% having completed some college, and 9.7% having completed a Master's degree, Ph.D or other advanced degree. 23.7% of respondents had an annual household income less than $25,000, 30.5% had an income between $25,000–$49,999, 21.8% had an income between $50,000–$74,999, 14.9% had an income between $75,000–$99,999, and 11% of respondents had an income of greater than $100,000 per year. The most common political affiliations chosen were democratic (42.9%) or independent (35.1%), with the remaining population split evenly between republicans (11%) and those who chose not specified (11%).

Table 2: Descriptive Statistics

Demographics	Frequency n=154	Percentage (%)
Gender		
Male	85	55.19
Female	69	44.81
Age (Years)		
Under 18	0	0.00
18-22	23	14.94
23-30	50	32.47
31-40	53	34.42
41-55	20	12.99
55-65	7	4.55
Over 65	1	0.65

Education Level		
No High School	0	0.00
High School/GED	21	13.64
Some College	50	32.47
Undergraduate Degree	68	44.16
Master's Degree	13	8.44
Ph.D/ Advanced Degree	2	1.30
Annual Household Income		
Under $25,000	35	22.73
$25,000–$49,999	47	30.52
$50,000–$74,999	32	20.78
$75,000–$99,999	23	14.94
Over $100,000	17	11.04
Political Affiliation		
Republican	17	11.04
Independent	54	35.06
Democratic	66	42.86
Not Specified	17	11.04

Behavior, Knowledge, and Food Related Values

Table 3 lists the descriptive statistics for both the behavior and the knowledge variables used in the analyses. Behavior scores ranged from 206.35 Eco-Points, the most environmentally friendly score, to 601.7 Eco-Points, with a mean of 381.3 and a standard deviation of 88.4. Knowledge scores ranged from 0–2, with an average knowledge score of .99 and a standard deviation of .51. A knowledge score of 0 represents the least knowledge, while a score of 2 represents the most.

Table 3: Descriptive Statistics for Behavior and Knowledge

Variable	Mean	Std. Dev.	Minimum	Maximum
Behavior (Eco-Points)	381.31	88.39	206.35	601.70
Knowledge	0.99	0.51	0	2

n = 154

Table 4 lists the descriptive statistics for the food-related value variables used in the analyses. The data are shown as the frequency and percentage of responses that were the categorized as the environmentally favorable responses. The values of convenience, low cost, and taste were coded to use "unimportant" as the most environmentally favorable response. 5 respondents (3.25%) rated convenience as being unimportant to them while making food choices, while 7 respondents (4.55%) rated low-cost foods as being unimportant, and 39 respondents (25.32%) said that it was unimportant for their food to simply taste good, regardless of the methods used to produce it. The values of health, locally grown, low environmental impact, organic, and humanely raised meat were coded as using the response of "very important" as the environmentally favorable response. 124 respondents (80.52%) rated health as being very important to them when making food choices, 64 respondents (41.56%) rated locally grown foods as being very important, 59 respondents (38.31%) rated low environmental impact foods as being very important, 28 respondents (18.18%) said it was very important that their food be organic, and 89 respondents (57.79%) rated humanely raised meat as being very important to them.

Table 4: Descriptive Statistics for Environmentally Favorable Food-Related Value Responses

Food-Related Values	Frequency of Favorable (n=154)	Percentage (%)
Convenience	5	3.25
Low Cost	7	4.55
Healthy	124	80.52
Locally Grown	64	41.56
Low Environmental Impact	59	38.31
Organic	28	18.18
Humanely Raised	89	57.79
Taste	39	25.32

To determine whether environmentally beneficial food consumption behavior is associated with environmental knowledge, I first regressed behavior on knowledge. Table 5 shows that knowledge is marginally associated with behavior (p=.08) such that for each 1-unit increase in knowledge, environmental behavior improves by 24.3 Eco-Points.

Table 5: Behavior Coefficient for Regressions of Behavior and Knowledge

	Model 1
Knowledge	-24.3^{+}
	(13.83)
n	154
R^2	0.02

+ p<.10, * p<.05, ** p<.01, *** p<.001

I then regressed behavior on each of the eight food-related values (Table 6). Table 6 shows that four of the food-related values, convenience, healthy, low impact, and organic, are associated with behavior in the expected direction. As convenience, health, low impact, and organic values each increase, so too does environmentally oriented food consumption behavior. Checking unimportant for the convenience value decreased behavior scores by 86.42 Eco-Points (p = .03), while checking very important for the healthy, low impact, and organic values decreased behavior scores by 42.67 Eco-Points (p = .04), 36.66 Eco-Points (p = .04), and 55.1 Eco-Points (p = .06), respectively.

