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Fresh Foods Irrigated With Recycled Water: A Framed Field Experiment on Consumer Response

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ABSTRACT

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Recycled water is one potential solution to meeting the growing demand for irrigation water in the U.S. and worldwide. However, widespread adoption of recycled water by agriculture will depend on consumers' acceptance of food crops grown with this water. In a revealed-preference dichotomous-choice framed field experiment, this study elicits consumers' willingness to pay (WTP) for fresh produce irrigated with recycled water. It also evaluates consumers' behavioral responses to information about the environmental benefits and potential health risks of recycled irrigation water. The results suggest that consumers are less willing to pay for produce irrigated with recycled water than for produce irrigated with water of an unspecified type. Information about potential health risks associated with recycled water reduces consumers' WTP by nearly 50% while information about its environmental benefits does not have a substantial impact. However, a behavioral intervention that presents individuals with a balanced information treatment leads to a 30% increase in mean WTP for produce irrigated with recycled water relative to the experimental control. However, this effect is only found with vegetables and not with fruit, perhaps because fruit is usually consumed raw. Most of the demographic characteristics analyzed in the experiment did not influence consumers' likelihood of purchasing produce irrigated with recycled water; the exception was presence of a child in the household—those consumers were less likely to purchase the produce, particularly fruits, irrigated with recycled water.

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Abstract

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1. Introduction

Agriculture accounts for nearly 70% of global consumption of fresh water (United Nations World Water Assessment Programme (WWAP), 2016). And by 2050, when the world's population reaches 9 billion, agricultural production will rise 50%, requiring a 15% increase in water withdrawals (World Bank, 2014). Furthermore, half of the world's population will live in water-stressed areas within the next ten years (World Health Organization (WHO), 2017). Given the growing scarcity of water and uncertain effects of climate change on the supply of surface and ground water traditionally used for irrigation, many countries are looking to nontraditional water sources such as recycled, treated wastewater[1] to meet the demands for agricultural irrigation. In the U.S., where agriculture accounts for 80% of fresh water use (U.S. Department of Agriculture (USDA), 2017), states such as California, Arizona, Florida, and Texas already augment their irrigation water supplies with recycled water (McNabb, 2017). However, successful widespread adoption of recycled water use by U.S. agriculture will ultimately depend on consumer demand for food crops grown with such water, especially if marketers begin to use labeling to identify the source of water used in the growth of product, such as the blueberries depicted in Figure 1 that were sold in major grocery stores in the mid-Atlantic and California in 2017.

Consumers have generally been hesitant to accept use of recycled water because of its "yuck factor" (Po et al., 2003; Dolnicar and Saunders, 2006; Schmidt, 2008; Haddad et al., 2009;

[1] According to the California Department of Water Resources, "recycled water is highly treated wastewater from various sources, such as domestic sewage, industrial wastewater and storm water runoff." (California Department of Water Resources (DWR), 2018. Accessed January 23, 2018, at www.water.ca.gov/pubs/conservation/recycled_water_use_in_the_landscape/recylandscape.pdf).

Rozin et al., 2015, Kecinski et al., 2017). Uses of recycled water that present consumers with a small probability of ingestion or personal contact, such as lawn watering, have been perceived as more acceptable than direct uses such as drinking and cooking (Po et al., 2005; Toze, 2006; Hurlimann, 2007; Dolnicar and Schäfer, 2009; Dolnicar and Hurlimann, 2010; Rock et al., 2012; Lease et al., 2014; Kecinski et al., 2016; Hurlimann and Dolnicar, 2016). Other studies have also shown that U.S. consumers' demand for food products falls dramatically in response to real and perceived health risks, particularly when substitute products are readily available (Dillaway et al., 2011; Messer et al., 2017). Although the public's acceptance of recycled water has received some attention in the literature, little is known about consumers' perceptions of food crops irrigated with recycled water or how information about recycled water influences those perceptions. This research aims to fill this gap in the literature.

Using an incentive-compatible dichotomous-choice frame-field field experiment involving 393 participants from the Mid-Atlantic region of the U.S., we measure consumers' willingness to pay (WTP) for strawberries, blueberries, spinach, and broccoli irrigated with water labeled as recycled, conventional, and unspecified. Dichotomous-choice experiments are designed to replicate real-world decision environments and have been shown to be demand-revealing, both theoretically (Satterthwaite, 1975) and empirically (Taylor et al., 2001; Wu et al. 2017). To our knowledge, this is the first study to elicit consumers' WTP for fresh produce irrigated with recycled water using a framed field experiment in which participants make actual purchasing decisions.[2] In addition, this study evaluates the effects of behavioral interventions on consumers' WTP for foods irrigated with recycled water. We investigate the effect of providing

[2] This paper is the first of a series of studies on consumer responses to foods grown with nontraditional waters that is being supported by the CONSERVE (COordinating Nontraditional Sustainable watER Use in Variable climatEs: A Center of Excellence at the Nexus of Sustainable Water Reuse, Food Crop Production, and Health) project that is funded by the USDA.

participants with different types of information associated with the environmental benefits and potential health risks of using recycled water for irrigation. We also explore how participants respond to these behavioral interventions when the information provided balances the risks and benefits.

Our results provide several economically significant and policy-relevant findings. First, we find that consumers are generally less willing to pay for produce irrigated with recycled water (mean WTP of $1.62) than for produce irrigated with water of an unspecified type (mean WTP of $2.08). In contrast, consumers' WTP for produce irrigated with conventional water ($2.07) is nearly identical to their WTP for water of an unspecified type. Our results suggest that consumers prefer produce grown with conventional water to produce grown with recycled water,[3] behavior that may result from feelings of disgust associated with the origin of recycled water (Po et al., 2003; Wester et al., 2016) or from perceived health risks associated with use of the water. These findings add to the literature documenting public resistance to uses of recycled water that involve direct human contact or consumption (Po et al., 2005; Menegaki et al., 2007; Hui and Cain, 2017).

