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Gaps in Risk Perceptions Between the United States and Israel: Field Experiments on Various Types of Nontraditional Water

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ABSTRACT

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Keywords: Nontraditional water, recycled water, stigma, consumer willingness-to-pay, food labeling, field experiments, irrigation water

In the first half of 2018, approximately 31% of the continental United States was experiencing some level of drought, conditions that are predicted to spread as climate change hastens shifts in the global water cycle. Despite nontraditional water being a cost-effective, safe, and commonly proposed solution for inadequate water supplies, broad adoption of nontraditional irrigation water at the farm level in the United States and across the world will depend on consumer acceptance of such practices. This study utilized field experiments in the United States and Israel to examine consumer preferences in two countries that are heterogenous in terms of the impacts of drought and experience level. We investigate how consumers respond to different types of nontraditional water and if exposure to scientific information about the benefits and risks of recycled water affects these preferences. The results suggest that Israeli consumers are significantly more accepting than U.S. consumers of produce irrigated with nontraditional water. We also find that the use of nontraditional water diminishes consumer demand by 87% in the United States and 20% in Israel, and that reductions in WTP vary by water type in both countri

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Introduction

In light of the pressing nature of current and future water scarcity issues, this research focuses on providing a better understanding of how consumers respond to water-cleansing technologies in general and, in particular, how they perceive agricultural products irrigated with nontraditional water. Any water source other than groundwater and treated surface water is considered nontraditional, including recycled gray, recycled black, recycled produced, recycled effluent, and desalinated, the sources we specifically examine in this paper (U.S. Department of Agriculture (USDA) 2017). Widespread adoption of nontraditional irrigation water in the United States and across the world is dependent on consumer acceptance of it, as no farmer will use nontraditional water if consumers reject food produced with it. Though Israel has been using nontraditional water in agriculture for 30 years, little research has been conducted on consumers' perceptions of the technology. Using economic field experiments involving 660 adult subjects,[i] we compare the responses of consumers in the United States and Israel for produce irrigated with nontraditional water and find stark differences in behavior between the two countries. Our field experiments were conducted in the United States and Israel, to determine whether consumer preferences for agricultural food products vary by country and type of nontraditional irrigation water. Prior studies have examined a single geographic area and thus have not addressed the effect of different types of nontraditional water used regionally. They also have portrayed nontraditional water as a homogenous commodity, describing it with catch-all terms such as recycled, reclaimed, or reused water. We address this gap in the literature by focusing on specific types of nontraditional water.

Background on water scarcity in the US and Israel

Severe water shortages and increasing agricultural demand for water forced Israel in the 1990s to pioneer not only new irrigation technologies but also new sources of water (Feitelson 2013; Menahem and Gilad 2013). In 2013, Israel’s use of nontraditional water exceeded its use of natural water by 45%, with 60% of the irrigation water used in agricultural production coming from nontraditional sources (Lipchin and Pennycock 2015). Innovations such as drip irrigation and large-scale adoption of nontraditional water in Israel have mitigated one of the most serious water crises in the world and enabled the country’s agricultural output to increase twelve-fold over thirty years (Lipchin and Pennycock 2015).

On average in the first half of 2018, approximately 31% of the continental United States was experiencing some level of drought, with 15% suffering from severe drought (USDA 2018). Addressing these water shortages is particularly pressing for farmers in the western United States, which encompasses 74% of the country’s irrigated acres (U.S. Geologic Survey (USGS) 2016a). The agricultural sector is responsible for 80% of all water consumption in the United States and more than 90% in many western states (USDA Economic Research Service (ERS) 2017). According to the Intergovernmental Panel on Climate Change’s (IPCC’s) Fifth Assessment Report, the strain on fresh water supplies will only increase as global warming induced climate change hastens shifts in the global water cycle, increasing the disparity between wet and dry regions (IPCC 2014).

A potential solution to this problem of drought is the use of nontraditional water in irrigation. Traditional irrigation water comes from a variety of sources, including surface water (rivers, lakes, ponds, and reservoirs) and ground water supplies (Centers for Disease Control and Prevention (CDC) 2009). Nontraditional irrigation water typically refers to recycled wastewater and to other types of water that are not fresh, such as salt water, which can be desalinated (USGS

2016b; WateReuse 2016). Several types of wastewater can be recycled, such as gray, black, effluent, and produced water. Gray water is household wastewater from washing, laundering, bathing, and showering (Environmental Protection Agency (EPA) 2016b) while black water comes from toilets and urinals (EPA 2016a). Effluent consists of gray and black water. Produced water comes from oil and gas drilling and is a mixture of water naturally stored in oil and gas pockets and the water injected into wells to extract the oil (Igunnu and Chen 2014). It is not the same as the mixture of water and chemicals used in hydraulic fracturing.

Despite nontraditional water being a cost-effective, safe, and commonly proposed solution for inadequate water supplies, broad adoption of nontraditional irrigation water at the farm level in the United States will depend on consumers' acceptance of such practices and their resulting willingness to pay (WTP) for the output of those fields (Gleick 2010; Chen et al. 2013). There was an uptick in use of nontraditional water sources for irrigation in the United States in the late 1990s (Lazarova and Bahri, 2004), but many agricultural producers have so far rejected its use because they have been concerned about consumers' responses. Previous research has shown that consumers in the United States have a lower WTP for produce irrigated with recycled water than conventional, but that their acceptance of these products can be increased through various means (Schmidt et al. 2017; Savchenko et al. 2018).

When Israel began moving aggressively toward implementing nontraditional water policies in the early 1990s, through the national water commissioner and Mekorot, Israel's national water company, there was little public discussion and no formal referendum. Israel's water management system is centralized and the government views water as a priority for national security that precludes individual rights (Gelpe 2010; Feitelson 2013; Kislev 2013; Menahem and Gilad 2013). Israel's strategy of unilaterally shifting national water policies would likely be problematic for the United States where individuals have well-established private water rights and governmental controls and regulation of water are assigned at federal, state, and local levels. The difficulty of using such a system in the United States is compounded by U.S. consumers' broad concerns about food safety and new agricultural technologies (Kanter, Messer, and Kaiser 2009; Dillaway et al. 2011; Eckley and McEowen 2012; Messer et al. 2015; Wu et al. 2015; Lusk, McFadden, and Wilson *Forthcoming*).

This study addresses three key questions:

1. How does consumer demand for produce irrigated with nontraditional water in the United States and Israel differ?
2. Does U.S. and Israeli consumers' WTP for produce irrigated with nontraditional water depend on the type of water (recycled gray, recycled black, and recycled produced water in the United States and desalinated water and recycled effluent in Israel)?
3. Does exposure to different types of scientific information about recycled water—benefits, risks, and both benefits and risks—change consumers WTP for produce irrigated with various types of water?

Table 1 summarizes our hypotheses regarding these questions and the conclusions drawn from the experiments. We find that use of nontraditional water diminishes consumer demand for produce irrigated with it and that the reduction in WTP varies by water type. Overall, Israeli consumers are significantly more accepting than U.S. consumers of produce irrigated with nontraditional water. However, scientific information about recycled water had no significant effect on participants in the United States or Israel.

