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Consumers' Willingness to Pay for Hydroponic Lettuce

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ABSTRACT

With continued advances in hydroponic plant production technology, an increasing number of farms have begun using hydroponic techniques to grow leaf lettuce and other food crops in a controlled environment. Recent controversy about the ongoing inclusion of hydroponics in the USDA organic program has highlighted uncertainty about marketing for hydroponic crops. In November 2017, the National Organic Standards Board voted not to recommend that hydroponic farms be banned from applying for organic certification. Since then, continued controversy has led a group of organic producers to start an additional independent certification program that would exclude hydroponic crops. While hydroponic production may provide benefits to producers, it is unclear how consumers currently perceive hydroponic production. This study used a non-hypothetical choice experiment with responses from 198 supermarket shoppers to estimate consumer willingness to pay for hydroponic and traditional lettuce both with and without organic certification. Randomized groups of shoppers were presented with one of three types of information about hydroponic production to determine if specific types of marketing might shift their attitudes and willingness to pay. The group of consumers not informed about hydroponic benefits required a significant discount to choose hydroponic lettuce, while groups that received positive information were indifferent between lettuce grown hydroponically or traditionally. In addition, providing information significantly improved attitudes toward the inclusion of hydroponics in the organic program.

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CONTENTS

INTRODUCTION

As the twenty-first century moves past its first decade, world population continues to grow rapidly. In a 2009 address, Jacques Diouf, the director-general of the UN Food and Agriculture Organization, pointed out the challenges that agriculture faces as global population grows toward a predicted 9.1 billion people by 2050. He noted that this growth will be an urban trend occurring entirely within the countries of the developing world (Diouf 2009). In fact, as of 2014 more than half of the world's population were already living in cities (UNDESA 2014). Demand for agricultural products is expected to double with these demographic shifts, so there will be additional stress placed on resources like land, water, and biodiversity as rising incomes shift consumer preferences toward food of higher quality (Diouf 2009). Meeting these global challenges will require innovation and increased efficiency from the agriculture industry.

History of the Hydroponic Industry

Food production can be increased either by farming more land or by increasing the productivity of land already under cultivation. The success of the Green Revolution over the past century was driven mainly by the adoption of improved plant varieties, along with the optimized use of inputs (Pingali 2012). With limited new arable land available, productivity enhancements remain a promising direction for agricultural progress (Wik, Pingali, and Broca 2008). Much modern agricultural research is focused on improving plant productivity via biotechnology and optimized input use (Borlaug 2000). Another method of improving plant yields involves controlling the environment itself. Examples of controlled environment agriculture (CEA) usually involve greenhouses or indoor systems. In addition to temperature control, many of these operations use hydroponic cultivation methods, where plants are raised without any soil, with the nutrients being delivered through water. Yields can be far higher using these systems due to higher density and an increased number of harvests per year (Barbosa et al. 2015).

Hydroponic techniques have been utilized as far back in history as Babylon's hanging gardens, but in the last several decades, improvements in artificial lighting, plastics, and plant science have made these systems increasingly popular (Jones, J. Benton 1997; Resh 2001). With these advances, farmers can substitute electric lighting for inconsistent sunlight, reuse irrigation water multiple times, stack plants vertically to save space, and precisely control nutrient levels to support rapid plant growth. While CEA growing systems make up only a small portion of total US lettuce production, their economic impact is sizeable. In 2014, sales of greenhouse-grown food crops in the United States approached 800 million dollars. Approximately 73% of this greenhouse production was hydroponic, with tomatoes and lettuce as the most important greenhouse crops generating more than 400 and 55 million dollars respectively (Vilsack and Reilly 2015).

Well-managed hydroponic operations may be able to claim sustainability advantages relative to field production. By heating or cooling the growing environment as needed, farmers can locate greenhouses near population centers in harsh climates. This can potentially reduce transit time and nutrient loss during shipment (Despommier 2010; Barrett 2007). Hydroponic operations also typically recirculate water within the system, at times reducing water usage by as much as 95% compared to outdoor growing (Despommier 2010). In addition, plants can grow in vertically stacked formats, reducing the amount of land used for production (Despommier 2010; Touliatos, Dodd, and McAinsh 2016). Since hydroponic systems eliminate soil contact, crops are often kept cleaner during harvest, and many operations report that enclosed growing areas reduce the need for pesticides (Kaiser and Ernst 2012; Brechner and Both 1996; Despommier 2010).

In light of the increasingly urban global population, a potential use for hydroponic farming is urban agriculture. Hydroponic systems allow for efficient crop production in a small area, and they provide protection from extreme climates and unpredictable weather (Despommier 2010). This often allows hydroponic farms to sell fresh products year-round and maintain consistent production even after weather events like hurricanes (Martin 2017). Of particular interest to city farmers is the possibility of growing hydroponically in urban areas with contaminated or missing soil since hydroponic systems require no soil contact (Biernbaum et al. 2016).

Despite the increasing use of hydroponic production, some critics contend that hydroponic agriculture is unsustainable due to its high energy use. Energy costs associated with artificial lighting and heating can be high for hydroponic farms, and the regional cost of electricity is one of the key considerations for some hydroponic farms since their crops grow indoors using only artificial light (Link 2016; Brechner and Both 1996). Some contend that these additional energy requirements largely offset any environmental benefits provided by hydroponic growing systems (Cox and Tassel 2010; Shackford 2014). As producers improve greenhouse design and find ways to increase lighting efficiency, however, this issue may pose less of a problem over time.

A good product marketing plan is often the difference between greenhouse operations that succeed and those that fail (Florida 2018). While retail and the food service industry are often the largest outlets for greenhouse-grown products, some hydroponic growers focus on selling high quality greens to restaurants, hotels, or customers at farmer's markets. One advantage of CEA production is consistent quality and availability, both of which provide value to retailers seeking reliability in their supply chains (Cook and Calvin 2005). Ultimately, however, consumers are the ones who choose products they prefer.

To remain profitable, CEA systems must often cover expenses not encountered in field growing. Initial construction of the greenhouse or indoor system takes extra capital, while running a reliable hydroponic system requires specialized knowledge and expertise. Finding a way to differentiate products at the consumer level and earn premium prices can be a key requirement for growers who need to justify the added expenses of hydroponic production. We chose to study consumer valuation for lettuce since it is one of the easiest crops to grow hydroponically and makes up a large part of the current hydroponic market (Kaiser and Ernst 2012; Vilsack and Reilly 2015). The Fayetteville-Springdale-Rogers, AR-MO metro area where our study was conducted was recently listed as one of the fifty urban areas most representative of the overall United States population (WalletHub 2016).

Several US producers have recently invested in large hydroponic farms in major urban areas to meet growing demand for locally grown, hydroponic greens (Link 2016). In the past decade, large hydroponic farms have been built in cities like Chicago, IL, New York, NY and Newark, NJ (Link 2016; McKay 2017). One company, Gotham Greens, recently announced plans to invest 12.5 million dollars building a second greenhouse in the Chicago area to serve the local market (Trotter 2018). Their first Chicago greenhouse was constructed in 2015 (Greens 2018). These companies seem to expect market growth and profitability if they can give consumers the product attributes they want. Despite the importance of hydroponic technology to the greenhouse industry, however, there is little research available about how consumers perceive and value the process of growing plants without soil.

Marketing Hydroponic Crops

In addition to basic attributes like appearance and taste, many modern consumers consider both how their food was made and how its production affects the environment. These credence attributes are not directly observable by the consumer and must be communicated in other ways (Nelson 1970; Darby and Karni 1973). Ecological claims, quality guarantees, and other "value-based labels" are increasingly being used to differentiate products based on superior quality or on specific aspects of their production process (McEachern and Warnaby 2008). When considering how consumers view hydroponically grown food, it is important to understand how their preferences toward production attributes are formed.

While consumer preferences for attributes like food safety and cleanliness may be relatively straightforward, the consumer perceptions of sustainability attributes can be more complicated. Vermeir and Verbeke (2006) propose an adapted consumer behavior model to help describe consumer purchase intent for sustainable food. They consider purchase intent as a function of three main components. The first, "personal values, needs, and motivation," links to a consumer's involvement in sustainability issues themselves. The second, "information and knowledge," determines the level of uncertainty the consumer feels regarding sustainability attributes. The third component, "behavioral control," mainly involves the ease of finding and purchasing sustainable food products (Vermeir and Verbeke 2006).

Since the information and knowledge component of the purchase process can be influenced relatively easily by industry and by policymakers, this study focuses on understanding how valuations toward hydroponic lettuce change when shoppers are provided with extra information. The best choice of communication method for this information depends both on cost and effectiveness. In a 2008 study of labelling by McEachern and Warnaby, 80% of the respondents were interested in receiving more information about standards behind food labels. When asked to list their preference of information source, 60% chose in-store leaflets, 14% chose television, and only 3% chose labels on the product itself (McEachern and Warnaby 2008). Despite the value of tools like leaflets and television these approaches can be costly and complex, and package labels remain one of the most important ways to communicate product information that cannot be directly seen by the shopper (Howard and Allen 2006).

In the United States, the organic label has emerged as a way to easily communicate numerous credence attributes related to food production (Briggeman and Lusk 2011). The market for organic products has grown quickly since the labeling program was established, with organic food sales growing 8.4% in the United States to reach a total of $43 billion in 2016 ("Robust Organic Sector Stays on Upward Climb, Posts New Records in U.S. Sales" 2017). Organic fruits and vegetables have proven especially popular, with organic products holding an estimated 15% market share in these categories ("Robust Organic Sector Stays on Upward Climb, Posts New Records in U.S. Sales" 2017). One industry survey found that approximately 44% of consumers reported being willing to pay a premium of 20% or more for organic vegetables (Meyer 2018).

Until recently, it was difficult or impossible for hydroponic farmers to utilize the organic label. For the last several years, however, the USDA National Organic Program (NOP) has allowed certain hydroponic farms to receive certification in spite of recommendations by the National Organic Standards Board (NOSB) that hydroponics not be included in the organic program (Dewey 2017). This discrepancy reflects long-standing controversy in the industry regarding the legitimacy of hydroponics as part of an organic system. As far back as 1995, some advocates for organic production criticized hydroponic systems for lacking organically-derived nutrients (Jones, J. Benton 1997).

The recent debate has focused on the central role of soil health in the official definitions of organic agriculture (Dewey 2017; "Fall 2017 National Organic Standards Board (NOSB): The Organic Trade Association (OTA) Summary Report" 2018). While hydroponic operations may provide environmental benefits by avoiding soil completely, soil management is an important element in the original vision for organic farming and soil has been found to play a large role in managing atmospheric carbon levels worldwide (Biernbaum et al. 2016; Hayduk, Satoyama, and Vafadari 2015).