Second, our behavioral interventions (information treatments) demonstrate that shedding negative light on produce irrigated with recycled water reduces consumers' mean WTP by nearly 50% compared to consumers in the control group (who received no information) while providing positive information about the environmental benefits of recycled water has no substantial impact on its desirability. Interestingly, we find that a behavioral intervention that presents a

[3] According to the Centers for Disease Control and Prevention, conventional water comes from a variety of sources. Typical sources of conventional water include: surface water, groundwater from wells, rainwater, impounded water (ponds, reservoirs, and lakes), open canals, rivers, streams, and irrigation ditches (Centers for Disease Control and Prevention (CDC), 2016. Accessed January 23, 2018, at https://www.cdc.gov/healthywater/other/agricultural/index.html).

balanced approach (referring to both benefits and risks) leads to greater WTP, increasing by an average of almost 30% relative to the no-information control group. A few studies (Kajale and Becker, 2014; Messer et al., 2011, Price et al., 2015) have reported similar effects, finding that interventions presenting balanced content were more effective than a strictly positive nudge in increasing WTP. Interestingly, this effect of providing both sets of information was found mostly for vegetables and not fruit, suggesting a potential difference in response on whether the food is eaten raw (fruits) or frequently cooked (vegetables). These results contribute to the literature that explored the effects of information as a way of increasing public acceptance of recycled water (Hills et al., 2002; Dolnicar et al. 2010; Simpson and Stratton, 2011; Fielding and Roiko, 2014; Price et al., 2015).

Finally, contrary to the results of several prior studies (e.g., Menegaki et al., 2007; Dolnicar and Schäfer, 2009; Rock et al., 2012), we find that the demographic characteristics analyzed in our experiment do not significantly influence consumers' likelihood of purchasing produce irrigated with recycled water. The one characteristic that has an effect is the presence of a child in the household; consumers in those households are less likely to purchase produce, particularly fruit, irrigated with recycled water.

Understanding consumers' responses to crops irrigated with recycled water is critical for developing effective policies aimed at promoting use of recycled water for irrigation by U.S. farmers. Our findings provide useful insights into consumers' responses to food crops irrigated with recycled water and how behavioral interventions can influence those responses. Therefore, the results can inform and support decision-makers in designing more-effective policies to promote widespread acceptance of food crops grown with recycled water in the U.S.

2. Experiment Design

In this study, we use a revealed-preference single-bounded dichotomous-choice experiment to elicit participants' WTP for produce irrigated with different types of water. Dichotomous-choice designs rely on a posted-price mechanism that resembles a typical consumer purchase-decision environment. The framed field experiment was designed to determine consumers' WTP for produce irrigated with recycled water and answer the following questions (a summary of these questions, the corresponding hypotheses, and our basic conclusions is presented in Table 1):

(1) Do consumers change their WTP for produce irrigated with *recycled water* compared to produce irrigated with water of *unspecified* type?

(2) Do consumers change their WTP for produce irrigated with *conventional water* compared to produce irrigated with water of *unspecified* type?

(3) Does exposure to information about *environmental benefits* of recycled water change consumers' WTP for produce irrigated with *recycled* water?

(4) Does exposure to information about *health risks* associated with recycled water change consumers' WTP for produce irrigated with *recycled* water?

(5) Does exposure to information about *both environmental benefits and health risks* associated with recycled water change consumers' WTP for produce irrigated with recycled water?

In total, 393 individuals from the Mid-Atlantic region of the U.S. participated in the field experiment. Participants were randomly recruited at a large community event that attracts approximately 8,000 people each year. Each participant was given an iPad Pro and seated at a desk with privacy shields. The experiment took about 15 minutes to complete and each participant received a $10 participation fee that could be used to purchase produce during the experiment at posted prices. No communication among participants was allowed during the experiment to ensure that their decisions represented their individual preferences.

Participants were presented with twelve options to purchase strawberries, blueberries, spinach, and broccoli irrigated with recycled, conventional, and unspecified water sources (a within-subject design). This study did not involve deception. All of the food products procured for this research were irrigated with the type of water indicated in the design. The desire to get the actual products ultimately limited the type of produce that could be tested and required us to contact the producers directly to confirm that the information provided was true.

Participants were asked to make yes/no decisions regarding purchasing each product at a posted price. The posted prices were randomly drawn from a normal distribution with the mean equal to the average local market price for each product and a standard deviation equal to half the mean: $P \sim \mathrm{N}(3, 1.5^2)$ for strawberries, blueberries, and spinach and $P \sim \mathrm{N}(2, 1^2)$ for broccoli. At the end of the experiment, each participant earned cash and/or produce they chose to purchase.

To ensure incentive-compatibility, participants were instructed that their purchasing decisions were not hypothetical and that one of their decisions would be randomly selected for implementation at the end of the experiment. Therefore, the dominant strategy was to purchase produce at the posted price only if it was less than or equal to participants' true WTP. To avoid order effects, the interface presented the twelve options to each participant in a random order.

In the instructions presented on the screen, participants were provided with the following formal definitions of conventional and recycled water:

- "Conventional water comes from a variety of sources. Typical sources of conventional water include: surface water, groundwater from wells, rainwater, impounded water (ponds, reservoirs, and lakes), open canals, rivers, streams, and irrigation ditches." (Centers for Disease Control and Prevention (CDC), 2016).
- "Recycled water is highly treated wastewater from various sources, such as domestic sewage, industrial wastewater and storm water runoff." (California Department of Water Resources (DWR), 2018).

To explore the effect of information on consumers' WTP, the experiment interface randomly assigned participants to one of four treatments in a between-subject design: (1) information about environmental benefits of using recycled water for irrigating food, (2) information about the potential health risks associated with recycled irrigation water, (3) information about both environmental benefits and health risks, and (4) no information (control group).