Literature Review

Despite Israel's decades of experience with nontraditional water, we know of no studies that have examined consumer preferences in Israel for food produced with different types of nontraditional water. Over the last 20 years, as use of nontraditional water has been introduced in other parts of the world, a number of studies have examined consumers' responses to it. Several studies measured consumers' preferences for ingesting recycled drinking water and found that they had little interest in such water despite it being safe to drink (Dolnicar and Hurlimann 2009; Wester et al. 2016; Kecinski and Messer 2017). Another handful of studies, utilizing hypothetical stated-preference models that characterized recycled water using broad terms, examined consumers' concerns about eating produce irrigated with nontraditional water and similarly found that consumers' WTP declined when recycled water was used as opposed to "conventional" (Menegaki, Hanley, and Tsagarakis 2007; Bakopoulou et al. 2008; Menegaki et al. 2009; Hui and Cain 2017). There is evidence that the use of stated versus revealed preferences is particularly important for recycled drinking water projects. Po et al. (2005), for example, reported that stated preference studies conducted in several Australian communities indicated support for recycled water technologies that were later rejected in practice.

In a study in the Mid-Atlantic region of the United States, Savchenko et al. (2018), using a revealed-preference dichotomous-choice framed field experiment, found that consumers were less willing to purchase produce irrigated with recycled water than produce irrigated with water from conventional sources or an unspecified type. Several hypothetical stated-preference surveys have found similar results. Hui and Cain (2017) in a study of California consumers found that up to 40% in Orange County, where 70% of the agricultural water supply comes from an aquifer recharged with recycled water, would refuse to eat produce irrigated with it. A study in Greece by Bakopoulou et al. (2008), found that consumers in the Thessaly region were willing to purchase produce irrigated with recycled water but only at half the price of its conventional counterpart. Similarly, in another study in Greece, Menegaki, Hanley, and Tsagarakis (2007) found that consumers were less willing to buy and pay for produce irrigated with recycled wastewater relative to the same produce irrigated with conventional water.

Stigma is an important component of consumers' refusal to purchase and ingest produce irrigated with recycled water (Menegaki et al. 2009). In economics, stigma is most commonly defined as an overreaction to the risk something possesses (Fischhoff 2001, Walker 2001). If risk is continuous and proportional to an individual's risk attitude, then stigma represents a corner solution where the product is completely avoided. Rozin et al. (2015) provided insight into the rejection of recycled water by outlining the psychological impediments Americans express about drinking it. The primary obstacle is their perception of the water as "toilet to tap" (Dingfelder 2004), a view that can be transferred to produce irrigated with the water and that persists among some individuals regardless of how the water is treated and purified. This avoidance of the water despite it being scientifically deemed safe and treated such that the degree of contamination is as low if not lower than tap and bottled water has been interpreted as an example of the law of contagion. A concept in which objects that come into contact with each other acquire some of the properties of the other objects, an exchange that generally cannot be reversed (Rozin and Nemeroff 2002). Rozin and Nemeroff theorize that this "once in contact, always in contact" idea is evolutionarily wired into the human brain.

According to Rozin et al. (2015), reason-based evidence could dispel such beliefs in many individuals. However, it failed when consumers were relying solely on a spiritual model of contagion, a cognitive heuristic that many Americans typically apply to moral offenses. The authors found that the stigma of recycled drinking water diminished when it was used to recharge an aquifer, which presented a physical barrier to contamination, and was further reduced when the recycled water was allowed to remain in the aquifer for ten years before extracting it for drinking, instead of one year, representing a time barrier.

The idea of contagion was explored by Kecinski et al. (2016) using a series of incentive-compatible, revealed-preference economic experiments. Using a Becker-DeGroot-Marschak (BDM) mechanism, they elicited the amount of money (between $0 and $30) that participants required to agree to drink three ounces of water in which a sterilized cockroach had been dipped. The authors found that participants needed to be paid significantly more to drink the water that came in contact with a cockroach than to drink spring water, pointing to stigmatization from the cockroach, and some participants refused to drink the water even at $30. In a subsequent experiment, the authors elicited participants' willingness to accept (WTA) drinking three ounces of the water that came in contact with a cockroach and then was processed using one to four sequential steps to mitigate the stigma associated with it: boiling, filtering, dilution, and testing. They found that the four mitigation processes were equally effective in assuaging participants' concerns and that their WTP to ingest the water increased with the number of steps completed. Treatment with two steps was more successful than treatment with one, and treatment with three steps was more successful than treatment with two. Their results suggest that stigma associated with contaminated water diminishes when consumers have a more detailed understanding of the processing used to make it safe and the number of processes used.

Similarly, Kecinski and Messer (2017) showed that filtering recycled water could reduce the stigma associated with it and that other-regarding behavior and public discussions could too. Certain environmental conditions seem to have this effect as well. Dolnicar and Schäfer (2009) found that, after nearly five years of drought in Australia, acceptance of desalinated and recycled water had increased, after having been low historically. They determined that Australians were less resistant to desalinated water for close-to-body uses and more accepting of recycled water for garden watering and cleaning purposes. Hui and Cain (2017) found similar results in California; people were more accepting of using recycled water for irrigation than for close-to-body uses such as drinking, cooking, and bathing. What is more, consumers who were told that 70% of the water in their county came from an aquifer recharged with recycled water were more accepting of it than those who were not given that information. Likewise, Savchenko et al. (2018) showed that information about potential health risks lowered participants WTP for vegetables irrigated with recycled water while balanced information about both the benefits and risks raised WTP.

However, simply providing consumers with information on recycled water is not always enough. In 2004 in Australia, the Toowoomba city council began working on a plan to incorporate recycled wastewater into the municipal drinking water supply (Morgan and Grant-Smith 2015, Sedlak 2014) to deal with prolonged drought conditions and prevent a critical water shortage. Despite broad bi-partisan support, an initially small "No" campaign spread after the science behind the practice was misconstrued to reinforce the idea of the water as "toilet to tap." Because no scientist could absolutely guarantee that there would never be any issues with drinking recycled wastewater, the "No" campaign claimed the practice was too risky, leading residents to reject the proposal based on emotions. In their analysis of this case, Morgan and Grant-Smith concluded that the city council's biggest mistake was relying on the public's understanding of science and not addressing the emotional component of the issue.

The person conveying information, their perspective, and the receiver's prior beliefs can determine the effectiveness of the information in altering peoples' preferences. In a study on how different messengers affect consumer decisions about products produced with recycled water, Schmidt et al. (2017) found that participants responded least favorably to the scientist messenger, as opposed to government agencies, non-profit organizations, and newspapers. McFadden and Huffman (2017) found that consumers response to new food technology could be significantly altered depending on whose perspective of the benefits and risks they received—industry, scientific, or environmental. Research by McFadden and Lusk (2015) on the assimilation of scientific information about genetically modified food and global warming suggest that it is dependent on prior beliefs. They found that several factors drove the failure to converge a posterior belief to information including: misinterpreting information, illusionary correlations, selectively scrutinizing information, information-processing problems, knowledge, political affiliation, and cognitive function

Since prior studies suggest that consumers are biased against produce irrigated with nontraditional water and given the strong reactions prompted by earlier proposals for use of recycled water, perhaps it is best to avoid providing consumers with information about the type of water used to irrigate their produce. Currently, most labels on agricultural food products provide no information about the source of the irrigation water used, and several studies have shown that providing no or minimal information about a stigma-inducing characteristic is the best way to prevent consumers from rejecting the product. Messer et al. (2006), for example, found that the best way to prevent large losses in property values near contaminated land was to clean up the contamination quickly and quietly and, specifically, to avoid having the area labeled as an EPA Superfund site. Kecinski et al. (2017) in a study of consumer demand for oysters concluded that sharing information about how oysters from polluted waters were good for the environment because they filtered out excess nutrients did not increase consumers' WTP for the oysters; in fact, it reduced their WTP because it stigmatized the oysters. Providing no information about the polluted waters the oysters came from led to significantly greater WTP.