A 2016 report from a subcommittee of the NOSB highlighted the political opposition to hydroponics in the organic program as follows: “No matter what one thinks about which path is best, we can all accept that many in the organic community are opposed to the inclusion of hydroponic as organic. Failure to address that concern will inevitably undermine public and farmer support for the USDA Organic label” (Biernbaum et al. 2016). In support of this claim, they referenced a 2016 letter to the USDA secretary requesting an end to organic hydroponic certifications. The letter was “signed by 65 organic leaders, 15 former NOSB members, and 40 organizations whose total membership exceeds 2.2 million people” (Biernbaum et al. 2016).

In late 2017, the NOSB reconsidered the issue again at a meeting in Jacksonville, Florida. In a vote on November 1, the board failed to pass a motion to exclude hydroponic production from the organic program (“Voting Summary” 2017). This made it clear that hydroponic operations could continue to apply for organic certification and helped to clarify the future regulatory environment for organic hydroponic producers (Dewey 2017). Controversy continues, however, as some farmers express disappointment with the current direction of the organic program (Dewey 2017). Frustrated with recent changes, a group formed a new organization called the Real Organic Project which has announced plans to provide an independent certification to be used in addition to the organic label to indicate that products were not hydroponic or raised on farms that deny pasture access to their livestock (Rathke 2018).

Organic premiums are important incentives for farmers who transition into organic growing, and consumer trust is an important factor supporting those premiums (Delbridge et al. 2017). If consumers require a discount when lettuce is labeled as hydroponic, then allowing unlabeled hydroponic lettuce to use the organic label might eventually reduce organic premiums if consumer perceptions toward hydroponics remain negative. Following the logic of Lusk and Schroeder (2005) in their analysis of unlabeled genetically modified products, consumers who dislike hydroponic production and suspect that an organic product may have been grown hydroponically may reduce their valuation of the organic label accordingly (Lusk et al. 2005). If consumers demonstrate a consistent discount for hydroponic lettuce that does not diminish over time, organic program policymakers may want to consider excluding hydroponic crops or requiring an additional label identifying hydroponically grown products in the organic program in order to preserve the integrity of organic branding.

While organic labeling is one of the most recognizable options, there are alternate ways to differentiate hydroponic products. Programs like state marketing initiatives and "natural" labeling have shown various levels of success in earning consumer premiums (Onken, Bernard, and Pesek 2011). Marketing products as "locally grown" can also be an attractive option, but it requires efficient local distribution and limits the geographic extent of the market. Another possibility is promoting hydroponic production itself. Since hydroponic systems are typically the most notable difference between greenhouse and open-field farming, directly highlighting the benefits of hydroponic growing may offer a unique strategy for marketing (Narine, Ganpat, and Ali 2014). If there are ways to directly highlight the benefits of hydroponic production, producers may not need to pursue other certifications. It is unclear, however, what hydroponic benefits would be most relevant to consumers. While one recent study investigated the effect on consumer valuations of a set of general information about vertical, greenhouse, and field farming, we are unaware of any research on consumer valuations toward hydroponic compared to traditional crops or about consumer valuations toward specific benefits of hydroponic production (Coyle and Ellison 2017).

To test these differences, our study used an experimental design to test three types of positive information by randomly assigning respondents to treatment groups. One set of information focused on the environmental benefits of hydroponics. These participants were told how hydroponics can reduce water and land use. Another group was told how hydroponic growing systems can reduce pesticide use and soil contact. The third set of information explained how hydroponic farms can be located near densely populated areas even in harsh climates, reducing transit time from the product to the store. These three messages capture some of the most commonly cited benefits for hydroponic growing, and allowed for a test of what hydroponic production factors consumers might value.

Studying Consumer Valuations

There are several options for eliciting consumer valuations. Over the last decade, methods like conjoint analysis and contingent valuation have increasingly been replaced by more popular techniques like experimental auctions and choice experiments (Corrigan et al. 2009; Akaichi, Nayga, and Gil 2013). While experimental auction results are easily analyzed, it can be challenging to quickly introduce new participants to auction procedures in a supermarket setting (Corrigan et al. 2009). In contrast, choice experiments allow for valuation of multiple attributes at once within a presentation that realistically mimics an actual purchase decision (Lusk et al. 2004).

Choice experiments align with the 1966 theories of Lancaster by attributing utility gains that individuals receive from a purchase to specific attributes of the products themselves (Lancaster 1966; Corrigan et al. 2009). The frequency of choice can then be modeled according to McFadden's random utility theory, where observed choice frequencies are assumed to capture both observable population preferences and unobservable individual preferences (McFadden 1973).

More importantly for the validity of the valuation results is the choice between hypothetical and non-hypothetical experimental methods. There is well-documented evidence of hypothetical bias in valuations when consumers are not forced to make an actual purchase as a result of their choices (List and Gallet 2001). Methods like non-hypothetical experimental auctions and choice experiments with a binding choice have become popular ways to introduce incentive compatible behavior and avoid hypothetical bias (Gracia, Loureiro, and Nayga 2011; Corrigan et al. 2009).

Previous Research

The few previous examinations of consumer willingness to pay for hydroponic products have used different valuation methods and defined the products in slightly different ways. A 1999 hypothetical study in Taiwan estimated consumer willingness to pay (WTP) for hydroponic vegetables that were free of pesticide residue (Huang, Kan, and Fu 1999). A 2014 hypothetical contingent valuation experiment in Trinidad found an average price premium of 4% for "greenhouse-hydroponic" tomatoes as opposed to "open field" tomatoes. As part of the hydroponic description, that survey noted "The tomatoes are grown in a controlled environment without weeds or soil-borne diseases. Hydroponic systems recycle water and agrochemicals" (Narine, Ganpat, and Ali 2014). More recently, a 2017 study by Coyle and Ellison compared consumer WTP for three lettuce production methods, "Field Farming," "Greenhouse," and

“Vertical Farm.” Based on results from a non-hypothetical experimental auction, they found no significant differences in average consumer willingness to pay between the three methods (Coyle and Ellison 2017). They did find, however, that vertically farmed lettuce was perceived as significantly less natural than conventional lettuce and significantly less likely to be purchased by the interviewed consumers (Coyle and Ellison 2017). This led them to suggest that consumers might still be skeptical toward products labeled as hydroponic.

While the recent NOSB ruling confirmed that the organic market is still open to hydroponic crops, we are unaware of studies that test consumer WTP for products that are both organic and hydroponic. This information could be increasingly important for market differentiation as more hydroponic producers weigh the costs and benefits of pursuing organic certification. Retailers may also benefit from a better understanding of consumer perception and WTP for these attributes. A better understanding of consumer WTP is also relevant for policymakers as they consider how consumer confidence in the organic program will be affected by the decision to continue allowing hydroponic products. It may help to inform future discussions regarding proposals to mandate extra labeling for hydroponically grown products that use the organic label (“Fall 2017 National Organic Standards Board (NOSB): The Organic Trade Association (OTA) Summary Report” 2018).

Our study aimed to investigate the current market for hydroponic products and test potential marketing information that could be used to differentiate hydroponic lettuce. Our objective was to understand how information about hydroponic production methods might affect consumer perceptions and WTP for lettuce products with and without hydroponic and organic attributes. To accomplish this, we designed a survey and a non-hypothetical choice experiment to elicit preferences and estimate consumer willingness to pay for hydroponic lettuce and specific attributes.

METHODS

Experimental Procedure

Our survey was conducted with 215 participants at a regional supermarket over six consecutive days, May 17 through 22, 2017. As a screening mechanism, participants were asked during the survey if they had purchased lettuce within the last six months. Seventeen participants responded that they had not, so their responses were excluded to yield a final dataset with 198 responses. We recruited participants at the main entrance to a regional supermarket in Fayetteville, Arkansas. Shoppers who chose to participate used touch-screen tablet computers to complete the survey. The survey consisted of a questionnaire capturing socio-demographic and attitudinal variables and an economic choice experiment with a binding choice. Lettuce products used in the experiment were stored in coolers and the participants were informed that each lettuce product was available. The store stocked hydroponic lettuce in their produce department, but surveys were completed at the store entrance so that other lettuce options were not visible to participants. As a participation incentive, each person was given five dollars of store credit that could be used to purchase any item in the store.

We chose to conduct a Real (non-hypothetical) Choice Experiment (RCE) to compare valuations between lettuce products. This allowed participants to make incentive-compatible choices in a typical shopping context. Participants were told that they would make eight potential purchase decisions, and one of their decisions would be randomly selected as their binding choice at the conclusion of the survey. By providing the appropriate lettuce products and linking participant choices with a potential purchase at the end of the experiment, we were able to elicit preferences in a non-hypothetical manner.

Survey Structure

Respondents were first asked to rate the importance of a series of nineteen food product attributes (see Table 3) that they might encounter while shopping. Participants then received a practice question to familiarize them with the format of the upcoming choice experiment and went on to view one of four randomized sets of information on hydroponic growing methods. This was followed by a choice experiment designed to estimate how much consumers were willing to pay for specific products. After completing the choice experiment section, participants answered a series of questions about their prior familiarity with hydroponic and organic growing methods. This was meant to control for prior information that participants had learned apart from the information sets provided in the survey. They were then asked a series of questions about their opinions of conventional hydroponic production compared to traditional production or the organic versions of both methods. We followed Ellison and Coyle (2017) in asking participants to rate characteristics like naturalness and safety for the four growing methods (organic traditional, conventional traditional, organic hydroponic, and conventional hydroponic) (Coyle and Ellison 2017). Participants were then asked to indicate their opinion about whether hydroponics should be allowed to use the organic label. They were also asked if they would want their children to eat hydroponic lettuce at school. This question was meant to check if participant responses would stay consistent when reminded that children were involved. To determine significance of ratings differences across treatment groups, we followed Van Loo et al. (2015) in first using Kruskal-Wallis rank tests and further identifying any significant difference using two-sample Wilcoxon rank sum tests on each treatment group pair (Van Loo et al. 2015).

Choice Set Design

Attributes and levels from our choice experiment are shown in table 1, with an example choice set in figure 1. Price levels were chosen based on representative market prices for lettuce in the area. Participants were given a series of eight three-option choice sets of real lettuce products. Our final choice set design was generated through a three-phase procedure (Scarpa, Campbell, and Hutchinson 2007). This involved generating a fractional orthogonal design (See Appendix A) with 8 choice sets and testing it in a pilot survey. Secondly, multinomial logit coefficients were estimated from pilot survey data. Thirdly, these coefficients were used as Bayesian priors to generate a more efficient final design (See Appendix A) (Bliemer and Collins 2016).

Choice sets were presented in random order to avoid order effects in the responses. Product alternatives varied across the choice sets depending on the combination of three attribute levels: organic status (USDA Organic logo or no logo), growing method (Traditional or Hydroponic) and price ($1.00, $2.00, $3.00, or $4.00). Price levels were chosen based on the normal range of lettuce prices at supermarkets in the Northwest Arkansas region.