(1) *Benefit Treatment:* "According to the United States Environmental Protection Agency (EPA), 'In addition to providing a dependable, locally-controlled water supply, water recycling provides tremendous environmental benefits. By providing an additional source of water, water recycling can help us find ways to decrease the diversion of water from sensitive ecosystems. Other benefits include decreasing wastewater discharges and reducing and preventing pollution. Recycled water can also be used to create or enhance wetlands and riparian habitats.'" (Environmental Protection Agency (EPA), 2017).

(2) *Risk Treatment:* "According to cropscience.org, 'There have been a number of risk factors identified for using recycled waters for purposes such as agricultural

irrigation. Some risk factors are short term and vary in severity depending on the potential for human, animal or environmental contact (e.g., microbial pathogens), while others have longer term impacts which increase with continued use of recycled water (e.g., salt effects on soil).'" (Fourth International Crop Science Congress, 2004).

(3) *Both Benefit and Risk Treatment:* Participants in the third treatment group were presented with the statements from treatments 1 and 2. The order was randomized.

(4) *Control:* Participants in the control group received neither of the information treatments.

Once the participants completed the purchase part of the experiment, they completed a short survey presented on the iPad screen that collected information on their demographic characteristics, environmental attitudes, and shopping behaviors. Upon completion of the survey, a 12-sided digital die appeared on the participants' screens that was "thrown" to randomly determine which of their purchasing decisions would be selected for implementation. Since each roll of the digital die occurred on one participant's iPad, different participants had different products selected for implementation. Table 2 summarizes the products and treatments used in the experiment.

2.1. Data

The experiment collected data from 393 participants[4] from the Mid-Atlantic states of Delaware, Maryland, New Jersey, New York, Pennsylvania, Washington, D.C., and Virginia as well as from Georgia, Indiana, and California. Table 3 summarizes the participants' demographic characteristics. More than 40% of participants in the experiment were students. To address concerns about external validity, we created a subsample of adult participants to use in the analysis.[5] Demographic characteristics for both sets are presented in Table 3. Several differences between the two samples are apparent. The average age for the adults is 36 years versus 29 years for the full sample, 65% of the participants in the adult sample were women versus 72% in the full sample, and nearly 40% of the adults held a bachelor's degree versus 25% in the full sample. Only 10% of the participants in the adult sample earned less than $15,000 while 15% of participants in the full sample earned that amount.

2.2. Method

We evaluate the outcomes of the experiment using a single-bounded dichotomous-choice model of consumers' WTP for produce irrigated with different types of water. The participants made binary yes/no purchasing decisions for the twelve products offered at a posted price, P. Let D = {0,1} represent individual decisions in which the participants choose "yes" (D = 1) to buy the good only if their WTP is greater than or equal to the posted price:

$$\mathrm{D} = \begin{cases} 0 & WTP < P \quad \text{(No)} \\ 1 & WTP \geq P \quad \text{(Yes).} \end{cases} \tag{1}$$

The probability of each outcome can be expressed as

[4] The initial sample included 395 participants. We excluded observations for two participants because of missing data on income and education, thus reducing our sample to 393 individuals. This did not change the results of the study and the analysis using all 395 individuals is available from the authors upon request.
[5] Adult participants include individuals 22 years and older.

$$\Pr(Y = D) = \begin{cases} F\big(v(P, \mathbf{X}, \mathbf{Z})\big) \\ 1 - F\big(v(P, \mathbf{X}, \mathbf{Z})\big) \end{cases} \text{ for D} = \begin{cases} 0 \\ 1 \end{cases} \tag{2}$$

where F(•) is a cumulative distribution function, v is the difference in indirect utility between buying a product at the given price and declining the product, **X** is a vector of demographic characteristics, and **Z** is a vector that includes attributes of a product. Then, for participant i and product j,

$$v\big(P_{ij}, \mathbf{X}_i, \mathbf{Z}_j\big) = \alpha + \rho' P_{ij} + \lambda_1{}' \mathbf{X}_i + \lambda_2{}' \mathbf{Z}_j \tag{3}$$

where α, ρ, λ_1, and λ_2 are unknown parameters of interest to be estimated; $\mathbf{X}_i$ is a vector of observable demographic characteristics such as age, gender, income, education, and presence of children in the household and a set of dummy variables indicating information about recycled water each participant received; and $\mathbf{Z}_j$ is a vector of the twelve product/water-type combinations (four products and three different types of water).

For a given sample of *n* independent observations, the log-likelihood function is

$$\ln L = \sum_{i=1}^{n} \begin{Bmatrix} I_{Y_{D=0}} lnF\big(\alpha + \rho' P_{ij} + \lambda_1{}' X_i + \lambda_2{}' Z_j\big) + \\ I_{Y_{D=1}} ln\big[1 - F\big(\alpha + \rho' P_{ij} + \lambda_1{}' X_i + \lambda_2{}' Z_j\big)\big] \end{Bmatrix} \tag{4}$$

where I is the dummy variable that equals one when D equals one and equals zero otherwise and F(•) represents a standard logistic distribution with mean zero and variance of $(\frac{\pi}{\sqrt{3}})^2$.

3. Results

Each of the 393 participants made 12 purchasing decisions, yielding 4,716 observations. Overall, 38% of the adult participants and 35% of all participants made a "yes" decision in the chosen round and purchased produce at the posted price. The average posted price for yes-participants was \$1.98 in the adult subsample and \$2.05 in the full sample.

3.1. Random Effects Logit Models

To account for the panel nature of our data, we examine factors that affect the participants' decisions to purchase fresh produce using a random effects logistic regression. Table 4 reports the estimates from a model of all twelve choices (four types of produce, each irrigated with recycled, conventional, and unspecified water) for the full sample and the adult subsample. Dummy variables for each type of produce raised with the unspecified type of water (the baseline water type) and the control group that received no information about recycled water are the omitted baseline variables (variable definitions are provided in Appendix B).