Table 6: Coefficients for Regressions of Behavior on Food-Related Values

Values	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Convenience	-86.42*	—	—	—	—	—	—	—
	(39.70)	—	—	—	—	—	—	—
Cost	—	28.84	—	—	—	—	—	—
	—	(34.23)	—	—	—	—	—	—
Healthy	—	—	-42.67*	—	—	—	—	—
	—	—	(17.71)	—	—	—	—	—
Locally Grown	—	—	—	-20.38	—	—	—	—
	—	—	—	(14.41)	—	—	—	—
Low Impact	—	—	—	—	-36.66*	—	—	—
	—	—	—	—	(14.40)	—	—	—
Organic	—	—	—	—	—	-55.10**	—	—
	—	—	—	—	—	(17.98)	—	—
Humanely Raised	—	—	—	—	—	—	-22.32	—
	—	—	—	—	—	—	(14.35)	—
Taste	—	—	—	—	—	—	—	-1.22
	—	—	—	—	—	—	—	(16.43)
n	154	154	154	154	154	154	154	154
R^2	.03	.00	.04	.01	.04	.06	.02	.00

+ p<.10, * p<.05, ** p<.01, ***p<.001

In order to determine whether the association between behavior and each of the significant variables in Table 6 is explained in part by respondents' environmental knowledge, I then inserted knowledge into each of the regression models from Table 6 that had statistically significant coefficients (Table 7). Table 7 indicates that inserting knowledge into these equations has little effect on the convenience coefficient, but reduces the absolute value of the healthy, low impact, and organic coefficients by 11.22%, 12.79%, and 7.84%, respectively. This indicates that the effect of these variables on environmentally conscious food consumption behavior is explained in part by respondents' environmental knowledge.

Table 7: Coefficients for Regressions with Behavior on Values, Controlling for Knowledge

	Model 1	Model 2	Model 3	Model 4
Knowledge	-24.96^{+}	-18.37	-15.66	-16.92
	(13.66)	(13.97)	(14.26)	(13.80)
Convenience	-87.98*	—	—	—
	(39.41)	—	—	—
Health	—	-37.88*	—	—
	—	(18.04)	—	—
Low Impact	—	—	-31.97*	—
	—	—	(15.00)	—
Organic	—	—	—	-50.78**
	—	—	—	(18.29)
n	154.00	154.00	154.00	154.00
R^2	0.05	0.05	0.05	0.07

+ p<.10, * p<.05, ** p<.01, *** p<.001

Finally, to determine whether the effect of environmental knowledge on behavior is stronger for those who hold pro-environmental values, I added a term for the interaction between knowledge and values to the models listen in Table 7. However, as Table 8 indicates, none of these interaction term coefficients are statistically significant.

Table 8: Coefficients for Interaction Regressions of Behavior on Knowledge and Values

	Model 1	Model 2	Model 3	Model 4
Knowledge	-24.63+	-31.11	-3.84	-10.26
	(13.94)	(28.91)	(16.56)	(15.09)
Convenience	-78.99	—	—	—
	(81.08)	—	—	—
Knowledge x Convenience	-9.60	—	—	—
	(75.67)	—	—	—
Healthy	—	-51.94	—	—
	—	(33.26)	—	—
Knowledge x Healthy	—	16.64	—	—
	—	(33.05)	—	—
Low Impact	—	—	17.51	—
	—	—	(38.56)	—
Knowledge x Low Impact	—	—	-45.01	—
	—	—	(32.32)	—
Organic	—	—	—	-3.99
	—	—	—	(46.79)
Knowledge x Organic	—	—	—	-40.33
	—	—	—	(37.12)
n	154	154	154	154
R^2	0.05	0.05	0.06	0.07

+ p<.10, * p<.05, ** p<.01, *** p<.001

Behavior and Demographic Factors

Table 9 below lists the coefficients for the regressions of the behavior on each of the different demographic variables. Somewhat surprisingly, there were no significant relationships between behavior and any of these variables, though this may be due to the relatively small number of observations in the sample.

Table 9: Coefficients for Regressions of Behavior on Demographics

Demographics	Model 1	Model 2	Model 3	Model 4	Model 5
Age	-0.76	—	—	—	—
	(6.67)	—	—	—	—
Gender	—	-9.47	—	—	—
	—	(14.35)	—	—	—
Education	—	—	8.98	—	—
	—	—	(14.81)	—	—
Income	—	—	—	7.74	—
	—	—	—	(5.52)	—
Political Affiliation	—	—	—	—	-8.63
	—	—	—	—	(8.57)
n	154	154	154	154	154
R^2	0.00	0.00	0.00	0.01	0.01

+ p<.10, * p<.05, ** p<.01, *** p<.001

Discussion and Conclusion

In a society where agriculture and food production accounts for such a large portion of human impacts on the environment, understanding consumption behavior is important for making large-scale changes to create more sustainable consumption patterns in the United States. The goal of this study was to identify if consumers behaved in more environmentally responsible ways when consuming food based on their knowledge of the environmental impact of their food choices, their food-related values, or their demographic characteristics, as well as if environmental knowledge may account for some of the association between consumption behavior and certain food-related values.