During the choice experiment, participants were presented with the same generic photo for all lettuce alternatives and asked to make their choices based only on the attributes presented in the choice sets (see Figure 1). They were informed that all of the lettuce products were immediately available for purchase. Lettuce with each of the four combinations of organic status and growing method was stored at the experiment table, including an organic hydroponic variety delivered from a farm in Austin, TX within a day of being harvested. Prior to the November 2017 decision by the USDA, future organic certification status for hydroponic farms was less certain, but this particular farm had been certified due to its use of organic inputs and fish waste as the primary plant nutrient source as part of an aquaponics system.

To ensure that participants understood the choice set procedure, they were first given a practice choice question asking them to choose between two chocolate bar alternatives and a no purchase option. Their response was displayed along with another explanation of the binding choice process on the following page before moving forward with the choice experiment. At the conclusion of the survey, one randomly selected binding choice set was displayed with the participant's choice from within that choice set. Any participant who chose a product alternative rather than a "No-Buy" alternative in the randomly selected choice set was given the appropriate lettuce product with the appropriate price receipt to show to the cashier at the conclusion of their shopping trip. This receipt was used to add the price of their chosen lettuce to their total bill for the shopping trip.

Table 1. Attributes and levels from choice set design

Attribute	**Levels**
Price	\$1.00, \$2.00, \$3.00, or \$4.00 (PRICE)
Growing Method	"Traditionally Grown" OR "Hydroponically Grown" (HYDRO)
Organic Status	No Label OR USDA Organic Logo (ORG)

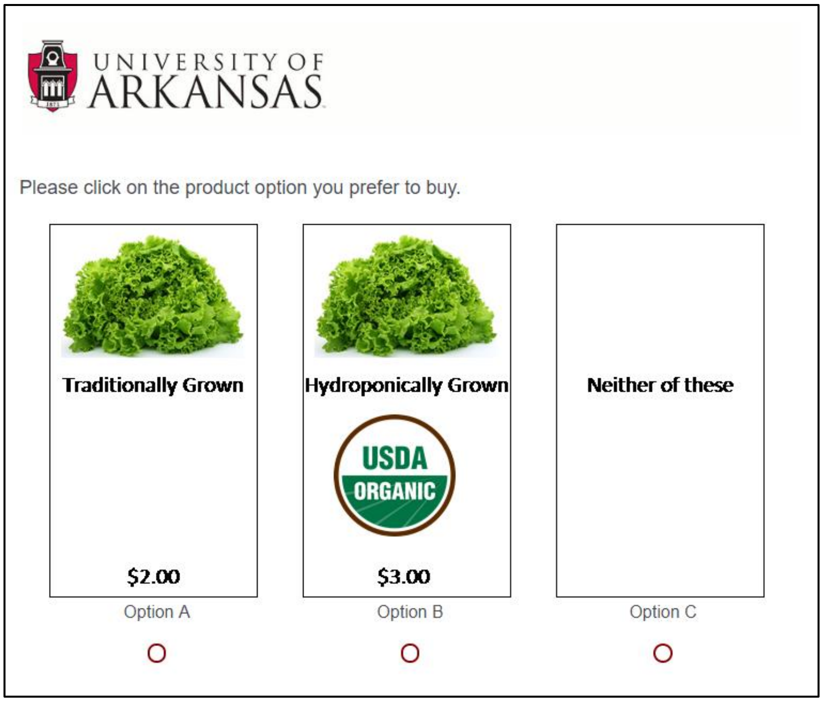

Figure 1. Example choice set from choice experiment

Hydroponic Information Treatments

To investigate the effect of different information about hydroponics, participants were randomly assigned to one of four treatment groups before starting the choice experiment. Participants in the control group did not receive any additional information about hydroponic growing, while participants in each of the other three groups received a short description of hydroponics and one positive aspect of the technology (See Appendix C). The environment group was told that hydroponics can reduce water and land use. The clean group was told that hydroponics can reduce soil contact and pesticide use. The local group was told that hydroponics can reduce food transit time by allowing farms to locate in areas with harsh weather and distribute locally.

Information treatments were chosen to represent current hydroponic marketing and potential marketing messages that could be used in the future by the hydroponic industry. The level of knowledge regarding hydroponic and organic production methods in the control group was considered representative of an average shopper who has not been given any additional information. Treatment groups were designed to estimate the preferences and WTP of consumers after exposure to one of three possible marketing messages. While no treatment group received a neutral hydroponics definition alone, our design assumed that future marketing messages promoting the benefits of hydroponic growing will necessarily be accompanied by some kind of definition to provide the consumer with a context for the information.

Econometric Analysis of Choice Experiment

As noted above, random utility theory provides a framework to estimate consumers' WTP values which considers both population and individual preferences (McFadden 1973; Train 2009). The utility, U, that alternative *j* provides to individual *n* in choice situation *t* is considered a function of observable and unobserved factors. That is,

(1) $$U_{njt} = V_{njt} + \varepsilon_{njt}$$

Estimated observable factors (*V*) are assumed to be representative of population preferences, while unobserved factors (ε) reflect individual differences. V_{njt} is assumed to be a linear function of product attributes, while the stochastic element, ε_{njt}, accounts for the unobserved individual effects and random noise. ε_{njt} is independently and identically distributed (IID) extreme value type-I (Gumbel) over alternatives and independent of the factors in V_{njt} (Bazzani et al. 2016).

As expected from the weak axiom of Random Utility Models (RUM), consumers make choices that maximize the utility they can derive from a good or service. Hence consumers are assumed to choose alternative *j* such that

(2) $$V_{njt} + \varepsilon_{njt} \geq V_{nkt} + \varepsilon_{nkt}$$

Moreover, the observable factors (V) of the utility function can be explained in terms of observed attributes and the associated parameters, as follows:

(3) $$V_{njt} = \beta' x_{njt} + \varepsilon_{njt}$$

where x_{njt} is a vector of observed variables relating to alternative *j* and individual *n*; β is a vector of structural taste parameters which characterize the different choices; ε_{njt} is the unobserved error term described in equation (1) which is assumed to be independent of the vectors β and *x*.

The selection of discrete choice model depends on assumptions about how the unobserved individual preferences are distributed. Under multinomial logit (MNL) specifications, this error term is assumed to be IID. Following the Lancaster Theory we assume that the utility consumers derive from a product can be segregated into marginal utilities derived from the attributes of the product (Lancaster 1966). In our experiment, the utility that respondent *n* gains from lettuce product *j* in choice situation *t* can be specified as

(4) $$U_{njt} = \beta_{NoBuy} + \beta_{Hydro} Hydro_{jt} + \beta_{Org} ORG_{jt} + \beta_{Price} PRICE_{jt} + \varepsilon_{njt}$$

where *HYDRO* and *ORG* are dummy variables for hydroponic and organic status respectively, which take a value of 1 if the lettuce is hydroponic or organic respectively, and 0 otherwise. *PRICE* is a continuous variable that takes the values of the four experimental design price levels. β_{NoBuy} is the alternative specific constant associated with the No-Buy option.

While the MNL is computationally convenient, it has several limitations for modeling discrete choice behavior. The distribution of unobserved individual preferences takes a Gumbel form, where each alternative is evaluated independently and all participants are assumed to share identical preferences (Train 2009). In addition, the model assumes independence of irrelevant alternatives (IIA), since individuals would be expected to make the same choice between alternatives regardless of the third alternative (Train 2009). This assumption becomes problematic since individuals may have heterogeneous preferences.

Models like the Random Parameter Logit (RPL) allow for preference heterogeneity among individuals using panel data. The RPL also relaxes the IIA assumption by allowing for these individual variations. In this format the non-price attribute coefficients; i.e., β_{Hydro}, and β_{Org}, are assumed to be random, following a normal distribution, while the price coefficient is assumed to be fixed.

In this form, the marginal willingness to pay (mWTP) for each attribute relative to the baseline can be calculated as the amount of price change that would make the individual indifferent between alternatives.[1] The mWTP is equivalent to the attribute coefficient divided by the

[1] For example, suppose we have two non-organic options, one hydroponic at *Price1* and one non-hydroponic at *Price2*. The two observable utilities are $V1$ and $V2$.

$$V1 = \beta_{NoBuy} + \beta_{Hydro} + \beta_{Price} Price1$$

$$V2 = \beta_{NoBuy} + \beta_{Price} Price2$$

Setting $V1 = V2$ and solving for the change in price required one can derive the WTP formula.

$$\beta_{NoBuy} + \beta_{Hydro} + \beta_{Price} * Price1 = \beta_{NoBuy} + \beta_{Price} * Price2$$

$$\beta_{Hydro} + \beta_{Price} * Price1 = \beta_{Price} * Price2$$

$$\beta_{Hydro} = -\beta_{Price} * Price1 + \beta_{Price} * Price2$$

$$\beta_{Hydro} = -\beta_{Price}(Price1 - Price2)$$

negative of the price coefficient. This captures the price difference required to make individuals indifferent between two lettuce alternatives (Lusk et al. 2004)

We refer to this model specification as a "preference space" model since the coefficients represent marginal contributions to individual utility. A problem with calculations of mWTP using this specification arises when the distribution of a random inverse price coefficient has no finite moments. Daly, Hess, and Train (2012) show that several popular choices for distribution fail to provide finite moments and that attempts to derive these moments using simulation can arrive at misleading estimates (Daly, Hess, and Train 2012). One option to resolve this is to hold the price coefficient fixed. Another option follows Train and Weeks (2005) with a model in which the distribution of WTP values is specified directly in the simulation rather than having to worry about the distribution of the quotient of two random parameters.

This model format, typically referred to as "willingness to pay space," has the utility and attribute coefficients enter the model already scaled by the inverse of the price coefficient. Specifically, in WTP space models the utility of individual *n* in choosing alternative *j* at choice task *t* can be specified as follows:

Since we are often interested in WTP values, we can reparametrize the equations in a way that mWTP enters directly into the utility function. This gives us an equivalent model where the coefficients are the actual willingness-to-pay values, meaning they are equal to the ratio between the non-price attributes and the price attribute. We refer to this model specification as residing in "willingness-to-pay space" since the coefficients represent marginal contributions to individual

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$$\frac{\beta_{Hydro}}{-\beta_{Price}} = Price1 - Price2 = WTP_{Hydro}$$

utility also known as the willingness to pay values. We estimate the WTP space model by holding the price coefficient constant at a value of -1 and representing the effect of price throughout the model with a scale parameter ϑ_{njt}.

(5) $$U'_{njt} = \vartheta_{njt}(\beta_{NoBuy_{jt}} + wtp_{1n}HYDRO_{jt} + wtp_{2n}ORG_{jt} - PRICE_{jt}) + \varepsilon'_{njt}$$

where ϑ_{njt} is the price/scale coefficient which represents the ratio between the price coefficient and the variance of the error term ε'. This parameter is treated as random with a log-normal distribution. wtp_1 and wtp_2 are the mWTP for the hydroponic and organic attributes respectively.