We provide the estimates from the full and partial samples; however, to maintain external validity, we draw conclusions primarily using the adult subsample. As evident from Table 4, most of the variables for the full and adult-only samples have the same sign and significance. The sign and significance of most of the variables remain the same when we expand the model to include a set of demographic characteristics for the adult-only sample.

As expected, price has a negative, statistically significant impact on consumers' likelihood of purchasing produce. We find that consumers are less likely to purchase produce irrigated with recycled water than the baseline produce irrigated with an unspecified type of water. In contrast, irrigation with conventional water has no statistically significant effect on consumers' decision to purchase relative to the baseline type of irrigation. Their apparent lack of acceptance of produce irrigated with recycled water could be related to feelings of disgust associated with the origin of recycled water (Po et al., 2003; Wester et al., 2016) and/or concerns about the potential health risks of using recycled water for irrigation.

In terms of the behavioral interventions (information treatments), we find that providing information about potential health risks reduces adult participants' likelihood of purchasing produce irrigated with recycled water, as indicated by the negative, statistically significant interaction term for produce irrigated with recycled water under the risk information treatment (*Recycled* × *Risk,* –1.365, $p < 0.001$). However (unlike consumers in the full sample), adults are more likely to purchase produce irrigated with recycled water when they receive both of the information treatments (*Recycled* × *Both*, 0.750, $p < 0.083$).

In the final column for the adult subsample, we report estimates of the interaction of recycled water and the set of demographic characteristics analyzed: age, gender, education, income, and presence of children in the household. While most of these standard demographic characteristics do not have a statistically significant effect on participants' purchasing decisions, we do find that consumers are less likely to purchase foods irrigated with recycled water when there are children (younger than 18) in the household. This result is interesting and makes intuitive sense; consumers' perceptions of risk associated with consuming fresh foods irrigated with recycled water could understandably be elevated when those foods would be consumed by children. Interestingly, the positive effect of the dual-statement information treatment on the likelihood of purchasing food irrigated with recycled water is more significant for these households (*Recycled* × *Both*, 0.929, $p < 0.029$), demonstrating the importance of controlling for these factors in the model.

To gain further insight into consumers' responses to different foods produced using recycled irrigation water, we separated the fruits and vegetables and estimated a random effects logistic model for those categories. The results are presented in Table 5 for only the adult consumers and the differences in the models is just the inclusion of the demographic variables. As expected, we again find that price is a statistically significant factor that negatively affects consumers' likelihood of purchasing both fruits and vegetables.

When examining WTP for fruits and vegetables produced using recycled irrigation water, we again find that consumers are less likely to purchase fruits and vegetables grown with recycled water when they receive the risk treatment. And although information concerning the potential health risks associated with using recycled water reduces the likelihood of purchasing both fruits and vegetables irrigated with recycled water, the dual-message treatment presenting information on both the risks and the benefits again has a positive, significant effect only on vegetable purchases. This effect may be driven by the fact that fruit is often consumed raw while vegetables are more often boiled, fried, or baked. We find a similar effect for fruits and vegetables for consumers from households that include children.

3.2. Mean Values for Willingness to Pay

We derive mean WTP values from the estimates from the random effects logistic model following Hanemann (1984):

$$WTP = \frac{1}{\hat{\rho}}\left(\hat{\alpha} + \hat{\lambda}'\overline{\mathbf{X}}\right) \quad (5)$$

where $\hat{\rho}$ is an absolute value representing the price coefficient, $\hat{\alpha}$ and $\hat{\lambda}$ are the estimated parameters, and $\overline{\mathbf{X}}$ is a vector of the means of the explanatory variables. Figure 2 illustrates mean WTP for the products irrigated with each type of water.[6] We find that consumers' WTP for foods

[6] The WTP estimates and 95% confidence intervals were calculated using the Krinsky-Robb parametric bootstrap method. See Hole (2007) for a discussion of different approaches to estimating WTP confidence intervals.

irrigated with conventional and unspecified water are almost identical ($2.07 and $2.08 respectively) but their WTP for foods irrigated with recycled water ($1.62) is more than 20% less.

We further explore the effects of the information treatments on consumer WTP in Figure 3. Consumers who learned of the potential health risks associated with recycled water were significantly less willing to pay for food irrigated with the water—as much as 50% less. Interestingly, though the benefit information treatment modestly increased mean WTP for food produced using recycled water (relative to the control group), providing both risk and benefit information yielded a nearly 30% increase in WTP for foods irrigated with recycled water.

Figure 4 demonstrates consumers' WTP for the produce aggregated into fruit and vegetable. Overall, consumers are less willing to pay for vegetables than for fruits regardless of the type of water used for irrigation. Use of recycled irrigation water reduced the mean WTP for fruits by 16% and vegetables by 32% relative to the unspecified-water baseline.

4. Conclusion

Although several states have already augmented their irrigation water supplies with recycled water, widespread adoption of this practice in the U.S. will depend on consumers' acceptance of the resulting products. Therefore, it is important to understand consumers' responses to fresh foods produced with recycled water. Using an incentive-compatible field experiment, this study provides the first non-hypothetical insights into consumers' WTP for fresh fruits and vegetables produced using recycled water for irrigation and how their WTP changes in response to behavioral interventions that provide consumers with information about recycled water. We compared consumers' responses to use of recycled and conventional irrigation water against a baseline of no information provided about the source of the irrigation water and to two information treatments (environmental benefits and potential health risks) regarding recycled water with a no-information control group.

Our results indicate that consumers' WTP decreases when they are aware that fresh foods (in this case select fruits and vegetables) were produced using recycled irrigation water. We also find that this decline in WTP is exacerbated when consumers are exposed to information about potential risks posed by recycled water, leading to a decrease in WTP of nearly 50%. Solely providing information about the environmental benefits of recycled water does not change their preferences, but providing them with the combination of information on environmental benefits and potential risks increases their mean WTP by about 30%. These results are consistent with several prior studies that found that balanced information treatments were more effective in increasing demand than positive information alone (Kajale and Becker, 2014; Messer et al., 2011), though the effect seems to be strongest with vegetables and not fruit.