Experiment Design

To assess consumers' WTP for produce irrigated with different types of nontraditional water, we conducted field experiments in the Mid-Atlantic and Southwest United States, as well as in Eilat, Israel, using a revealed-preference, single-bounded, dichotomous-choice experiment. Multiple studies have shown that a dichotomous-choice mechanism is more robust and less biased than other formats such as auctions because it is more representative of the type of decisions consumers typically make when considering an item—they either purchase it at the posted price or pass on buying it (Arrow et al. 1993; Loomis et al. 1997; Frykblom and Shogren 2000; Wu et al. 2014). Formally in this case, participant *i* is offered produce *j* irrigated with water type *k* at a listed price and either accepts (purchases) it (Accept = 1) or rejects (passes) it (Accept = 0).

$$Accept_{ijk} = \begin{cases} 1 \; if \; P_{ijk} \leq EU_{ijk} \\ 0 \; if \; P_{ijk} > EU_{ijk} \end{cases} \qquad (1)$$

If the price of P_{ijk} is less than or equal to a participant's expected utility, EU_{ijk}, the participant accepts it; otherwise, the participant rejects it. In the experiments, all the purchase opportunities were presented on a single page, so participants could go back and change previous decisions after making the final one to avoid bias associated with the discovered preference hypothesis (Plott 1996).

To determine whether consumers' preferences varied between countries that are heterogeneous in terms of the impacts of drought, experiments were conducted in two regions of the climate diverse United States—the Mid-Atlantic, which is a historically water-abundant area, and the Southwest, which is prone to drought; as well as in Eilat, Israel, an arid desert climate where nontraditional irrigation water has been used for decades. In the Mid-Atlantic, United States, data was collected at an urban farmer's market and at a regional transportation depot. In the Southwest, United States and in Israel, participants were recruited in a single location—at an agricultural festival in Yuma, Arizona, and on a promenade on the Eilat boardwalk, respectively.

At the start of the experiment, participants from the United States were endowed with $10 and participants in Israel an equivalent 40 new Israeli shekels (NIS), as payment for their time (see Appendix A). In the instructions, they were told to think of the money as a bank account from which they could withdraw funds to purchase produce irrigated with different types of water. They were also informed that one of their decisions would be randomly chosen and implemented, encouraging them to carefully consider each decision independently of the others (see Appendix A). Definitions for each type of irrigation water were provided to the participants at the beginning of the experiment, as well as, displayed on the purchase opportunities page. The definitions shown to the participants were as follows:

> **Conventional Water:** Traditional sources of irrigation water, such as surface water (rivers, lakes, ponds, and reservoirs) and well water (CDC 2009).
>
> **Desalinated Water:** Saline water that has had its dissolved salts removed (USGS 2016).
>
> **Recycled Black Water:** Treated wastewater from toilets and urinals (EPA 2016a).
>
> **Recycled Effluent:** Treated wastewater from washing, laundering, bathing, showering, toilets, and urinals (EPA 2016a, EPA 2016b).
>
> **Recycled Gray Water:** Treated wastewater from washing, laundering, bathing, or showering (EPA 2016b).
>
> **Recycled Produced Water:** Treated wastewater from oil and gas drilling operations (Igunnu and Chen 2014).

In the United States, the experiments were in English, while in Israel they were in Hebrew. The wording was drafted in English and then translated into Hebrew by a professional translator associated with the Arava Institute for Environmental Studies. All the experiments were completed on tablet computers using a Willow-based program that both administered the experiment and collected the data.

The products offered in the experiments were “debranded” by removing all identifying labels and displayed in one area so participants could examine them. Because of the general prohibition on deception in experimental economics (Rousu et al. 2015), the types of produce and nontraditional irrigation water used in each region varied, due to what was available in the local grocery stores at the time (see table 2). This affected the number of real purchasing decisions offered between the United States and Israel.

In the United States, participants were presented with fifteen purchase opportunities as a within subject treatment (see figure 1)—five versions of three types of produce. The first version served as a control and replicated how most produce is labeled in the United States; it provided no information about the type of irrigation water used on the products. The four treatment groups were conventional, recycled gray, recycled black, and recycled produced irrigation water. The produce offered in the Mid-Atlantic experiment consisted of baby carrots, almonds, and grapes; in the Southwest experiment, participants were offered baby carrots, almonds, and clementines.

In Israel, participants were presented with eight purchase opportunities—four versions of two types of produce, clementines and dates. As in the experiments in the United States, the first version provided no information about the type of irrigation water. The treatment groups were conventional, desalinated, and recycled effluent (a combination of recycled gray and black water) irrigation water.

Presentation of the food decisions was randomized across participants to avoid order effects. Prices were randomly generated and drawn from a normal distribution, ranging from $0 to $10 in the United States and NIS0 to NIS40 in Israel. In all cases, the standard deviation was half of the respective mean price.[ii]

The experiments also tested the effects of various kinds of scientific information about recycled water using a no-information control group and three treatments—its benefits only, its risks only, and its benefits and risks (presented in a randomized order). The information treatments were developed in English and then translated into Hebrew for the experiment in Israel. Each participant was randomly assigned to one of the groups and given the information at the beginning of the experiment.

> *Benefit Information 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 [riverside] habitats."
>
> *Risk Information 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., [effects of salt and heavy metals] on soil)."

After reviewing the information, the participants responded to the purchase opportunities by selecting yes or no and then completed a survey (see Appendix B) that collected information on their demographic characteristics, political views, food preferences, and opinions on related topics.

At the end of the experiment, a digital dice was “rolled” to select the purchase opportunity to be implemented. Participants who selected yes for the implemented option received the produce and the balance of their $10/INS40 endowments after deducting the purchase price. Thus, for example, if the purchase price for the binding option in one of the United States experiments was $2, they received the produce and the remaining $8. Participants who selected no for the implemented option received the entire $10/NIS40 participation fee and received no produce.

Results

The experiments successfully collected data from 660 adult consumers: 458 participants from the United States, and 202 participants from Israel, resulting in a total of 8,486 observations. Table 3 presents summary statistics for the treatments and the characteristics collected by the survey. Because of the binary nature of the data (yes/no decisions), a logit model was used to isolate the effect of each treatment and type of irrigation water, as well as to explore the effects of demographic characteristics on the likelihood of purchasing each type of produce. To analyze the data from the within-subject comparisons (15 observations per participant in the United States and 8 observations per participant in Israel, see table 2), we implemented a random effects specification and estimated the coefficients using clustered standard errors. Since we are particularly interested in differences in WTP between consumers in the United States, where large-scale adoption of nontraditional water is being considered, and Israel, where nontraditional water has been used on a national scale for decades, we begin by analyzing the three experiments together in a combined, unbalanced cross-sectional data set using the following three models (see table 4). Equation 2 examines the between-subject, within-subject, and regional variables, and equations 3 and 4 incorporate relevant demographic variables and interaction terms, respectively.

$$log\frac{P_{ij}}{1-P_{ij}} = \alpha + \beta_1 * Price_{ij} + \beta_2 * Treatment_i + \beta_3 * Produce_{ij} + \beta_4 * WaterType_{ij} + \beta_5 * Region_i + \mu_i + \varepsilon_{ij} \quad (2)$$

$$log\frac{P_{ij}}{1-P_{ij}} = \alpha + \beta_1 * Price_{ij} + \beta_2 * Treatment_i + \beta_3 * Produce_{ij} + \beta_4 * WaterType_{ij} + \beta_5 * Region_i + \beta_6 * X_{ij} + \mu_i + \varepsilon_{ij} \quad (3)$$

$$log\frac{P_{ij}}{1-P_{ij}} = \alpha + \beta_1 * Price_{ij} + \beta_2 * Treatment_i + \beta_3 * Produce_{ij} + \beta_4 * WaterType_{ij} + \beta_5 * Region_i + \beta_6 * X_{ij} + \beta_7 * (Region_i WaterType_{ij}) + \beta_8 * (Grows_i WaterType_{ij}) + \beta_9 * (Grows_i Region_i) + \beta_{10} * (HeardAbout_i WaterType_{ij}) + \beta_{11} * (HeardAbout_i Region_i) + \mu_i + \varepsilon_{ij} \quad (4)$$

where $\mu_i \sim N(0, \sigma^2_\mu)$ and $\varepsilon_{ij} \sim N(0, \sigma^2)$.