For our experiment, we chose the RPL with Error Components specification (RPL-EC) (Scarpa, Campbell, and Hutchinson 2007). This is a popular method of modeling discrete choices, and we chose it because our experimental design is characterized by the two purchasing alternatives which vary over all the choice tasks, and a No-Buy alternative, which instead remains fixed (Bazzani et al. 2017). In this model, the purchase alternatives share an additional component that allows for differences in variance between these two alternatives and the No-Buy alternative (Bazzani et al. 2017; Scarpa, Thiene, and Marangon 2007). In this form, the utility that individual *n* derives from alternative *j* in choice set *t* can be shown as:

(6) $$U_{njt} = \vartheta_{njt}(\beta_{NoBuy_{jt}} + wtp_{1n}HYDRO_{jt} + wtp_{2n}ORG_{jt} + PRICE_{jt} + \eta_{njt}) + \varepsilon_{njt}$$

where η_{njt} is the normally distributed error component fixed at mean zero.

In order to test the effect of information, we first estimated four separate RPL-EC models in WTP space using data from the four treatment groups. The total WTP for hydroponic and organic lettuce was calculated as the sum of the WTP for a lettuce buying option (alternative A or B in the choice sets) and the individual coefficients for the appropriate attribute. The individual WTP estimates from each group were then compared between control and treatment groups using two-tailed two-sample t-tests to determine the significance of the treatment effect. Average premiums and discounts toward the hydroponic and organic attributes were then reported in percentage form for each treatment group.

While the relatively small sample size of this study makes it difficult to estimate the effect of individual factors involved in preference formation for hydroponics, we estimated RPL-EC models for each treatment group that included variables for the interaction of gender, bachelor's degree, and prior familiarity with hydroponics on WTP for the hydroponic attribute.

(7) $$U_{njt} = \vartheta_{njt}(\beta_{NoBuy_{jt}} + \text{wtp}_{1n} HYDRO_{jt} + \text{wtp}_{2n} ORG_{jt} - PRICE_{jt} + \text{wtp}_3 (Hydro * Gender)_{njt} + \text{wtp}_4 (Hydro * College)_{njt} + \text{wtp}_5 (Hydro * HydroFamiliarity)_{njt} + \text{wtp}_6 (Hydro * Gender)_{njt} + \text{wtp}_7 (Hydro * College)_{njt} + \text{wtp}_8 (Hydro * HydroFamiliarity)_{njt} + \eta_{njt}) + \varepsilon_{njt}$$

Finally, we ran a pooled model using responses from all the treatment groups. Each treatment group was described using dummy variables with a value equal to 1 in case the respondent belonged to the treatment group and 0 otherwise. Interaction terms between these treatment group variables and the non-price variables were included to estimate the following model specification:

(8) $$U_{njt} = \vartheta_{njt}(ASC_{jt} + \text{wtp}_{1n} HYDRO_{jt} + \text{wtp}_{2n} ORG_{jt} - PRICE_{jt} + d_1 (HYDRO * Trt1)_{njt} + d_2 (HYDRO * Trt2)_{njt} + d_3 (HYDRO * Trt3)_{njt} + d_4 (ORG * Trt1)_{njt} + d_5 (ORG * Trt2)_{njt} + d_6 (ORG * Trt3)_{njt} + \eta_{njt}) + \varepsilon_{njt}$$

where d_1, d_2, d_3, d_4, d_5 and d_6, are coefficients of the interaction terms that capture the effects of each information treatment on the mWTP for the NOBUY, HYDRO and ORG attributes. Models were estimated using functions from the "gmnl" package for R (Sarrias and Daziano 2017).

RESULTS

Descriptive Statistics

Demographics of the final sample (after excluding participants who reported not purchasing lettuce in the last six months) are shown in Table 2. A 2006 study by Carpenter and Moore collected a demographically representative sample of reported US shoppers, identified when they indicated shopping for household food "always, often or on occasion" (Carpenter and Moore 2006). While demographics continue to change over time, this study provides a relevant demographic comparison for the US grocery shopper population. The majority of our respondents were female (60.6%), similar to their sample (73%). Most participants in our sample were white (89.8%), which is close to their sample's 81.3% of Caucasian shoppers. Median age for our sample was 52, which was younger, but still close to their median age of 57. Compared to the 2006 shopper sample, our sample group was more educated, with 39.4% and 30.3% with bachelor's degrees or graduate degrees respectively, compared to 22.2% and 13.2%. This is partly explained by the fact that the supermarket is located in a university town. Our participants also reported higher income, with 36.8% of the participants earning above $100,000 annually compared to 9.9% in the 2006 study. While this may be affected by inflation in the intervening years, it does suggest that our sample is skewed toward higher income. Results of Carpenter and Moore's 2006 study suggest that higher-income shoppers tend to shop more frequently at specialty grocery stores and warehouse clubs, while more education was seen to reduce shopping frequency at supercenters (Carpenter and Moore 2006). Our experiment was done in a traditional supermarket, and given the observed high income and education, our respondents might also share these tendencies.

Table 2: Summary statistics for demographic characteristics of the sample

Demographic	Sample
Number	198
Gender (%)	
Male	39.4
Female	60.6
Race (%)	
White	89.8
Age (%)[1,2]	
20 – 24 years	6.1
25 – 34 years	18.2
35 – 44 years	13.6
45 – 54 years	18.7
55 – 64 years	27.3
65 – 74 years	10.6
75 – 84 years	2.5
85 years or older	0.5
Median Age	52
Educational Level (%) (Population 25 years and older)[2]	
Less than High School	0
High school graduate (or GED)	6.1
Some college, no degree	18.7
2-year degree (Associate's)	4.5
4-year degree (Bachelor's)	39.4
Graduate or professional degree	30.3
Annual Household Income[2]	
Less than $10,000	3.5
$10,000 - $49,999	20.2
$50,000 - $99,999	27.3
$100,000 - $149,999	14.1
$150,000 +	22.7

1. Category percentages do not add up to 100% due to three responses with missing values and two individuals whose ages were between 18 and 20 years old.
2. Category percentages do not add up to 100% since some respondents declined to answer.

Before beginning the choice experiment, respondents were asked to rate the importance of different attributes when choosing lettuce products (Table 3). Attributes rated most important were "Freshness", with 81.4% of respondents considering it "extremely important", and "Taste", with 62.3% of the respondents rating taste “extremely important”. These results are similar to other studies and industry surveys, some of which identify taste as most important, and others which find that nutritional value and freshness are ranked highest (Bonti-ankomah and Yiridoe 2006). Other attributes like cleanliness, food safety, and “pesticide free” were rated highly as well. The organic label attribute ranked 16 out of 19 attributes, below locally grown attributes like “Grown in Arkansas” or “Grown in Fayetteville.” Despite this, however, the standard deviation for the organic label was the highest of any attribute, suggesting that consumers differ widely in their preference for organic.

Table 3: Rated importance of lettuce attributes on a 5-point scale where 1 = “not at all important” and 5 = “extremely important

Attribute	**Mean**	**Std. deviation**
Freshness	3.79	0.46
Taste	3.53	0.69
Appearance	3.44	0.81
Cleanliness	3.42	0.79
Food Safety	3.41	0.91
Pesticide Free	3.15	1.10
Nutritional Value	2.91	1.06
Environmental Impact	2.73	1.23
Shelf Life	2.62	1.09
Convenience	2.60	1.17
Grown in the United States	2.58	1.26
Price	2.33	1.11
Grown in AR	2.26	1.27
Grown in northwest AR	2.15	1.27
Grown in Fayetteville	1.98	1.28
Organic Label	1.97	1.32
Packaging	1.72	1.19
Novelty	1.16	1.06
Brand	0.87	0.98

Differences in household income across the treatment groups were close to significance at the 5% level, which likely reflects the lower percentage of individuals in the environmental information treatment group who fell into the upper income category. Overall, there are no statistically significant differences in demographic profile across the treatment groups, suggesting that the randomization procedure was successful.

Table 4: Demographic comparisons across information treatment groups. Respondents were randomly assigned to one of the four treatment groups (Control, Environment, Clean, or Local).

Category	**Control group**	**Environment group**	**Clean group**	**Local group**	**Chi-Square test[3]**
Sample size	50	49	50	49	
Female (%)	56.0	61.2	56.0	69.4	p = 0.48
52 years or older (%)[1]	44.9	45.8	59.2	49.0	p = 0.47
White (%)	81.0	86.0	95.8	86.0	p = 0.27
4-year degree or higher (%)	72.0	73.5	66.0	67.3	p = 0.82
Income of $50,000+ (%)[2]	74.0	49.0	64.0	69.4	p = 0.06
Children at home (%)	24.0	26.5	26.0	26.5	p = 0.99

1. As the median age in our sample, 52 was chosen as the break point. Treatment group sizes were 49, 48, 49, and 49 respectively for age data due to three missing values.
2. Household Income categories were not uniformly distributed, so income break point was chosen above 42,336, the median annual income for Arkansas in the 2012-2016 ACS 5-Year Estimates.
3. Results of Chi-Square tests for homogeneity indicate the likelihood that differences between groups are the result of chance.

Participants' prior levels of rated familiarity with hydroponics and organics are shown in table 5. Also shown is the reported frequency of searching for the organic logo when shopping. No significant differences were observed across groups after recoding responses as values between 1 and 5 and using Kruskal-Wallis rank tests. This suggests that observed changes in attitude and willingness to pay across treatment groups are unlikely to have been caused by existing differences in prior familiarity or shopping behavior. Despite efforts to control for prior familiarity and shopping behavior, these variables were self-reported. This could lead to over or under-estimation of treatment effects if familiarity levels were reported differently across groups. The hydroponic growing method was reported to be less familiar than the organic certification for our sample population. Only 18% of the sample reported being "very" or "extremely" familiar with hydroponics. Interestingly, 32% of shoppers reported searching for the organic logo "regularly" or "always" even though only 26% reported being "very" or "extremely" familiar with the USDA organic certification.

Table 5. Reported levels of prior familiarity and organic shopping behavior

Variable	**Low**	**Medium**	**High**
Prior familiarity with hydroponic growing methods[1]	49%	33%	18%
Prior familiarity with USDA organic certification[1]	40%	34%	26%
Frequency of searching for organic logo while shopping[2]	33%	35%	32%

1. *Low* = "slightly familiar" or "not at all familiar," *Medium* = "moderately familiar," *High* = "very familiar" or "extremely familiar"
2. *Low* = "rarely" or "never," *Medium* = "sometimes," *High* = "regularly" or "always"

Information Effects on Attitude

To gain a better understanding of how each information treatment affected consumer perceptions, participants were asked to rate the safety, quality, and "naturalness" of four different growing methods (organic traditional, conventional traditional, organic hydroponic, and conventional hydroponic) used in the choice experiment. Average ratings across treatment groups are shown in table 6 for the two hydroponic methods. Organic hydroponics received higher ratings than conventional hydroponics on every category, but the treatments showed no significant effect on consumer attitudes toward safety, quality, or naturalness.