Our study revealed no significant effect from the demographic characteristics analyzed but did identify a decrease in consumers' WTP for produce irrigated with recycled water, when a child was present in the household, and the effect was particularly strong for the likelihood of purchasing the fresh fruit offered (strawberries and blueberries), which typically would be consumed without being cooked.

These findings provide valuable information for policy-makers and the food industry about consumers' likely responses to foods produced using recycled irrigation water and different types of information intended to promote consumers' acceptance of such foods. It might seem counter-productive, for example, to provide information about the health risks of using recycled water. But pairing that information with information about its environmental benefits and the high degree to which such water is treated was shown to be more effective than providing information only about its environmental benefits.

Future research should explore potential heterogeneity in consumers' responses to fresh and processed foods produced using recycled irrigation water to determine whether processing relieves consumers' concerns as studies have found that consumers' responses to genetic modification varies based on whether the foods are whole or manufactured (He and Bernard, 2011; Lusk et al., 2015). Furthermore, additional research is needed to understand how various behavioral interventions affect consumers' attitudes toward foods produced using recycled water. Finally, since we found no effect from common demographic characteristics other than the presence of children in the household, future studies should examine the effects of consumer shopping behaviors and other characteristics, such as environmental or political preferences.

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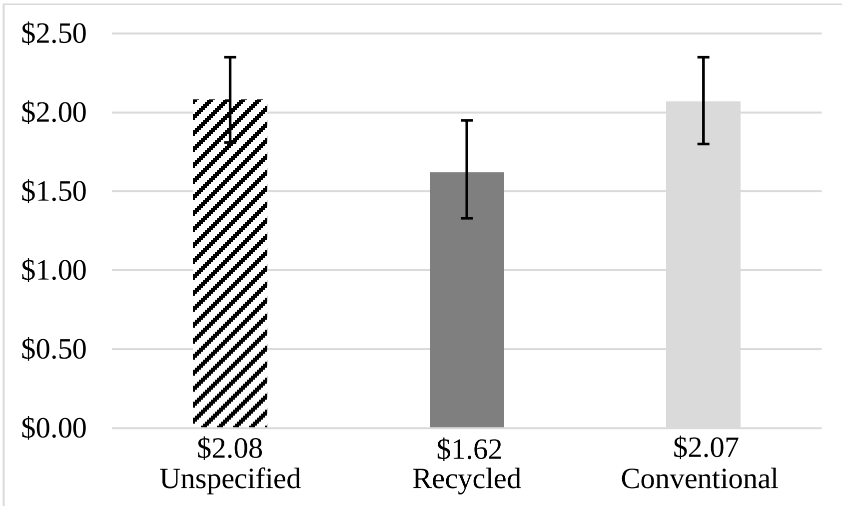
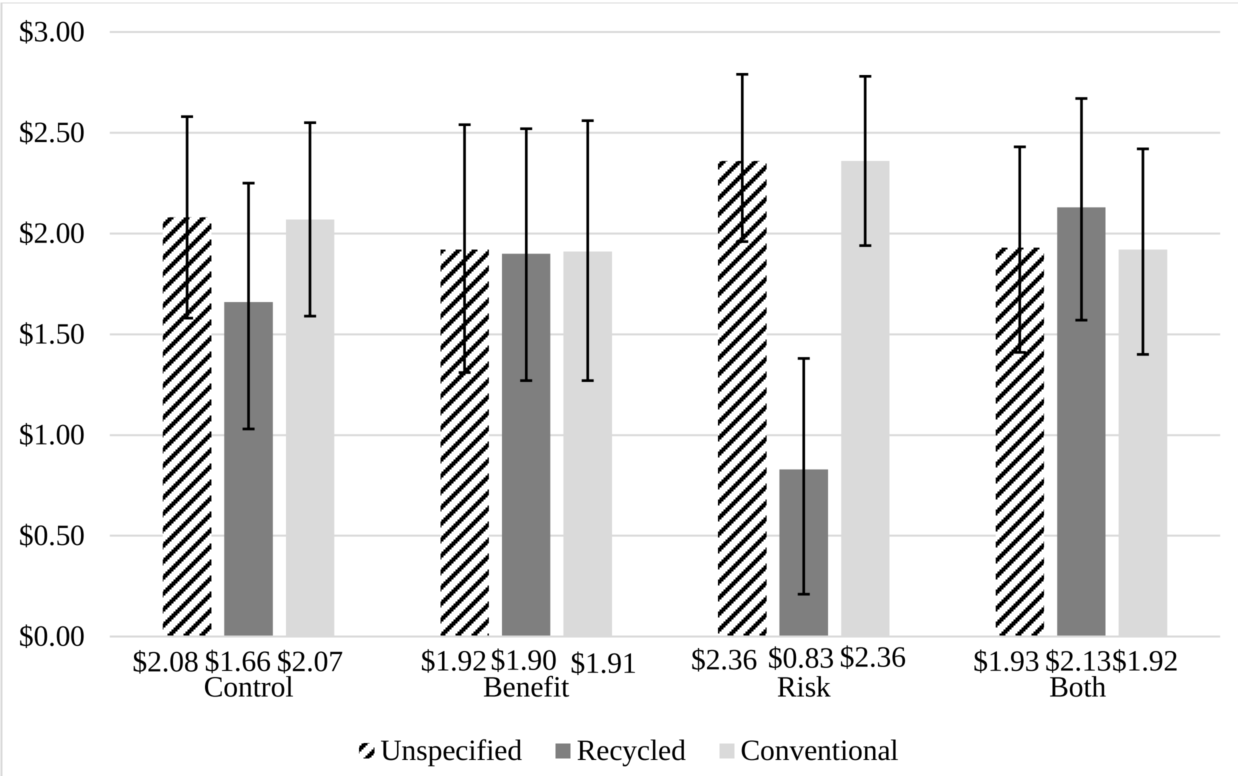
Figure 1. Photo of front-of-package labeling of water source for blueberries.