This research found that there is an association between a consumer's knowledge of the environmental impacts of their food choices and environmentally conscious consumption behavior. This supports the idea that those who have more knowledge of the environmental impacts of food production tend to consume foods with lower eco-scores, therefore lowering their environmental impact from food consumption. This research also found that certain food-related values are associated with environmentally conscious consumption behavior. For example, consumers who do not value convenience when making food choices tend to behave in more environmentally responsible ways when consuming food, while consumers who place importance on healthy foods, foods with low environmental impacts, and organic foods tend to make more sustainable food choices. The food-related values of health, low environmental impact, and organic were partially explained by a consumer's knowledge of the environmental impacts of their food choices. However, the effect of environmental knowledge on consumption behavior does not vary according to a consumer's food-related values. Finally, there was no association found between a consumer's behavior and their demographic characteristics.

These results provide an opportunity to educate the public about the environmental impacts of food production in an effort to encourage more sustainable food purchases. The positive relationship between environmental knowledge and behavior suggests that increasing awareness of the harmful impacts of food production will positively influence how people act when making food choices. In addition, environmental education may help create more positive food-related values in individuals, leading them to increase their consumption of healthful, organic, and low-impact foods. People cannot begin to think about the environment as a deciding factor while making food choices if they are unaware of the positive change their actions could make individually. Therefore, the results of this study support a belief that environmental education in schools, media, and various community programs would be an effective place to use resources dedicated to lowering the US ecological footprint.

This thesis was limited, in part, by its small sample size. A larger number of observations would have provided a sample population that was more generalizable to the American public, leading to more accurate statistical data. With a sample size of n=154, some relationships may have been skewed due to certain variables having only a small number of observations for specific answers. For example, only 5 of the 154 participants rated "unimportant" for the value of convenience, which could account for some of the significance of the regression for behavior on convenience. Another limitation of the study lies in the inability to use an official LCA database for agricultural impact scores. An official LCA database would have allowed the survey to present a more comprehensive list of food options in order to more truthfully model participants' food consumption behavior. This would have created more accurate behavior scores, accounting for sustainability differences in a diverse selection of diets. A third limitation of this study was the use of categorical data collection instead of using questions that would provide continuous data. This study could have benefited by allowing participants to rate their values on a sliding scale, instead of a 3-point Likert scale.

A possibility for further research is to do a more in-depth study using complete LCA data when it becomes available, providing more food category options to better represent individuals' actual consumption patterns. Additionally, a study with more questions regarding environmental knowledge would provide a more accurate measure of participants' knowledge of the environmental impacts of food production. Similarly, it could be beneficial to include more value-related questions to get a better look at how environmental knowledge accounts for certain values held by consumers. Following an additional study, it would be beneficial to look into different types of environmental education methods to determine the best way to increase consumer awareness of the impacts of food production, therefore leading to positive behavioral changes.

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Appendix: Survey

Consumption Behavior
How often do you consume the foods below? Check the most appropriate box.

	Less than once/month	1-3 times/month	1-3 times/week	Almost daily	Once/day or more
Nonorganic Beef					
Organic Beef					
Nonorganic Chicken					
Organic Chicken					
Nonorganic Pork					
Organic Pork					
Nonorganic Dairy					
Organic Dairy					
Eggs					
Nonorganic Vegetables					
Organic Vegetables					

Knowledge/Awareness of impacts
Rate your level of awareness by checking the most accurate box:
1= Never heard of this concept
2=Know of concept, unsure if true
3=Am fully aware

	1	2	3
The food we purchase has a large impact on our ecological footprint			
Organic farming decreases soil degradation			
Organic fruits and vegetables uses less energy to produce than conventional fruits and vegetables because of the energy intensive pesticide production process			
Organic farming decreases water pollution			
Producing one pound of beef requires 100 times more water than producing 1 pound wheat			
Nonorganic beef has approximately an 80 times greater environmental impact than organic vegetables			

Food Values
Rate how important each of the following is to you:
1= Very important
2= Neutral
3= Unimportant

	1	2	3
The food I consume should be convenient to purchase and prepare.			
The food I eat should be low cost.			
The food I eat should be healthy.			
The food I eat should be locally grown, when possible.			
The food I eat should have a low environmental impact.			
The food I eat should be organic.			
Please check very important for this question. *(This was an attention check)*			
The meat I consume should be humanely raised.			
I don’t care how it’s produced, my food should taste good			

Demographics
Circle the appropriate choices:

Age:
- Under 18
- 18-22
- 23-30
- 31-40
- 41-55
- 55-65
- Over 65

Gender:
- Female
- Male
- Not Specified

Education Completed:
- Did not complete high school
- High school/GED
- Some College
- Undergraduate Degree
- Master’s Degree
- Ph.D. or other Advanced Degree

Annual Household Income:

- Under $25,000
- $25,000-$49,999
- $50,000-$74,999
- $75,000-$99,999
- Over 100,000

Political Affiliation:

- Republican
- Independent
- Democratic
- Not Specified