Table 6. Ratings of the safety, quality, and naturalness of hydroponic growing methods across information treatment groups.

Variable	Control	Environment	Clean	Local
Safety Rating[1]				
Hydroponic	3.42[a] (1.01)[4]	3.35[a] (0.99)	3.36[a] (1.05)	3.78[a] (0.96)
Organic Hydroponic	3.74[a] (0.99)	4.04[a] (0.82)	4.02[a] (0.89)	4.18[a] (0.88)
Traditional	3.46[a] (0.91)	3.02[a] (0.95)	3.04[a] (1.11)	3.35[a] (1.20)
Organic Traditional	3.96[a] (0.86)	3.86[a] (0.82)	3.96[a] (0.92)	4.14[a] (0.98)
Quality Rating[2]				
Hydroponic	3.34[a] (1.00)	3.51[a] (0.87)	3.24[a] (0.98)	3.55[a] (0.98)
Organic Hydroponic	3.74[a] (0.99)	4.08[a] (0.73)	4.04[a] (0.97)	4.16[a] (0.83)
Traditional	3.48[a] (0.95)	3.08[a] (1.00)	3.04[a] (1.18)	3.24[a] (1.05)
Organic Traditional	4.08[a] (0.89)	4.10[a] (0.71)	4.00[a] (0.88)	4.08[a] (0.95)
Naturalness Rating[3]				
Hydroponic	2.66[a] (1.12)	3.12[a] (1.11)	2.76[a] (1.22)	2.98[a] (1.15)
Organic Hydroponic	3.08[a] (1.31)	3.65[a] (1.05)	3.42[a] (1.25)	3.59[a] (1.15)
Traditional	3.12[a] (0.98)	3.18[a] (1.13)	3.16[a] (1.30)	3.16[a] (1.33)
Organic Traditional	4.04[a] (1.01)	4.14[a] (0.87)	4.20[a] (0.93)	4.16[a] (0.92)

[a,b] Differing subscripts across rows indicate statistically significant differences from Kruskal-Wallis rank tests, $p < 0.05$. Two sample Wilcoxon rank sum (Mann-Whitney) tests, $p < 0.05$ were used for identification of discovered differences.

1. 1 = “Very unsafe” 5 = “Very safe”
2. 1 = “Low quality” 5 = “High quality”
3. 1 = “Unnatural” 5 = “Natural”
4. Numbers in parentheses are standard deviations.

Most participants responded neither positively or negatively when asked, “Do you think that food grown hydroponically should be allowed to use the organic label?” In the groups that received information, however, only about half as many respondents were neutral on the issue. Compared to the control group, twice as many respondents in each of the three treatment groups were positive toward the idea of including hydroponics in the organic program. Interestingly, the percentage of negative responses also doubled, but never rose above 12%, suggesting that the extra information made a small group of people more negative toward the idea of hydroponics in the organic program. Overall, extra information seemed to increase the clarity of participants’ positions on the issue, and the percentage increase in positive responses outweighed the increase in negative sentiment.

Table 7. Percentages of positive, neutral, and negative responses to the following question: "Do you think that food grown hydroponically should be allowed to use the organic label?"

Treatment Group	Control	Environment	Clean	Local
Negative (somewhat or strongly disagree) (%)	4%	12%	10%	10%
Neutral (neither agree nor disagree) (%)	68%	31%	36%	31%
Positive (somewhat or strongly agree) (%)	28%	57%	54%	59%

Information Effects on Willingness to Pay

Coefficients were estimated for each treatment group with RPL-EC models in WTP space. A comparison of model estimates is shown in table 7. No significant premium was observed for the hydroponic attribute in any of the treatment groups, while the organic premium was seen to be significant in each treatment group.[2] The mWTP for hydroponic lettuce was significantly negative in the control group, but insignificant for each group where consumers were exposed to positive information about hydroponics. The standard deviation of the random hydroponic parameter, however, was significant at the 5% level for the control group and at the 1% level for each of the treatment groups. This suggests that preferences toward hydroponics vary widely across consumers.

[2] No significant effect was found for the interaction of hydroponic and organic attributes. This suggests that consumers value the two attributes independently, and that an organic label would generate a similar premium for hydroponic lettuce as for traditional lettuce after taking into account whatever premium or discount is associated with the hydroponic attribute by itself.

Table 8: RPL-EC model estimates in WTP space for each information treatment group. Coefficients represent WTP effects of each variable. Both mean and standard deviation are reported for random parameters. A Hydro x Organic interaction term was originally included, but its coefficient was insignificant under MNL assumptions and so was excluded from subsequent analyses.

Variables ($)	**Coefficient**	**Control**	**Environment**	**Clean**	**Local**
No-Buy	μ	-2.61	-4.49	-6.36	-5.52
		(0.76)***[1,2]	(1.01)***	(1.73)***	(1.39)***
Product Attributes					
Hydro	μ	-1.47	0.04	-0.44	-0.52
		(0.34)***	(0.63)	(0.39)	(0.4)
	σ	1.26	3.87	2.1	2.04
		(0.49)**	(0.67)***	(0.39)***	(0.4)***
Organic	μ	1.44	1.32	1.72	1.49
		(0.43)***	(0.39)***	(0.39)***	(0.34)***
	σ	1.83	2.34	2.06	1.62
		(0.39)***	(0.5)***	(0.38)***	(0.33)***
Error Component	σ	5.28	5.57	7.38	6.31
		(1.17)***	(1.57)***	(2.01)***	(1.91)***
Log Likelihood		-235.46	-229.44	-240.83	-234.52
# of choice sets[2]		400	392	400	392

1. Asterisks indicate significance. *** = 0.01, ** = 0.05, * = 0.1
2. Numbers in parentheses are standard errors.
3. Each individual in the group completed 8 choice sets.

This variation can be seen in figure 2 where the frequency distribution of estimated hydroponic WTP is shown for individuals in each treatment group. Estimated willingness to pay for baseline lettuce was calculated as the sum of the alternative specific constant (the negative of the NoBuy coefficient) and the normally distributed individual attribute coefficients for the hydroponic parameter. The environmental group had some consumers willing to pay more than $6 for hydroponic, with others requiring a $6 discount to purchase hydroponic lettuce. Both the clean and local information treatment groups had a concentration of consumers requiring a slight discount, with none of the consumers in these groups willing to pay more than $6 or requiring more than $6 in discount for hydroponic

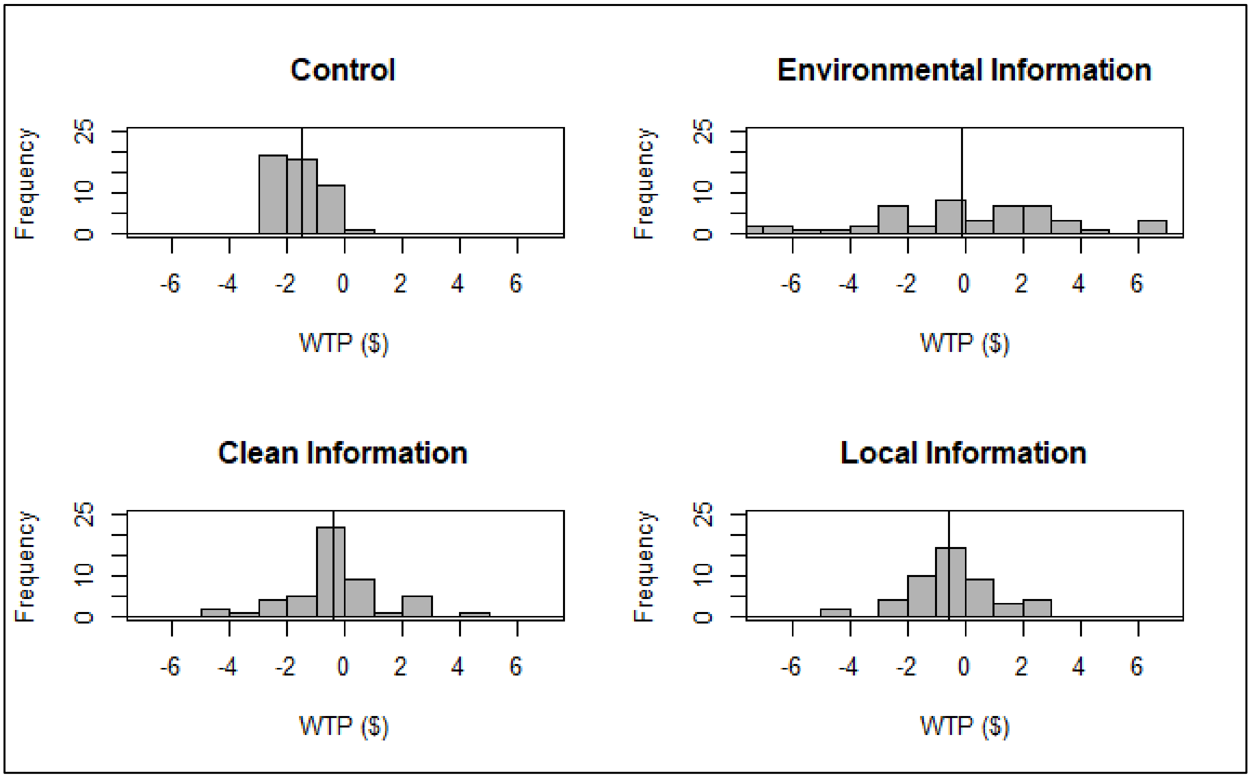

Figure 2. Distribution of Individual Hydroponic WTP Estimates within each information treatment group. The vertical line represents mean WTP for hydroponic attribute within each group.

The significance of information effects on marginal WTP for hydroponics can be seen in table 8. Tests of the hypothesis of equality between individual hydroponic mWTP values in the control group and each treatment group showed significant differences between the control group and each of the treatment groups. In contrast, there was no observable information effect on consumer mWTP for organic. This suggests that consumers who were exposed to information about the benefits of hydroponic lettuce would on average be indifferent between lettuce grown hydroponically or traditionally. Given the significant observed heterogeneity in preferences, however, there would likely be some consumers with much higher or lower mWTP for hydroponics.