Figure 2: Mean WTP for Produce Irrigated with Recycled, Conventional and Unspecified Water Types.



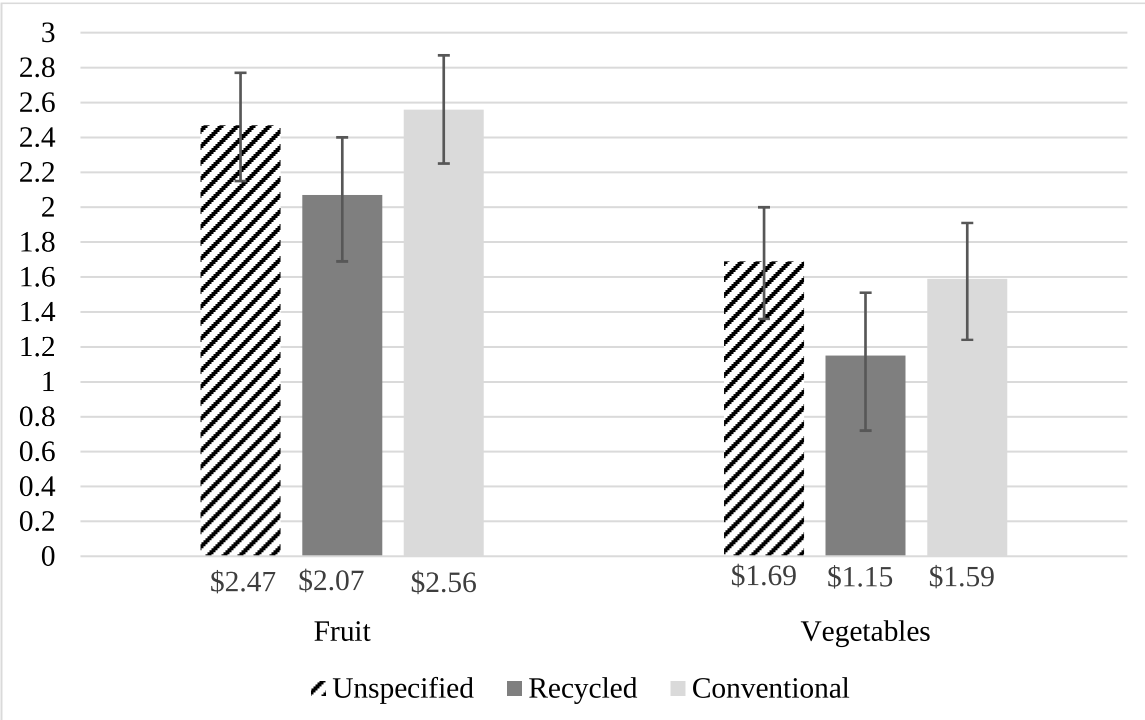
Note: Error bars represent 95% Confidence Interval for WTP measures obtained through Krinsky and Robb parametric bootstrap procedure.

Figure 3: Mean WTP for Produce Irrigated with Recycled, Conventional and Unspecified Water Types by Treatment.



Note: Error bars represent 95% Confidence Interval for WTP measures obtained through Krinsky and Robb parametric bootstrap procedure.

Figure 4: Mean WTP for Fruits and Vegetables Irrigated with Recycled, Conventional and Unspecified Water.



Note: Error bars represent 95% Confidence Interval for WTP measures obtained through Krinsky and Robb parametric bootstrap procedure.

Table 1: Summary of Research Questions, Hypothesis Tests, and Results.

Research Question	Hypothesis Test	Results
Irrigation Water Type		
(1) Do consumers change their WTP for produce irrigated with *recycled* water compared to produce irrigated with water of unspecified type?	H_0 : $\text{WTP}^{\text{Recycle}} = \text{WTP}^{\text{No Info}}$ H_A : $\text{WTP}^{\text{Recycle}} \neq \text{WTP}^{\text{No Info}}$	**Reject**. Consumers lowered their WTP for produce irrigated with recycled water.
(2) Do consumers change their WTP for produce irrigated with *conventional* water compared to produce irrigated with water of unspecified type?	H_0 : $\text{WTP}^{\text{Convention}} = \text{WTP}^{\text{No Info}}$ H_A : $\text{WTP}^{\text{Convention}} \neq \text{WTP}^{\text{No Info}}$	**Fail to Reject**.
Information Effects		
(3) Does exposure to information about *environmental benefits* of recycled water change consumers' WTP for produce irrigated with recycled water?	H_0 : $\text{WTP}^{\text{Positive}} = \text{WTP}^{\text{Control}}$ H_A : $\text{WTP}^{\text{Positive}} \neq \text{WTP}^{\text{Control}}$	**Fail to Reject**.
(4) Does exposure to information about *health risks* associated with recycled water change consumers' WTP for produce irrigated with *recycled* water?	H_0 : $\text{WTP}^{\text{Negative}} = \text{WTP}^{\text{Control}}$ H_A : $\text{WTP}^{\text{Negative}} \neq \text{WTP}^{\text{Control}}$	**Reject**. Consumers who received negative information treatment had lower WTP for produce irrigated with recycled water compared to control group.
(5) Does exposure to information about *both environmental benefits and health risks* associated with recycled water change consumer's WTP for produce irrigated with *recycled* water?	H_0 : $\text{WTP}^{\text{Both}} = \text{WTP}^{\text{Control}}$ H_A : $\text{WTP}^{\text{Both}} \neq \text{WTP}^{\text{Control}}$	**Reject**. Consumers who received a balanced information treatment had higher WTP for produce irrigated with recycled water compared to control group.