P_{ij} is the probability that participant *i* will choose yes for purchase option *j*.

$Price_{ij}$ is the posted price for participant *i*, purchase option *j*.

$Treatment_i$ is a matrix of dummy variables for the information treatments: benefits (B), risks (C), and benefits plus risks (D), with no information (A) as the omitted variable.

$Produce_{ij}$ is a matrix of dummy variables for clementines, almonds, and grapes, with baby carrots and dates as the omitted variables.

$WaterType_{ij}$ is a matrix of dummy variables for no-information and nontraditional water (a combination of all the nontraditional water types used in the experiments), with conventional water as the omitted variable.

$Region_i$ is a dummy variable for participant *i*'s country in which participants who live in the United States are assigned a value of 1 and Israeli participants are assigned a value of 0.

X_{ij} is a matrix of the demographic variables.[iii]

$Region_iWaterType_{ij}$ is a matrix of interaction effects for participants who live in the United States and type of irrigation water (no information, nontraditional).

$Grows_iWaterType_{ij}$ is a matrix of interaction effects between participants who grow their own food (working on a farm or tending a backyard garden) and type of irrigation water (no information, nontraditional)

$Grows_iRegion_i$ is a matrix of interaction effects between participants who grow their own food (working on a farm or tending a backyard garden) and those who live in the United States.

$HeardAbout_iWaterType_{ij}$ is a matrix of interaction effects between participants who had heard of any type of nontraditional water before participating in the experiment and type of irrigation water (no information, nontraditional).

$HeardAbout_iRegion_i$ is a matrix of interaction effects between participants who had heard of any type of nontraditional water before participating and those who live in the United States.

To examine the effects of the different types of nontraditional water used in the United States experiments we use three models. The resulting coefficients are presented in table 5. The first two models are identical in structure to equations 2 and 3, respectively. The third is similar to equation 4 but incorporates slightly different interaction terms and the variable $Mid\text{-}Atlantic_i$, a session specific fixed effect:

$$\log \frac{P_{ij}}{1-P_{ij}} = \alpha + \beta_1 * Price_{ij} + \beta_2 * Treatment_i + \beta_3 * Produce_{ij} + \beta_4 * WaterType_{ij} + \beta_5 * Mid\text{-}Atlantic_i + \beta_6 * X_{ij} + \beta_7 * (Grows_iWaterType_{ij}) + \beta_8 * (HeardAbout_iWaterType_{ij}) + \mu_i + \varepsilon_{ij} \quad (5)$$

where $\mu_i \sim N(0, \sigma_\mu^2)$ and $\varepsilon_{ij} \sim N(0, \sigma^2)$.

Similarly, the three models used to examine the effects of each nontraditional type of water in the Israel experiment are iterations of equations 2, 3, and 5, but omit the session specific fixed effect variable. The resulting coefficients are presented in table 6.

In each of the models for all three samples, we find, at a 1% significance level, that participants are more likely to purchase produce irrigated with conventional water than produce irrigated with nontraditional water. However, the degree of stigma associated with nontraditional water in the United States and Israel is different. In the United States analysis (table 5), the least stigma is attached to recycled gray water, followed by slightly greater stigma for recycled produced water, and recycled black water. The results from the analysis of Israeli consumers (table 6) show that desalinated water is associated with significantly less stigma than recycled effluent (less than half as much). Wald tests show a significant difference (at a 1% level) in acceptance for all of the types of water (see Table 7). In equation 5, the difference in acceptance between recycled gray and recycled produced water in the United States is only significant at the 10% level, and there is no longer a significant difference between the water types used in the Israel experiment.

In table 4, the interaction effect between nontraditional water and region indicate that the negative consumer response toward nontraditional irrigation water is greater in the United States than in Israel, likely because of Israelis' awareness of their country's severe water constraints and their familiarity with the use of nontraditional water for irrigation (Rejwan 2011). Before taking part in the research, most of the Israeli participants had heard of desalinated water and recycled effluent, whereas in the United States experiments, only about half of the participants had heard about the different types of nontraditional water before participating (see table 3). However, U.S. participants were more likely to purchase produce that had been irrigated with nontraditional water when they had already heard about it relative to those who had not (see table 4). Looking at the United States only sample in table 5, we see that previous knowledge about recycled gray and recycled produced water reduces the degree of stigma associated with those technologies for consumers in the United States. Our results thus indicate that increased familiarity with nontraditional water reduces the degree of stigma associated with it.

However, increased familiarity with different types of nontraditional water seems to exacerbate the stigma towards the most stigmatizing types of water in the United States and Israel. Previous knowledge about recycled gray and recycled produced water reduced participants acceptance of produce irrigated with recycled black water in the United States, while increased familiarity with desalinated water decreased Israeli participants acceptance of produce irrigated with recycled effluent. Similar results have been found in studies on conventional and organic milk; consumers' WTP for conventional milk, which contains the synthetically produced growth hormone rBST, declines upon introduction of rBST-free and organic milk because those alternatives are perceived as safer and healthier (Kanter, Messer, and Kaiser 2009).

We used the results from equation 3 to generate estimates of U.S. and Israeli consumers' WTP for produce irrigated with recycled water using Krinsky and Robb confidence intervals (Jeanty 2007). The WTP estimates are significant at the 1% level for all but produced water in the United States, which is not statistically significant (see table 8). We do not report the estimate for recycled black water because the estimate was zero and statistically insignificant. Figure 2 depicts the overall drop in WTP for produce irrigated with nontraditional water relative to produce irrigated with conventional water. For U.S. consumers who have little or no experience with recycled water, the drop in WTP was 87%. For consumers in Israel, where recycled water has been used nationwide for several decades and makes up approximately 60% of the water supply for irrigation (Lipchin and Pennycock 2015), there was still a significant and surprising drop in WTP of 20%. The large difference in magnitude in the changes in WTP in the United States and Israel reflects the interaction effect for nontraditional water and region in equation 4 (see table 4). Figure 3 examines the differences between U.S. and Israeli consumers in greater detail. In the United States, consumers' WTP for recycled gray water is nearly 74% less than their WTP for conventional water while in Israel consumers' WTP for recycled effluent is only 28% less than their WTP for conventional water.