Table 9. Hypothesis tests for significant differences in WTP for the hydroponic attribute between information treatment groups

Hypothesis Tests (T-tests)	**Hydroponic**	**Organic**
H_0: $(WTP^{Cont.} – WTP^{Env.}) = 0$		
Control	-1.47	1.44
Environment	0.04	1.32
p-value	< 0.01	0.82
H_0: $(WTP^{Cont.} – WTP^{Clean}) = 0$		
Control	-1.47	1.44
Clean	-0.44	1.72
p-value	< 0.01	0.38
H_0: $(WTP^{Cont.} – WTP^{Local}) = 0$		
Control	-1.47	1.44
Local	-0.52	1.49
p-value	< 0.01	0.78

The mWTP estimates from table 8 are shown as percentage premiums or discounts in table 9. As before, WTP for baseline lettuce is calculated as the negative of the alternative specific constant and used as the base for the percentage changes. The organic attribute significantly increased WTP within each information treatment group, ranging from a premium of 27% in the clean and local groups and 55% in the control group. This is slightly higher than the average organic premiums reported in the literature. While a wide range of price premiums have been reported, a 2006 review article suggested that 10-20% is typically the most that consumers will pay (Bonti-ankomah and Yiridoe 2006). Interestingly, since a few customers are willing to pay more, it is not uncommon to see higher retail prices in the marketplace (Bonti-ankomah and Yiridoe 2006). If this pattern also applies to demand for hydroponics, it helps explain why several local supermarkets near our study location were observed to charge premium prices for hydroponic products despite our findings of lower willingness to pay for hydroponics overall.

Table 10. Hydroponic attribute premiums and discounts in percentage form across treatment groups

Attribute	**Control**	**Environment**	**Clean**	**Local**
Lettuce (Base)	$2.61	$4.49	$6.36	$5.52
Hydroponic	-56%***	1%	-7%	-9%
Organic	55%***	29%***	27%***	27%***

1. Asterisks indicate significance of hydroponic variable in each treatment group model. *** = 0.01, ** = 0.05, * = 0.1

When analyzed using a pooled model, the choice experiment data showed a significant information effect in the environmental group. The other two treatment group interactions were close to significance at a 10% level, both with a p-value below 0.11. The NoBuy interaction coefficients showed that participants were significantly more likely to choose one of the purchase alternatives in the choice sets rather than choosing a no-purchase option.

Table 11. RPL-EC (WTP space) model estimates for pooled model. Coefficients represent WTP effects of each variable. Both mean and standard deviation are reported for random parameters.

Variables	**Coefficient**	**All Groups**
NoBuy ($)	μ	-2.29***
Hydro ($)	μ	-1.54***
	σ	5.62***
Organic ($)	μ	1.32***
	σ	2.38***
NoBuy Interactions		
NoBuy x Environment ($)	μ	-2.26**
NoBuy x Clean ($)	μ	-3.16**
NoBuy x Local ($)	μ	-2.06*
Hydroponic Interactions		
Hydro x Environment ($)	μ	1.37**
Hydro x Clean ($)	μ	1.02
Hydro x Local ($)	μ	1.02
Organic Interactions		
Organic x Environment ($)	μ	0.04
Organic x Clean ($)	μ	0.22
Organic x Local ($)	μ	0.07
Error Component ($)	σ	1.88***
Log Likelihood		-954.86
# of choice sets[2]		1584

1. Asterisks indicate significance. *** = 0.01, ** = 0.05, * = 0.1
2. Each individual in the group completed 8 choice sets.

While mWTP is significantly negative for the hydroponic attribute among people who received no information, it is important to understand what individual factors may be related to this hydroponic discount. It is likely that prior familiarity with the hydroponic growing method would have a strong influence on willingness to pay for a relatively new attribute like hydroponics, especially for the group that received no additional information. In addition to prior familiarity, we tested the effect of gender and having a four-year college degree. When these three variables, *Female*, *4yr College*, and *HydroFamiliarity*, were included in the model, estimates showed the standard deviation for the hydroponic coefficient to be insignificant for the control group. Four-year college and prior familiarity variables were significant at the 1% level, suggesting that these two variables help to explain the majority of the hydroponic discount. Evidently, education and prior familiarity influence people to be willing to pay more for hydroponics, although the average willingness to pay still does not lead to a premium over traditionally grown lettuce.

Consumer acceptance of new food products is based on a complex interaction of factors, including consumer attitudes toward the technology itself and the food industry as a whole (Henson 1995). The significant positive effect of hydroponic familiarity in these results shows that increased knowledge about the growing method generally results in higher valuations for hydroponics. While it is possible that familiarity with hydroponics is associated with other traits like an increased involvement in the food industry, these results still point to the potential value of increased hydroponic marketing. It seems that consumers discount hydroponic lettuce more when they are unfamiliar with the process. If it is unfamiliarity that leads to a hydroponic discount rather than an informed, negative perception, then simply increasing familiarity may be an effective way to increase valuations toward hydroponics. The significance of the four-year college variable also suggests that initial marketing may be most effective with more educated consumers.

Table 12: RPL-EC model estimates in WTP space across Treatment Groups with Explanatory Variables. Coefficients represent WTP effects of each variable. Both mean and standard deviation are reported for random parameters.

Variables ($)	Coefficient	Control	Environment	Clean	Local
Buy	μ	2.04[1]	4.53*	2.62	4.57
Hydro	μ	-4.12***	-4.63**	-2.18	-2.71**
	σ	0.09	3.51***	1.98***	1.69***
Organic	μ	-0.14	-0.21	0.88	0.26
	σ	1.74***	2.05***	1.82***	1.46***
Individual Attributes					
Hydro x Female	μ	-0.69	1.47	1.22	0.39
Hydro x 4yr College	μ	2.13***	0.72	0.07	-0.34
Hydro x HydroFamiliarity	μ	0.72***	1.13**	0.36	0.90**
Organic x Female	μ	1.39*	0.61	-1.09	1.28*
Organic x 4yr College	μ	0.27	-0.55	1.18	0.70
Organic x HydroFamiliarity	μ	0.27	0.66*	0.23	-0.06
Error Component	σ	5.05***	5.45***	6.79***	6.54***
Log Likelihood		-221.09	-226.83	-236.74	-228.52
# of choice sets[2]		400	392	400	392

1. Asterisks indicate significance. *** = 0.01, ** = 0.05, * = 0.1
2. Each individual in the group completed 8 choice sets.

CONCLUSIONS

Our results suggest that consumers are generally unfamiliar with hydroponics (Table 5) and require a discount to choose hydroponic lettuce. Consumers who were not provided with information about hydroponics required a discount of $1.47 to choose lettuce labeled "hydroponically grown." While information treatments showed no significant effect on consumer attitudes toward hydroponics, they did seem to improve opinions toward hydroponics in the organic program. In addition, WTP for hydroponics increased significantly for groups informed about environmental, clean, or local benefits of hydroponic growing. This could be because consumer perceptions toward hydroponics actually improve after receiving information. Alternatively, it could be that WTP increases simply because consumers feel more informed about the product they are buying, even though their perceptions of safety, quality, and naturalness have not dramatically shifted. On average, our results indicate that consumers who read a short message about hydroponic benefits would be indifferent between traditionally grown lettuce and lettuce with both a hydroponic label.

Our results generally support the findings of Coyle and Ellison (2017). They found no significant differences in consumer valuations between vertically, greenhouse, and field farmed lettuce. This matches our results for those groups that received one of the information treatments. Unlike their findings, however, our results showed a significant information effect since each message provided in our study significantly increased consumer willingness to pay (Coyle and Ellison 2017). This significant effect was not enough to generate a hydroponic premium, however, in any of the three information treatment groups.

Policy

Of the participants in this study, 49% reported being “slightly” or “not at all” familiar with hydroponics, while only 18% reported being “very” or “extremely” familiar. If this level of familiarity is representative of the broader population, then perceptions of hydroponic products in the organic program may depend on how consumer education proceeds in the coming years. In this environment, marketing will likely have an important influence on consumer attitudes and valuations.

Our results suggest that most consumers are undecided regarding hydroponics in the organic program. When asked their opinion about including hydroponics under the organic label, the majority of control group participants chose to “neither agree nor disagree.” Opinions on the question were quite different for participants who received positive information, however. In these groups the percentage of neutral responses dropped by half, while the percentage of positive responses doubled. The number of negative responses increased as well, but remained close to 10% in each treatment group. These dramatic shifts in attitude suggest that consumer opinions are easily swayed by the information they receive.

While consumers' stated opinions regarding organic hydroponics shifted from neutral toward positive when given extra information, their willingness to pay only shifted from negative to neutral in the choice experiment. This suggests that increased marketing of the hydroponic growing method may mainly serve to make consumers indifferent between hydroponic and traditional growing. None of the three information treatments in this study led to a significant premium for hydroponic lettuce, although each group displayed a significant WTP for the organic attribute. For the hydroponic industry, there may be little incentive to invest in consumer education. Instead, they may simply acquire organic certification and rely on existing positive perceptions toward the organic label to support an organic price point.

While the organic program has chosen to include hydroponics, this lack of incentives to follow up and educate consumers needs to be considered carefully. If consumers remain unfamiliar with hydroponics or become convinced that soil-less production is inferior to growing in soil, some may place less value on organic products that do not clearly indicate their growing method. Since information still plays such an important role in shaping consumer opinions on this issue, policymakers should keep track of evolving perceptions toward hydroponics.

Industry

Our results suggest that hydroponic producers should seriously consider acquiring organic certification. The observed increase in WTP due to the organic attribute was at least 27% in each of the information treatment groups (Table 10), which could potentially outweigh the additional costs of certification. Hydroponic producers looking to differentiate their products may also consider highlighting benefits without referencing the hydroponic growing system itself. Few process changes would likely be required to back up claims of reduced land and water use, for example.

In addition, both producers and retailers should continue to focus on providing key attributes like freshness, taste, and appearance. These three were rated most important in this study, while characteristics like organic label and local status were given lower priority (Table 3). Hydroponic producers will likely build a positive reputation for the growing method if they are able to provide these key attributes more consistently than traditional growers. Differences in the visual and sensory quality of hydroponic and traditional products could potentially help to explain why some supermarkets in the northwest Arkansas area already sell hydroponic lettuce at a premium price instead of discounting the products as expected based on the choice experiment considering the effect of the hydroponic label alone.

Limitations and Future Research

Observations for this study were limited to a single survey location at a specific time of year. Since fresh produce is subject to seasonal changes in supply and demand, estimated willingness to pay may vary at other times of the year. Consumer willingness to pay for hydroponics should also be examined in other retail formats since buying trends and demographics may be different outside of the traditional supermarket context.

This study only considered willingness to pay for lettuce despite the fact that other crops can be grown hydroponically. Due to the logistical difficulties involved in providing all product options for a non-hypothetical choice experiment, the study was limited to three product attributes and three information treatment groups. Further research should examine interactions between the hydroponic attribute and other product attributes like "locally grown" or "genetically modified."

In addition, other types and combinations of marketing information should be presented. This could involve testing combinations of positive messages as was done in this study, or comparing consumer valuations after exposure to positive information, negative information, or both. As the hydroponic market expands, researchers may also have opportunities to utilize real market purchase data to better understand consumer demand.