Table 2: Experimental Design

			Number of Participants	Total
Between-subject Treatments	Control		97	
	Positive		99	
	Negative		104	
	Both		93	393
Produce	Strawberry	No Specification	393	
		Conventional		
		Recycled		
	Blueberry	No Specification	393	
		Conventional		
		Recycled		
	Spinach	No Specification	393	
		Conventional		
		Recycled		
	Broccoli	No Specification	393	393
		Conventional		
		Recycled		

Table 3: Summary Statistics for Demographic Variables by Sample.

Variable	Full Sample	Adult Participants
Number of respondents	393	211
Average age	28.5	36
	Percentage of participants	
Female	71.5%	64.9%
Children under 18 in the household	19.3%	23.7%
Education		
Less than high school	1.3%	2.37%
Some high school	0.8%	0.47%
High school graduate	7.1%	2.84%
Some college	46.1%	17.54%
Associate degree	2.5%	4.27%
Bachelor degree	24.7%	39.81%
Graduate degree/Professional degree	17.6%	32.7%
Income		
Less than $10,000	13.5%	8.53%
$10,000-$14,999	1.5%	1.9%
$15,000-$24,999	8.1%	12.32%
$25,000-$34,999	5.1%	7.11%
$35,000-$49,999	8.4%	13.27%
$50,000-$74,999	14.8%	19.43%
$75,000-$99,999	11.7%	9.48%
$100,000-$149,999	20.6%	17.06%
$150,000-$199,999	8.1%	7.58%
$200,000-$249,999	3.1%	1.42%
$250,000 and above	5.1%	1.9%

Table 4: Random Effects Logit Model: Impact of Explanatory Variables on Purchase Decisions.

Purchase Decision	Full Sample	Adult Participants	
(Yes/No)	(1)	(2)	(3)
Price	-1.132***	-1.219***	-1.230***
	(0.0637)	(0.0872)	(0.0852)
Recycled	-0.447*	-0.508*	0.246
	(0.242)	(0.286)	(0.743)
Conventional	-0.0225	-0.0105	-0.00687
	(0.108)	(0.149)	(0.150)
Benefit	-0.216	-0.191	-0.211
	(0.342)	(0.479)	(0.504)
Risk	0.827**	0.351	0.276
	(0.324)	(0.382)	(0.401)
Both	0.270	-0.182	-0.320
	(0.329)	(0.420)	(0.442)
Strawberry	1.399***	1.286***	1.297***
	(0.127)	(0.160)	(0.160)
Blueberry	1.206***	1.197***	1.205***
	(0.120)	(0.161)	(0.162)
Spinach	0.523***	0.471***	0.485***
	(0.114)	(0.157)	(0.157)
Recycled x Benefit	0.526	0.480	0.447
	(0.344)	(0.481)	(0.480)
Recycled x Risk	-1.109***	-1.365***	-1.292***
	(0.352)	(0.428)	(0.426)
Recycled x Both	0.494	0.750*	0.929**
	(0.349)	(0.432)	(0.425)
Age			0.00722
			(0.00990)
Age x Recycled			-0.000953
			(0.0103)
Female			-0.0459
			(0.316)
Female x Recycled			0.198
			(0.334)
Income			0.0353
			(0.0502)
Income x Recycled			-0.0412
			(0.0530)
Education			0.104
			(0.104)
Education x Recycled			-0.0929
			(0.116)
Children			0.413
			(0.371)
Children x Recycled			-0.821*
			(0.451)
Constant	1.093***	1.794***	0.808
	(0.264)	(0.353)	(0.760)
N of Observations	4,716	2,532	2,532

Note: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5: Random Effect Logit Model: Impact of Explanatory Variables on Purchase Decision by Fruit and Vegetable Category.

Purchase Decision	Fruit		Vegetables	
(Yes/No)	(1)	(2)	(3)	(4)
Price	-1.302***	-1.324***	-1.148***	-1.155***
	(0.118)	(0.114)	(0.119)	(0.119)
Recycled	-0.484	0.415	-0.558*	-0.0262
	(0.403)	(1.042)	(0.323)	(0.907)
Conventional	0.118	0.127	-0.117	-0.116
	(0.198)	(0.201)	(0.185)	(0.186)
Benefit	-0.190	-0.127	-0.168	-0.270
	(0.520)	(0.550)	(0.496)	(0.516)
Risk	0.0564	0.00131	0.580	0.491
	(0.435)	(0.459)	(0.411)	(0.415)
Both	-0.0713	-0.219	-0.325	-0.487
	(0.511)	(0.535)	(0.419)	(0.433)
Recycled x Benefit	0.654	0.554	0.287	0.309
	(0.599)	(0.631)	(0.565)	(0.563)
Recycled x Risk	-1.172**	-1.088*	-1.418***	-1.415***
	(0.592)	(0.621)	(0.493)	(0.490)
Recycled x Both	0.457	0.900	0.960*	0.984**
	(0.622)	(0.632)	(0.494)	(0.490)
Age		-0.00236		0.0164
		(0.0116)		(0.0103)
Age x Recycled		0.00825		-0.00950
		(0.0141)		(0.0123)
Female		-0.205		0.0762
		(0.365)		(0.322)
Female x Recycled		0.367		0.0978
		(0.462)		(0.388)
Income		0.0766		-0.0129
		(0.0567)		(0.0514)
Income x Recycled		-0.0612		-0.0230
		(0.0691)		(0.0608)
Education		0.0901		0.125
		(0.122)		(0.101)
Education x Recycled		-0.167		-0.0143
		(0.159)		(0.128)
Children		0.654		0.301
		(0.422)		(0.380)
Children x Recycled		-1.703***		-0.122
		(0.567)		(0.507)
Constant	3.261***	2.441***	1.910***	0.836
	(0.464)	(0.897)	(0.377)	(0.781)
N of Observations	1,266	1,266	1,266	1,266