A number of previous studies have shown that exposing consumers to information and messaging can influence their decisions on food (Hayes, Fox, and Shogren 2002; Marette et al. 2010; Dillaway et al. 2011; Messer et al. 2015; Wu et al. 2015; McFadden and Huffman 2017). Others, however, have shown that technical and scientific information have little or no effect on consumers' perceptions of water that would likely provoke the contagion heuristic (Morgan and Grant-Smith 2015; Hui and Cain 2017). Our results for the information treatments are in line with the second set of studies as none of those treatments in our experiments produced significant differences in WTP for the produce.

Results of Exploratory Analysis

In the United States only sample, participants who grew their own food were more accepting of recycled black and recycled gray water than participants who did not (see table 5). This positive effect of food cultivation could arise from dual sources of familiarity. First, the perception that something is potentially dangerous tends to diminish with the number of barriers between an individual and the source of contagion (Dolnicar and Schäfer 2009; Kecinski et al. 2016; Hui and Cain 2017; Kecinski and Messer 2017). People who are involved in growing their own food likely have a greater understanding of the barriers that exist between irrigation water and the produce that ends up on their table. Second, people who grow their own food are likely aware of the many other potential sources of contagion in the field. However, this finding is speculative since the experiments were not designed to test it and thus it should be explored further in future research.

Conclusions

Reliable supplies of water for agricultural production and drinking are threatened in not only the United States, but across the globe. According to the IPCC (2014), the strain on fresh water supplies worldwide will intensify as global warming induced climate change hastens shifts in the global water cycle, increasing the disparity between wet and dry regions. Considering the agricultural sectors large share of water consumption, new sources of water are needed to maintain production in the future. Nontraditional sources of irrigation water are promoted as a cost-effective and safe solution to water scarcity in the United States and have been practiced as a matter of national policy in Israel for 30 years, but no prior studies have compared public acceptance of these technologies in different countries nor have they examined different kinds of nontraditional water. Instead, research into the use of nontraditional irrigation water has treated it as a globally homogenous commodity. Using economic field experiments, we compare consumer perceptions and WTP for produce irrigated with nontraditional water in Israel and the United States. We evaluate three types of nontraditional water in the United States (recycled gray, recycled black, and recycled produced water) and two types in Israel (desalinated water and recycled effluent).

We find that, generally, despite the apparent safety of the food, consumers associate stigma with nontraditional irrigation water. U.S. consumers' mean WTP for produce irrigated with nontraditional water was 87% less than their mean WTP for produce irrigated with conventional water. Consumers in Israel are more accepting of nontraditional irrigation water, but their mean WTP for produce irrigated with it is 20% less than their mean WTP for produce irrigated with conventional water. Our analysis of interactions between WTP and characteristics such as the participants' familiarity with recycled water technologies indicates that Israel's severe water constraints and Israelis' overall familiarity with the use of nontraditional water drives this striking difference. These results indicate that raising awareness among U.S. consumers of the threats posed by water scarcity and the decades long success of nontraditional water in Israel could increase acceptance of it in agricultural products in the United States. This point is bolstered by our finding that prior knowledge about recycled gray and recycled produced water among U.S. participants is associated with greater acceptance of produce irrigated with it.

Our analysis indicates that some types of nontraditional water are more likely to be accepted (recycled gray water in the United States and desalinated water in Israel) than others that provoke the most stigma: recycled black water in the United States and recycled effluent in Israel. These types of nontraditional water are most strongly linked in consumers' minds to the concept of toilet to tap, the reason most often cited by consumers for rejecting nontraditional water as a potable water source (Menegaki et al. 2009; Morgan and Grant-Smith 2015; Rozin et al. 2015; Hui and Cain 2017). Programs designed to increase reliance on nontraditional water can prioritize the least-stigmatized sources.

We also find, however, that differentiating between types of recycled water can increase acceptance of some types of water and simultaneously increase the stigma associated with others.

These results show that prior knowledge among U.S. consumers about recycled gray and recycled produced water was associated with greater stigmatization of recycled black water. Similarly, in Israel, prior knowledge about desalinated water decreased consumers' acceptance of produce irrigated with recycled effluent. The mechanism behind this effect appears to be related to consumers' knowledge that there are alternatives to using the most stigmatized type of water.

Our finding that consumers associated stigma with nontraditional sources of irrigation water is in line with results by Savchenko et al. (2018). However, unlike Savchenko et al., scientific information about the benefits and risks of recycled irrigation water had no significant effect on consumers perceptions. Thus, in addition to raising public awareness about the threats posed by water scarcity and the success of Israel's use of nontraditional water, programs might benefit from emphasizing the number of barriers between recycled water and the food on consumers' tables since prior experience growing food in our experiments was associated with greater acceptance of nontraditional irrigation water, likely because of their increased familiarity with food cultivation processes. This is an important area for future study.

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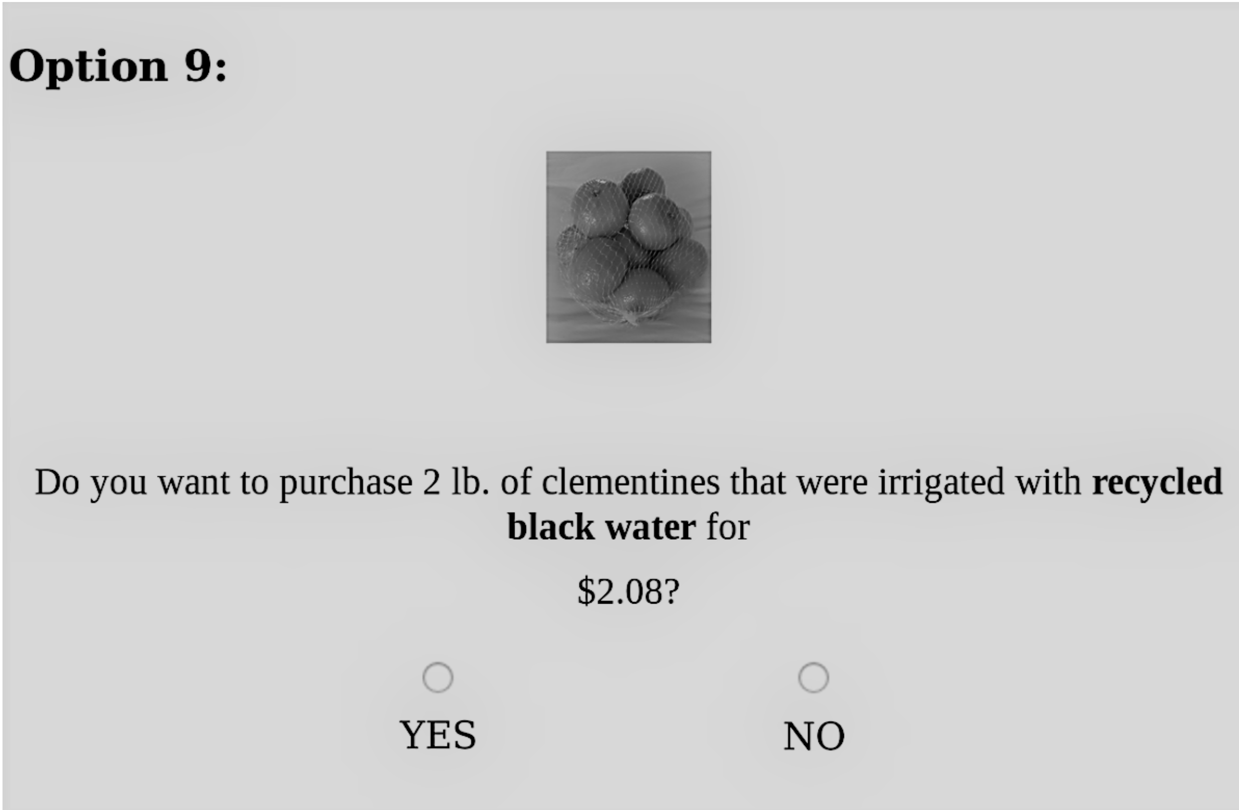