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APPENDIX A

Table 13. Final Choice Set Design

	Lettuce Product A[1]			Lettuce Product B		
Choice Task[2]	Price	Growing Method	Organic Status	Price	Growing Method	Organic Status
1	$2.00	Hydroponic	Organic	$3.00	Hydroponic	Non-organic
2	$4.00	Traditional	Non-organic	$1.00	Hydroponic	Non-organic
3	$1.00	Traditional	Non-organic	$4.00	Traditional	Organic
4	$4.00	Traditional	Organic	$1.00	Hydroponic	Organic
5	$3.00	Hydroponic	Non-organic	$2.00	Traditional	Organic
6	$3.00	Hydroponic	Organic	$2.00	Traditional	Non-organic
7	$2.00	Hydroponic	Non-organic	$3.00	Hydroponic	Organic
8	$1.00	Traditional	Organic	$4.00	Traditional	Non-organic

1. Every choice task also includes a “neither of these” option.
2. The order of choice tasks and alternatives A and B within each choice task was randomized.

Table 14. Pilot Survey Choice Set Design

	Lettuce Product A[1]			Lettuce Product B		
Choice Task[2]	Price	Growing Method	Organic Status	Price	Growing Method	Organic Status
1	$1.00	Hydroponic	Non-organic	$2.00	Traditional	Organic
2	$1.00	Hydroponic	Organic	$2.00	Traditional	Non-organic
3	$3.00	Traditional	Organic	$1.00	Hydroponic	Organic
4	$3.00	Traditional	Non-organic	$3.00	Traditional	Organic
5	$2.00	Traditional	Organic	$4.00	Hydroponic	Non-organic
6	$2.00	Traditional	Non-organic	$4.00	Hydroponic	Organic
7	$4.00	Hydroponic	Non-organic	$3.00	Traditional	Non-organic
8	$4.00	Hydroponic	Organic	$1.00	Hydroponic	Non-organic

1. Every choice task also includes a “neither of these” option.
2. The order of choice tasks was randomized.

APPENDIX B

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

April 27, 2017

MEMORANDUM

TO:	Daniel Gilmour Claudia Bazzani Grant West Rodolfo Nayga
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	17-04-634
Protocol Title:	*Consumer Willingness to Pay for Hydroponic Lettuce*
Review Type:	☒ EXEMPT ☐ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 04/27/2017 Expiration Date: 04/26/2018

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (https://vpred.uark.edu/units/rscp/index.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 220 participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

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

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UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

April 27, 2018

MEMORANDUM

TO:	Daniel Gilmour Claudia Bazzani Grant West Heather Arielle Snell Rodolfo Nayga
FROM:	Ro Windwalker IRB Coordinator
RE:	EXEMPT PROJECT CONTINUATION
IRB Protocol #:	17-04-634
Protocol Title:	*Consumer Willingness to Pay for Hydroponic Lettuce*
Review Type:	☒ EXEMPT
New Approval Date:	04/27/2018

Your request to extend the referenced protocol has been approved by the IRB. We will no longer be requiring continuing reviews for exempt protocols.

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 should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

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

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APPENDIX C

In the survey screen before the choice set began, participants were given a brief introduction to the USDA organic program using the wording that follows:

> The United States Department of Agriculture (USDA) has an organic certification program for food and other agricultural products. Products in this survey with a USDA organic logo are grown on certified organic farms, and products without the label are not.

The wordings from the information set received by each treatment group are as follows:

Control

> (No Information)

Environment

> Lettuce is typically grown in soil using traditional farming practices. A different method involves growing plants in water instead of soil. This method, referred to as hydroponic, raises plants in water with added mineral nutrients.
>
> Hydroponic farms can use 70-95% less water than traditional farming because the water can be collected and recirculated many times. This can also reduce fertilizer use and eliminate runoff from fields. Plants grown hydroponically do not require fertile soil and can be easily stacked in a vertical format to save space. This method of growing plants vertically uses less farmland to produce food (Despommier, 2010).

Clean

Lettuce is typically grown in soil using traditional farming practices. A different method involves growing plants in water instead of soil. This method, referred to as hydroponic, raises plants in water with added mineral nutrients.

Hydroponic crops are usually grown in enclosed buildings. This controlled environment can reduce or eliminate the need to use pesticides on the plants. Hydroponic crops also have less contact with soil than traditional crops. This may allow them to stay cleaner during the harvest process (Despommier, 2010).

Local

Lettuce is typically grown in soil using traditional farming practices. A different method involves growing plants in water instead of soil. This method, referred to as hydroponic, raises plants in water with added mineral nutrients.

Hydroponic crops are usually grown in enclosed buildings. This controlled environment protects plants from harsh climates and unpredictable weather. This allows some hydroponic farms to locate close to urban areas with unfavorable climates and still deliver consistent shipments of lettuce year-round. Many of these farms are close enough to deliver produce to the store on the same day that it was harvested. Nutrient levels in fresh produce begin to drop after harvest, so reducing transportation time can improve the nutritional value of the lettuce compared to products that take longer to arrive at the store (Despommier, 2010).

APPENDIX D

Have you purchased lettuce in the past 6 months?

- ○ Yes
- ○ No

Product characteristics

How important to you are the following product characteristics when making choices concerning lettuce?

	Extremely important	Very important	Moderately important	Slightly important	Not at all important
Nutritional Value	○	○	○	○	○
Novelty (Something new or original)	○	○	○	○	○
Appearance (Texture, Color)	○	○	○	○	○
Taste	○	○	○	○	○
Convenience (Easiness to Prepare)	○	○	○	○	○
Packaging	○	○	○	○	○
Brand Name	○	○	○	○	○
Price	○	○	○	○	○
Food Safety	○	○	○	○	○
Environmental Impact	○	○	○	○	○

How important to you are the following product characteristics when making choices concerning lettuce?

	Extremely important	Very important	Moderately important	Slightly important	Not at all important
Freshness	O	O	O	O	O
Long Shelf Life	O	O	O	O	O
Cleanliness	O	O	O	O	O
Free of Pesticides	O	O	O	O	O
Organic Label	O	O	O	O	O
Grown in America	O	O	O	O	O
Grown in Arkansas	O	O	O	O	O
Grown in Northwest Arkansas	O	O	O	O	O
Grown in Fayetteville	O	O	O	O	O

Instructions 1

In this part of this survey, you will be presented with a series of choice tasks and asked to choose between two different product options or a third "neither of these" option.

The choices that you make are potential purchase decisions. You will complete 8 choice tasks, and the survey software will randomly select just one of these choice tasks at the completion of the survey. This selected choice task will represent your binding final purchase decision. Each choice task has the same probability of being selected.

For example, if choice task 2 gets chosen at the end of the survey, you will be shown the product option that you chose in choice task 2. If you chose a lettuce product (option A or option B) in choice task 2, you will purchase that product at the listed price. If you chose the "neither of these" option (option C), you will not need to purchase any product.

Only one choice task will be selected, so even if you choose a purchase option in every task, you will never have to make more than one purchase at the end of the survey. It is in your best interest to choose the options that represent exactly what you are willing to pay.

Practice Choice Scenario

Here is an example choice set as practice before you make your actual choices.

Each of these products represents a 4 ounce chocolate bar. Please click on the product option you prefer to buy.

Practice Choice Scenario Results

Okay, now let's look at your results from the practice round, assuming this choice scenario was randomly selected as binding. Your selected choice is shown below. If this were an actual choice scenario, you would receive this product and pay the listed price.

{Selected Choice from Practice Scenario}

When you are ready, proceed to the next page for descriptions and the eight actual choice sets. Remember that the following choices are potential purchase decisions, and one scenario will be randomly selected as binding at the completion of the survey.

Instructions 2

On the following eight pages, you will see descriptions of two different heads of lettuce.
You will receive information about the following three characteristics for each product. Actual product size and appearances may vary, but for the purposes of this survey, please assume that these other characteristics of the lettuce are similar across all options.

1. Organic certification status
2. Growing method (hydroponic or traditional)
3. Price

{*Control Group*
The United States Department of Agriculture (USDA) has an organic certification program for food and other agricultural products. Products in this survey with a USDA organic logo are grown on certified organic farms, and products without the label are not.}

{*Environmental Group*
The United States Department of Agriculture (USDA) has an organic certification program for food and other agricultural products. Products in this survey with a USDA organic logo are grown on certified organic farms, and products without the label are not.

Lettuce is typically grown in soil using traditional farming practices. A different method involves growing plants in water instead of soil. This method, referred to as hydroponic, raises plants in water with added mineral nutrients.

Hydroponic farms can use 70-95% less water than traditional farming because the water can be collected and recirculated many times. This can also reduce fertilizer use and eliminate runoff from fields. Plants grown hydroponically do not require fertile soil and can be easily stacked in a vertical format to save space. This method of growing plants vertically uses less farmland to produce food (Despommier, 2010).}

{*Clean Group*
The United States Department of Agriculture (USDA) has an organic certification program for food and other agricultural products. Products in this survey with a USDA organic logo are grown on certified organic farms, and products without the label are not.

Lettuce is typically grown in soil using traditional farming practices. A different method involves growing plants in water instead of soil. This method, referred to as hydroponic, raises plants in water with added mineral nutrients.

Hydroponic crops are usually grown in enclosed buildings. This controlled environment can reduce or eliminate the need to use pesticides on the plants. Hydroponic crops also have less contact with soil than traditional crops. This may allow them to stay cleaner during the harvest process (Despommier, 2010).}

{*Local Group*
The United States Department of Agriculture (USDA) has an organic certification program for food and other agricultural products. Products in this survey with a USDA organic logo are grown on certified organic farms, and products without the label are not.

Lettuce is typically grown in soil using traditional farming practices. A different method involves growing plants in water instead of soil. This method, referred to as hydroponic, raises plants in water with added mineral nutrients.

Hydroponic crops are usually grown in enclosed buildings. This controlled environment protects plants from harsh climates and unpredictable weather. This allows some hydroponic farms to locate close to urban areas with unfavorable climates and still deliver consistent shipments of lettuce year-round. Many of these farms are close enough to deliver produce to the store on the same day that it was harvested. Nutrient levels in fresh produce begin to drop after harvest, so reducing transportation time can improve the nutritional value of the lettuce compared to products that take longer to arrive at the store (Despommier, 2010).}

When you are ready, proceed to the next page to view the first of eight actual choice scenarios. Remember that one of your choice scenarios will be randomly selected at the end of the survey and you will actually purchase the option you chose in that scenario.

Scenario 1
Please click on the product option you prefer to buy.