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix A: Survey

Please answer the following questions:

1. What is your age?

2. What is your zip code?

3. What is your gender?
   - Male
   - Female
   - Other (please specify)

4. Which one of the following categories best describes your employment status:
   - Government
   - Education
   - Business
   - Agriculture
   - Student
   - Other (please specify)

5. Are you:
   - Politically liberal
   - Politically moderate
   - Politically conservative
   - Other (please specify)

6. Which category best describes your household income (before taxes) in 2015?
   - Less than $10,000
   - $10,000-$14,999
   - $15,000-$24,999
   - $25,000-$34,999
   - $35,000-$49,999
   - $50,000-$74,999
   - $75,000-$99,999
   - $100,000-$149,999
   - $150,000-$199,999
   - $200,000-$249,999
   - $250,000 and above

7. What is the highest level of education that you have completed?
   - Grade school
   - Some high school
   - High school graduate
   - Some college credit
   - Associate degree
   - Bachelor's degree
   - Graduate degree/Professional

8. Do you have a child/children under the age of 18 years old in your household?
   - Yes
   - No

9. How often do you consume the following produce:

   Strawberries:

   ____ times per month

   Blueberries:

   ____ times per month

   Broccoli:

   ____ times per month

   Spinach:

   ____ times per month

10. Are you the primary shopper in your household?
    - Yes
    - No

11. What is the percentage of organic foods in your overall vegetable and fruit consumption?

    Non-Organic (50%) ———— Organic (50%)

12. Do you grow your own food?
    - Yes
    - No

13. Which do you prefer?

- ◯ Local Food
- ◯ Non-Local Food
- ◯ Don't care

14. How important are the following produce characteristics to you?

Taste: **5**
Not Important (1) **Very Important (9)**

Appearance: **5**
Not Important (1) **Very Important (9)**

Smell: **5**
Not Important (1) **Very Important (9)**

Price: **5**
Not Important (1) **Very Important (9)**

Organic: **5**
Not Important (1) **Very Important (9)**

Non-Genetically Modified Organisms: **5**
Not Important (1) **Very Important (9)**

Growing Location: **5**
Not Important (1) **Very Important (9)**

Brand: **5**
Not Important (1) **Very Important (9)**

15. Have you ever heard of recycled/reclaimed/reused water before today?

- ◯ Yes
- ◯ No

16. How do you drink your water?

- ◯ Bottled Water
- ◯ Filtered Tap Water
- ◯ Tap Water
- ◯ Other (please specify) ______

17. Please check the areas in which you're concerned about water availability.

- ☐ Your Community
- ☐ Your State
- ☐ United States
- ☐ Worldwide
- ☐ I'm not concerned.

18. Are you concerned about water availability in the following time periods?

Present: **5**
Not At All (1) **Very Concerned (9)**

Next 10 Years: **5**
Not At All (1) **Very Concerned (9)**

Next 30 Years: **5**
Not At All (1) **Very Concerned (9)**

Greater than 30 years: **5**
Not At All (1) **Very Concerned (9)**

19. How concerned are you about climate change in...

Your Community: **5**
Not At All (1) **Very Concerned (9)**

Your State: **5**
Not At All (1) **Very Concerned (9)**

United States: **5**
Not At All (1) **Very Concerned (9)**

Worldwide: **5**
Not At All (1) **Very Concerned (9)**

20. How do you feel about these different types of non-traditional waters for irrigation?

Grey Water: **5**

It generally refers to the wastewater generated from household uses like bathing and washing clothes.

Dislike (1) **Like (9)**

Black Water: **5**

Also described as Brown Water. It generally refers to the wastewater generated from toilets.

Dislike (1) **Like (9)**

Brackish Water: **5**

It is typically defined as distastefully salty but less saline than seawater (between 1,000 to 10,000 ppm [parts per million] in total dissolved solids [TDS]). In addition to certain surface water settings such as estuaries, brackish water can be found in aquifers.

Dislike (1) **Like (9)**

Industrial Water: **5**

It generally means process and non-process wastewater from manufacturing, commercial, mining, and silvicultural (forestry) facilities or activities, including the runoff and leachate from areas that receive pollutants associated with industrial or commercial storage, handling or processing, and all other wastewater not otherwise defined as domestic wastewater.

Dislike (1) **Like (9)**

Rain Water: **5**

Generally, the term rain water refers to water coming from rooftops and other aboveground surfaces.

Dislike (1) **Like (9)**

Storm Water: **5**

Generally, the term storm water refers to rainwater collected from non-roof surfaces, such as parking lots, hardscapes, and landscapes surrounding urban buildings.

Dislike (1) **Like (9)**

21. How do you feel about using these types of water in agricultural produce production?

Conventional Water: **5**

Dislike (1) **Like (9)**

Non-traditional: **5**

Dislike (1) **Like (9)**

22. Which do you prefer for use in agricultural meat production?

Conventional Water: **5**

Dislike (1) **Like (9)**

Non-traditional: **5**

Dislike (1) **Like (9)**

Finish and Submit

Appendix B: Variable Definitions

Variable	Description
Price	Randomly posted price
Recycled	Equals 1 for produce irrigated with recycled water
Conventional	Equals 1 for produce irrigated with conventional water
Benefit	Equals 1 if participant is in the group that received information about environmental benefits of recycled water
Risk	Equals 1 if participant is in the group that received information about health risk associated with recycled water
Both	Equals 1 if participant is in the group that received a balanced information treatment that includes information about both benefits and risks
Recycled x Benefit	Interaction term between produce irrigated with recycled water and environmental benefit information treatment
Recycled x Risk	Interaction term between produce irrigated with recycled water and health risk information treatment
Recycled x Both	Interaction term between produce irrigated with recycled water and a balanced information treatment

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