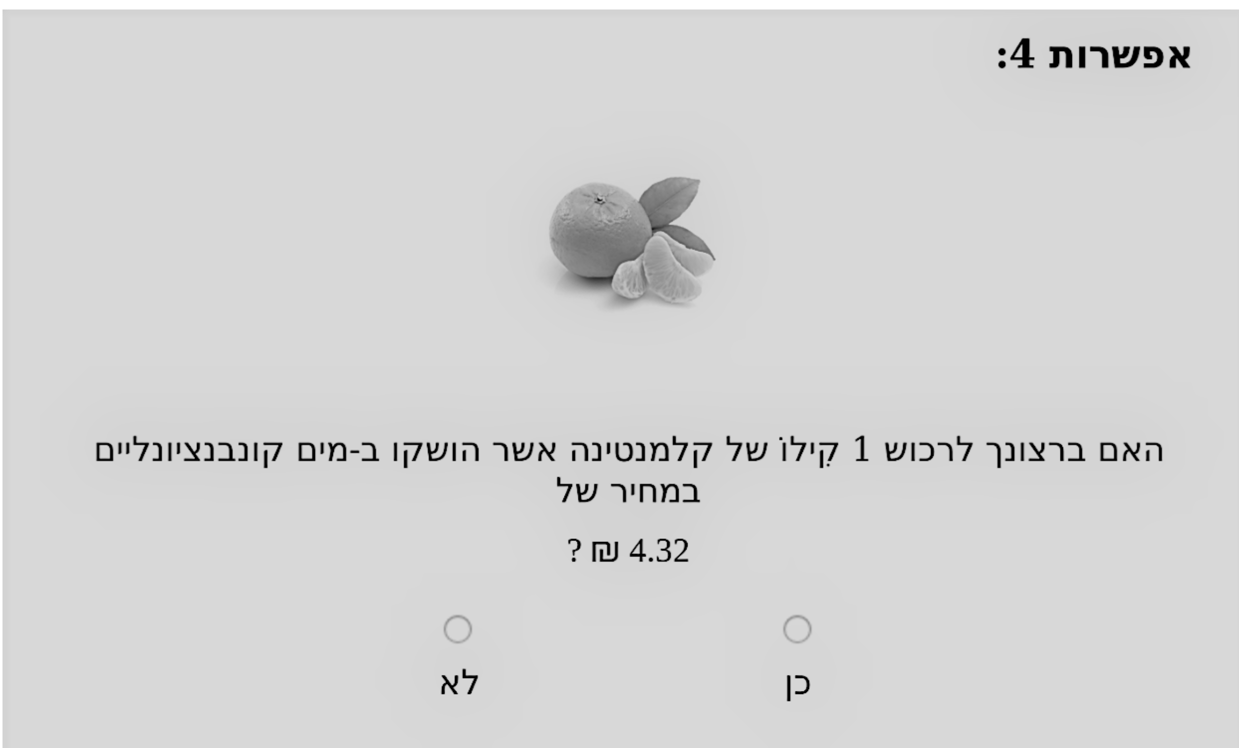

Figure 1. Screenshots of food purchase options in the United States and Israel.

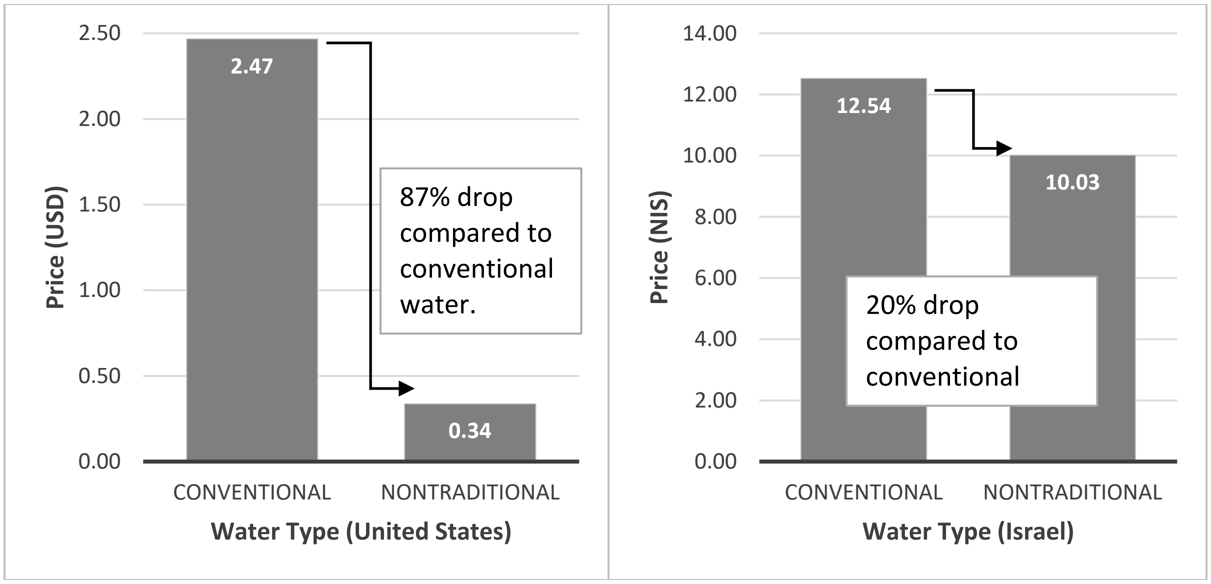

Figure 2. United States and Israel mean willingness-to-pay

Note: In the United States, the nontraditional water estimate consisted of recycled gray, and recycled produced water. In Israel, the nontraditional water estimate consisted of desalinated water and recycled effluent, which is the combination of recycled gray and recycled black water.