Option A	Option B	Option C
 Hydroponically Grown USDA ORGANIC $2.00	 Hydroponically Grown $3.00	Neither of these

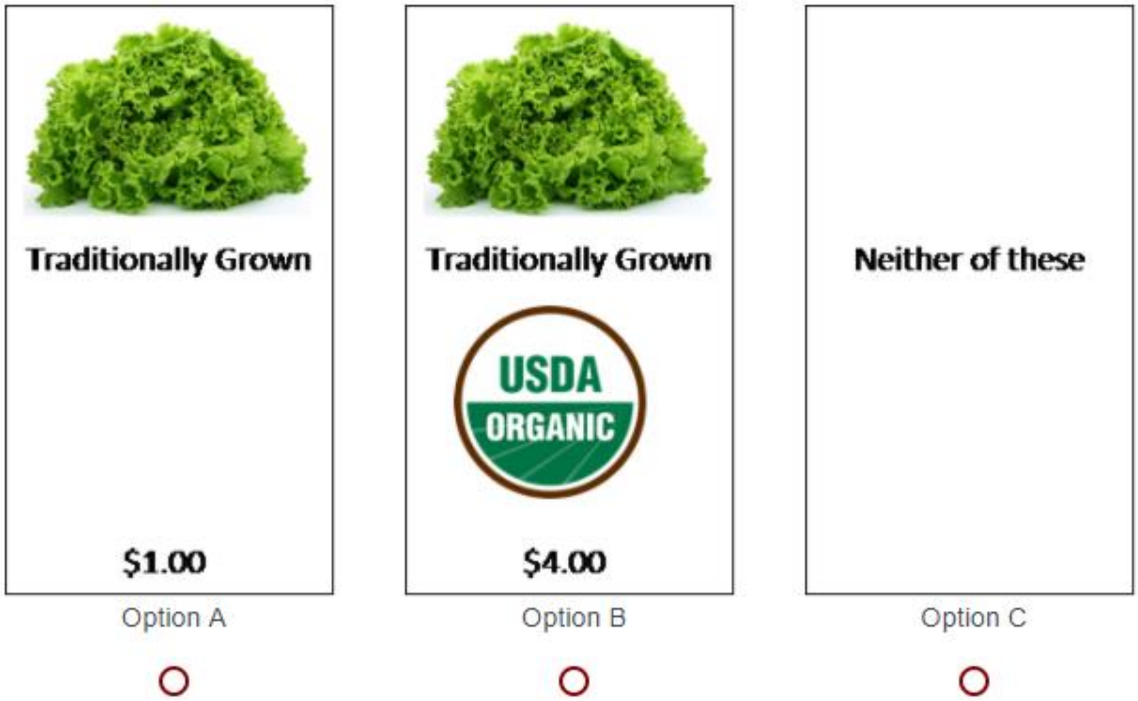
Option A ○ Option B ○ Option C ○

Scenario 2
Please click on the product option you prefer to buy.

Option A	Option B	Option C
 Traditionally Grown $4.00	 Hydroponically Grown $1.00	Neither of these

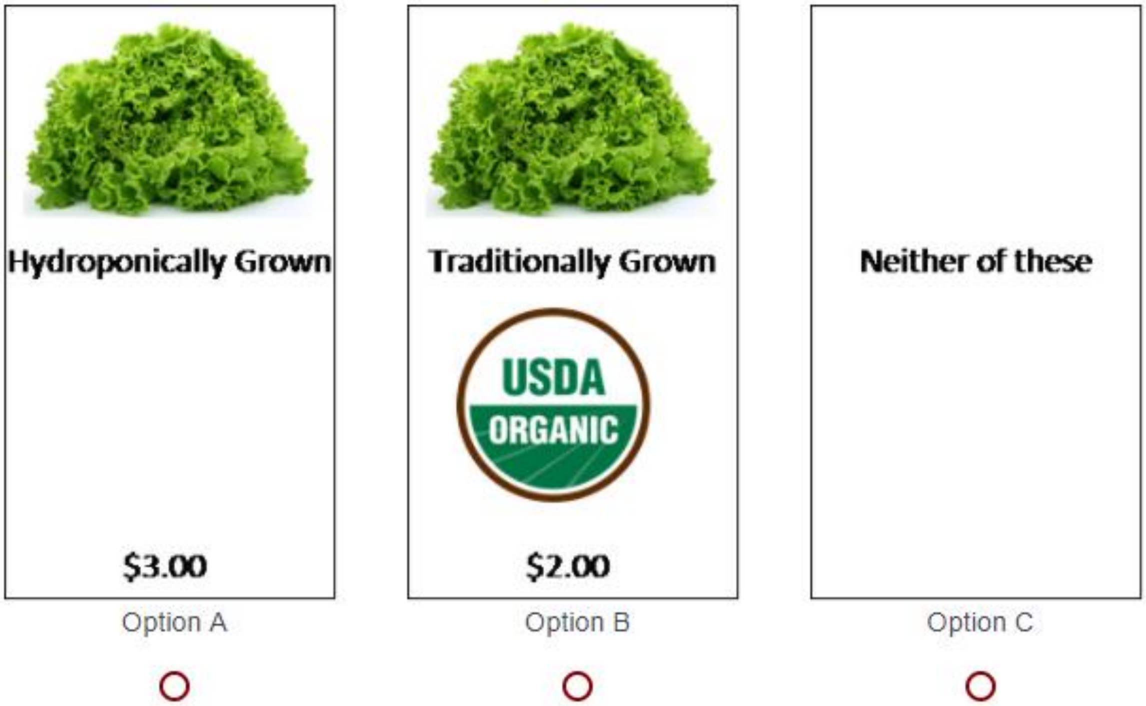
Option A ○ Option B ○ Option C ○

Scenario 3
Please click on the product option you prefer to buy.



Scenario 4
Please click on the product option you prefer to buy.

Scenario 5
Please click on the product option you prefer to buy.



Scenario 6
Please click on the product option you prefer to buy.

Scenario 7

Please click on the product option you prefer to buy.

Option A	Option B	Option C
 Hydroponically Grown $2.00	 Hydroponically Grown USDA ORGANIC $3.00	Neither of these

Scenario 8

Please click on the product option you prefer to buy.

Option A	Option B	Option C
 Traditionally Grown USDA ORGANIC $1.00	 Traditionally Grown $4.00	Neither of these

Perceptions
In this part of the survey, you will be asked to rate your perceptions about different lettuce production methods.

On a scale from 1 to 5 where 1 means low knowledge and 5 means high knowlege, how would you rate your knowledge about each of these growing methods?

	Low knowledge				High knowledge
Traditional non-organic	O	O	O	O	O
Traditional organic	O	O	O	O	O
Hydroponic non-organic	O	O	O	O	O
Hydroponic organic	O	O	O	O	O

On a scale from 1 to 5 where 1 means unnatural and 5 means natural, how would you rate the "naturalness" of lettuce grown using each of these growing methods?

	Unnatural				Natural
Traditional non-organic	O	O	O	O	O
Traditional organic	O	O	O	O	O
Hydroponic non-organic	O	O	O	O	O
Hydroponic organic	O	O	O	O	O

On a scale from 1 to 5 where 1 means very unsafe and 5 means very safe, how would you rate the safety of lettuce grown using each of these growing methods?

	Very unsafe				Very safe
Traditional non-organic	O	O	O	O	O
Traditional organic	O	O	O	O	O
Hydroponic non-organic	O	O	O	O	O
Hydroponic organic	O	O	O	O	O

On a scale from 1 to 5 where 1 means low quality and 5 means high quality, how would you rate the quality of lettuce grown using each of these growing methods?

	Low quality				High quality
Traditional non-organic	O	O	O	O	O
Traditional organic	O	O	O	O	O
Hydroponic non-organic	O	O	O	O	O
Hydroponic organic	O	O	O	O	O

On a scale from 1 to 5 where 1 means very unwilling to buy and 5 means very willing to buy, how would you rate the willingness of the average Harps shopper to buy lettuce grown using each of these growing methods?

	Very unwilling to buy				Very willing to buy
Traditional non-organic	O	O	O	O	O
Traditional organic	O	O	O	O	O
Hydroponic non-organic	O	O	O	O	O
Hydroponic organic	O	O	O	O	O

Prior Knowledge of Organic

Before beginning this survey, how familiar were you with the USDA organic certification?

- ○ Extremely familiar
- ○ Very familiar
- ○ Moderately familiar
- ○ Slightly familiar
- ○ Not at all familiar

Before beginning this survey, how familiar were you with hydroponic growing methods?

- ○ Extremely familiar
- ○ Very familiar
- ○ Moderately familiar
- ○ Slightly familiar
- ○ Not at all familiar

Please indicate if you think this statement is true or false: *Organic products are permitted to contain up to 5% genetically modified ingredients.*

- ○ True
- ○ False

Please indicate if you think this statement is true or false: *The speed of hydroponic growing is usually slower than traditional growing because plants grown hydroponically take more time to mature.*

- ○ True
- ○ False

How often do you search for organic logos when buying food products?

- ○ Always
- ○ Regularly
- ○ Sometimes
- ○ Rarely
- ○ Never

Do you think that food grown hydroponically should be allowed to use the organic label?

- ○ Strongly agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Strongly disagree

Would you want your child to eat hydroponic lettuce as part of their lunch at school?

- ○ Definitely yes
- ○ Probably yes
- ○ Might or might not
- ○ Probably not
- ○ Definitely not

Demographics

In what year were you born?

[ ]

Which of these best represents your gender?

- ○ Male
- ○ Female

What is the highest level of education you have completed?

- ○ Less than high school degree
- ○ High school graduate (high school diploma or equivalent including GED)
- ○ Some college but no degree
- ○ Associate degree in college (2-year)
- ○ Bachelor's degree in college (4-year)
- ○ Master's degree
- ○ Doctoral degree
- ○ Professional degree (JD, MD)
- ○ I do not wish to answer

How many adults (18 years old or older) are in your household, including yourself?

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ More than 6

How many children (younger than 18 years old) are in your household?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ More than 5

Please indicate your approximate household income in 2016 before taxes.

- ○ Less than $10,000
- ○ $10,000 to $19,999
- ○ $20,000 to $29,999
- ○ $30,000 to $39,999
- ○ $40,000 to $49,999
- ○ $50,000 to $59,999
- ○ $60,000 to $69,999
- ○ $70,000 to $79,999
- ○ $80,000 to $89,999
- ○ $90,000 to $99,999
- ○ $100,000 to $149,999
- ○ $150,000 or more
- ○ I do not know
- ○ I do not wish to answer

Which of the following best describes your race or ethnic background (more than one may apply)?

- ☐ White non-Hispanic
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Hispanic
- ☐ Other (please specify) ________
- ☐ I do not wish to answer

Which of the following best describes your current employment status?

- ◯ Unemployed not looking for work
- ◯ Retired
- ◯ Student
- ◯ Employed part time
- ◯ Employed full time
- ◯ Unemployed looking for work
- ◯ Disabled

Results

At this point the survey software has randomly selected one of your choice scenarios as binding. Let's look at your choice from that binding choice scenario.

{Selected Choice from Randomly Chosen Scenario (Scenario 1-8)}

Your randomly selected choice is shown above. Please show this screen to the researcher.

If you selected a lettuce product in this scenario, you will receive a receipt for this product at the listed price. Please take this receipt with you to the store register for payment at the end of your shopping trip.

If you did not select a lettuce product in this scenario, then you are finished with this survey.

The FDA recommends that people "wash all produce thoroughly under running water before preparing and/or eating." (FDA, 2015)

Thanks for your participation!

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