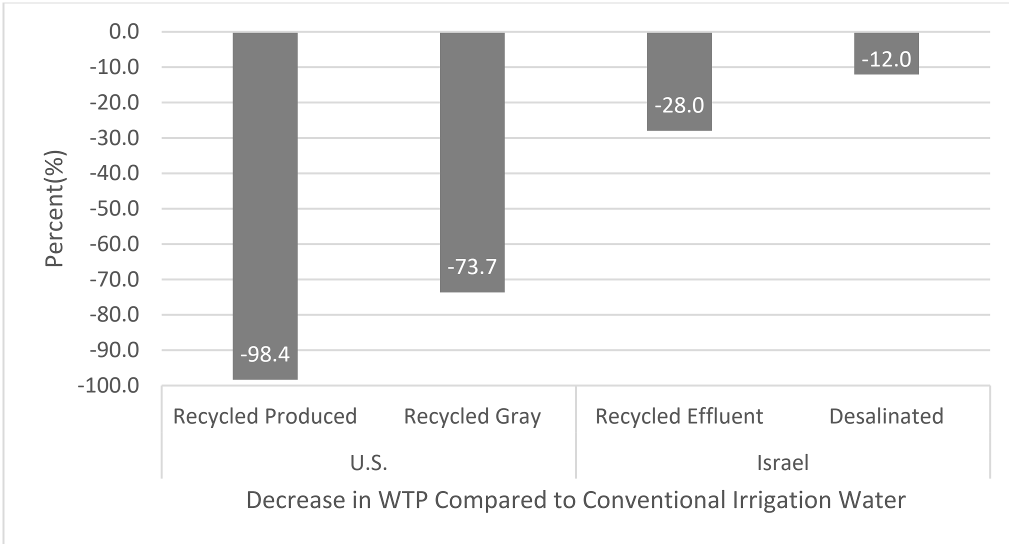

Figure 3. Bias against nontraditional irrigation water

Table 1. Research Questions and Results

Question	Hypothesis Statement	Results
1. Does consumers WTP for produce irrigated with nontraditional water vary by nontraditional water type (recycled gray, recycled black, and recycled produced in the United States; desalinated and recycled effluent in Israel)?	For each type of nontraditional water *a* and all other types of nontraditional water *b* $H_0: WTP_a^{Nontraditional} = WTP_b^{Nontraditional}$ $H_A: WTP_a^{Nontraditional} \neq WTP_b^{Nontraditional}$	Reject H_0 (displayed in tables 4, 5, and 6, all significant at 1 percent level, except equation 5 in table 6). WTP for nontraditional water varies by type.
2. What are the differences between consumer demand for produce irrigated with nontraditional water in the United States versus Israel?	$H_0: WTP_{U.S.}^{Nontraditional} = WTP_{Israel}^{Nontraditional}$ $H_A: WTP_{U.S.}^{Nontraditional} \neq WTP_{Israel}^{Nontraditional}$	Reject H_0 (table 4). WTP for nontraditional water dropped by 87% for U.S. participants compared to conventional water, whereas it only dropped 20% for Israeli's.
3. Does exposure to different types of scientific information about recycled water (benefits, risks, and both benefits and risks) *change* consumers WTP for produce irrigated with various types of water?	For water type *c*, information type *d* and control group *e* which received no information about recycled water $H_0: WTP_{cd} = WTP_{ce}$ $H_A: WTP_{cd} \neq WTP_{ce}$	Fail to Reject H_0 (tables 4, 5, and 6). All the information treatments were insignificant.

Table 2. Experiment Design

			Number of Participants	Total
Between-Subject Treatments	Control		163	
	Benefits		172	
	Risks		159	
	Both		166	660
Within-Subject Treatments (U.S.)	Grapes (U.S.)	No Specification	259	
		Conventional		
		Recycled Gray		
		Recycled Black		
		Recycled Produced		
	Almonds	No Specification	458	
		Conventional		
		Recycled Gray		
		Recycled Black		
		Recycled Produced		
	Baby Carrots	No Specification	458	
		Conventional		
		Recycled Gray		
		Recycled Black		
		Recycled Produced		
	Clementines (Southwest)	No Specification	199	
		Conventional		
		Recycled Gray		
		Recycled Black		
		Recycled Produced		458
Within-Subject Treatments (Israel)	Clementines	No Specification	202	
		Conventional		
		Desalinated		
		Recycled Effluent		
	Dates	No Specification	202	
		Conventional		
		Desalinated		
		Recycled Effluent		202

Table 3. Summary Statistics

		United States	Israel
	Total Participants	458	202
Treatment	*(A) No Information*	115	48
	(B) Benefits	120	52
	(C) Risks	109	50
	(D) Both Benefits & Risks	114	52
Demographics	*Female*	55%	47%
	Primary Shopper	70%	77%
	Grows Food	35%	8%
Education	*High School or Less*	14%	58%
	Some College	21%	11%
	Associate Degree	10%	5%
	Bachelor's Degree	30%	14%
	Graduate Degree	25%	11%
Heard About	*Recycled Gray*	57%	
	Recycled Black	43%	
	Recycled Produced	47%	
	Desalinated		85%
	Recycled Effluent		75%
Political Affiliation	*Liberal*	30%	32%
	Conservative	27%	11%
	Moderate or Other	43%	57%
Income	*Minimum*	< $10,000	< NIS40,000
	Maximum	≥ $250,000	≥ NIS960,000
	Median	$50,000-$74,000	NIS40,000-NIS79,999
	Mean	$50,000-$74,000	NIS80,000-NIS119,999
Age	*Minimum*	18	18
	Maximum	85	76
	Median	54	47
	Mean	50	44

Table 4. Models of Consumer Behavior (Data from the United States and Israel)

		Equation 2		Equation 3		Equation 4	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Price	-0.105***	0.009	-0.104***	0.009	-0.101***	0.009
Treatment	*(B) Benefits*	0.099	0.166	0.107	0.159	0.124	0.160
	(C) Risks	-0.054	0.164	-0.055	0.162	-0.028	0.164
	(D) Both Benefits & Risks	-0.019	0.169	0.004	0.162	0.001	0.162
Produce	*Clementines*	-0.519***	0.080	-0.497***	0.079	-0.511***	0.080
	Almonds	-0.251***	0.062	-0.255***	0.062	-0.266***	0.063
	Grapes	-0.039	0.077	-0.063	0.077	-0.064	0.079
Water Type	*No Information*	-0.055	0.086	-0.055	0.086	-0.339	0.222
	Nontraditional	-1.562***	0.100	-1.562***	0.100	-1.641***	0.264
Region	*U.S.*	-1.484***	0.153	-1.820***	0.194	-2.091***	0.321
Demographics	*Female*			0.085	0.116	0.078	0.117
	Age			-0.005	0.003	-0.005	0.003
	Primary Shopper			0.143	0.136	0.148	0.137
	Salary			0.041	0.025	0.042*	0.025
	Grows Food			0.353***	0.125	0.119	0.380
Education	*Some College*			0.227	0.196	0.263	0.198
	Associate Degree			0.314	0.232	0.302	0.233
	Bachelor's Degree			0.459***	0.172	0.497***	0.177
	Graduate Degree			0.721***	0.179	0.758***	0.181
Heard About	*Nontraditional*			0.313***	0.121	-0.478*	0.266
Interactions	*US*NoInfo*					0.222	0.211
	*US*Nontraditional*					-0.530**	0.243
	*Grows*NoInfo*					0.237	0.198
	*Grows*Nontrad*					0.473**	0.216
	*Grows*US*					-0.087	0.387
	*HeardNontrad*NoInfo*					0.069	0.179
	*HeardNontrad*Nontrad*					0.551***	0.208
	*HeardNontrad*US*					0.668**	0.268
Total N		8,486		8,486		8,486	
Total Participants		660		660		660	

***Significant at the 1% level **Significant at the 5% level *Significant at the 10% level

Table 5. Models of Consumer Behavior (Data from Only the United States)

		Equation 2		Equation 3		Equation 5	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Price	-0.733***	0.041	-0.734***	0.041	-0.747***	0.041
Treatment	*(B) Benefits*	0.223	0.234	0.271	0.216	0.275	0.222
	(C) Risks	0.016	0.224	0.025	0.220	0.031	0.227
	(D) Both Benefits & Risks	-0.146	0.238	-0.063	0.222	-0.065	0.228
Produce	*Almonds*	0.769***	0.093	0.769***	0.093	0.785***	0.095
	Grapes	0.565***	0.100	0.566***	0.100	0.576***	0.103
	Clementines	0.825***	0.107	0.825***	0.107	0.846***	0.108
Water Type	*No Information*	-0.037	0.106	-0.038	0.106	-0.114	0.188
	Recycled Gray	-1.334***	0.138	-1.336***	0.138	-2.531***	0.272
	Recycled Black	-2.853***	0.176	-2.852***	0.176	-3.636***	0.348
	Recycled Produced	-1.779***	0.149	-1.782***	0.149	-2.138***	0.292
Session Fixed Effect	*MidAtlantic*	0.090	0.165	-0.259	0.186	-0.287	0.191
Demographics	*Female*	1.259	0.211	0.128	0.157	0.132	0.162
	Age			-0.006	0.005	-0.007	0.005
	Primary Shopper			0.062	0.180	0.065	0.186
	Salary			0.118***	0.034	0.124***	0.035
	Grows Food			0.432***	0.154	0.146	0.227
Education	*Some College*			0.473	0.289	0.496*	0.298
	Associate Degree			0.484	0.335	0.514	0.343
	Bachelor's Degree			0.723***	0.275	0.749***	0.285
	Graduate Degree			1.292***	0.271	1.350***	0.279
Heard About	*Recycled Gray*			0.507***	0.198	0.065	0.284
	Recycled Black			-0.126	0.184	0.122	0.271
	Recycled Produced			-0.139	0.162	-0.376	0.243
Interactions	*Grows*NoInfo*					0.203	0.227
	*Grows*Gray*					0.552*	0.288
	*Grows*Black*					0.855**	0.363
	*Grows*Produced*					0.169	0.310
	*HeardGray*NoInfo*					-0.024	0.292
	*HeardGray*Gray*					1.701***	0.394
	*HeardGray*Black*					0.465	0.532
	*HeardGray*Produced*					0.413	0.399
	*HeardBlack*NoInfo*					0.136	0.286
	*HeardBlack*Gray*					-0.608*	0.365
	*HeardBlack*Black*					0.189	0.496
	*HeardBlack*Produced*					-0.956**	0.393
	*HeardProduced*NoInfo*					-0.088	0.241
	*HeardProduced*Gray*					0.365	0.311
	*HeardProduced*Black*					0.033	0.406
	*HeardProduced*Produced*					0.945*	0.337
Total N		6,870		6,870		6,870	
Groups		458		458		458	

***Significant at the 1% level **Significant at the 5% level *Significant at the 10% level

Table 6. Models of Consumer Behavior (Data from Only Israel)

		Equation 2		Equation 3		Equation 5	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Price	-0.473***	0.079	-0.477***	0.079	-0.513***	0.082
Treatment	*(B) Benefits*	-0.162	0.288	-0.217	0.286	-0.227	0.292
	(C) Risks	-0.239	0.310	-0.248	0.310	-0.254	0.318
	(D) Both Benefits & Risks	0.137	0.291	0.066	0.298	0.066	0.304
Produce	*Clementines*	-7.138***	1.264	-7.206***	1.262	-7.770***	1.308
Water Type	*No Information*	-0.257	0.165	-0.256	0.165	-0.676	0.562
	Desalinated	-0.722***	0.207	-0.723***	0.207	-1.211**	0.510
	Recycled Effluent	-1.678***	0.257	-1.677***	0.256	-1.025*	0.568
Demographics	*Female*			0.179	0.215	0.185	0.220
	Age			-0.006	0.006	-0.006	0.006
	Primary Shopper			0.328	0.273	0.330	0.278
	Salary			-0.054	0.045	-0.054	0.046
	Grows Food			0.646*	0.363	0.250	0.540
Education	*Some College*			0.236	0.363	0.232	0.370
	Associate Degree			0.466	0.433	0.468	0.444
	Bachelor's Degree			0.562*	0.296	0.575*	0.303
	Graduate Degree			-0.209	0.381	-0.215	0.389
Heard About	*Desalinated*			-0.009	0.341	0.034	0.517
	Recycled Effluent			0.015	0.305	-0.087	0.467
Interactions	*Grows*NoInfo*					0.683	0.665
	*Grows*Desalinated*					0.249	0.651
	*Grows*Recycled*					0.744	0.864
	*HeardDesal*NoInfo*					0.125	0.561
	*HeardDesal*Desal*					0.859	0.652
	*HeardDesal*Recycled Effluent*					-1.323*	0.700
	*HeardRecycled*NoInfo*					0.347	0.346
	*HeardRecycled*Desal*					-0.366	0.570
	*HeardRecycled*Recycled*					0.478	0.670
Total N		1,616		1,616		1,616	
Groups		202		202		202	

***Significant at the 1% level **Significant at the 5% level *Significant at the 10% level

Table 7. Wald Tests for United States and Israel Sample, United States Only Sample, and Israel Only Sample

Model	Wald Test	$\chi 2$	Sig. Lev.
Table 4 Equation 2	*No Information = Nontraditional*	286.39	0.000
Table 4 Equation 3	*No Information = Nontraditional*	286.34	0.000
Table 4 Equation 4	*No Information = Nontraditional*	34.92	0.000
Table 6 Equation 2	*Recycled Gray = No Information*	107.24	0.000
Table 6 Equation 2	*Recycled Gray = Recycled Black*	97.61	0.000
Table 6 Equation 2	*Recycled Gray = Recycled Produced*	11.14	0.001
Table 6 Equation 2	*Recycled Black = No Information*	286.68	0.000
Table 6 Equation 2	*Recycled Black = Recycled Produced*	39.54	0.000
Table 6 Equation 2	*Recycled Produced = No Information*	160.35	0.000
Table 6 Equation 3	*Recycled Gray = No Information*	107.48	0.000
Table 6 Equation 3	*Recycled Gray = Recycled Black*	97.82	0.000
Table 6 Equation 3	*Recycled Gray = Recycled Produced*	11.19	0.001
Table 6 Equation 3	*Recycled Black = No Information*	287.89	0.000
Table 6 Equation 3	*Recycled Black = Recycled Produced*	39.46	0.000
Table 6 Equation 3	*Recycled Produced = No Information*	161.04	0.000
Table 6 Equation 5	*Recycled Gray = No Information*	95.55	0.000
Table 6 Equation 5	*Recycled Gray = Recycled Black*	14.16	0.000
Table 6 Equation 5	*Recycled Gray = Recycled Produced*	2.84	0.092
Table 6 Equation 5	*Recycled Black = No Information*	118.26	0.000
Table 6 Equation 5	*Recycled Black = Recycled Produced*	22.11	0.000
Table 6 Equation 5	*Recycled Produced = No Information*	58.39	0.000
Table 7 Equation 2	*Desalinated = No Information*	7.37	0.007
Table 7 Equation 2	*Desalinated = Recycled Effluent*	19.93	0.000
Table 7 Equation 2	*Recycled Effluent = No Information*	42.05	0.000
Table 7 Equation 3	*Desalinated = No Information*	7.41	0.007
Table 7 Equation 3	*Desalinated = Recycled Effluent*	19.89	0.000
Table 7 Equation 3	*Recycled Effluent = No Information*	42.13	0.000
Table 7 Equation 5	*Desalinated = No Information*	1.27	0.259
Table 7 Equation 5	*Desalinated = Recycled Effluent*	0.17	0.679
Table 7 Equation 5	*Recycled Effluent = No Information*	0.50	0.481

Table 8. Willingness-to-Pay Estimates

	Water Type	WTP	Sig. Lev.
United States	*Conventional*	$2.47	0.000
	No Information	$2.42	0.000
	Recycled Gray	$0.65	0.000
	Recycled Produced	$0.04	0.426
	Nontraditional (Recycled Gray and Recycled Produced)	$0.34	0.027
Israel	*Conventional*	NIS12.54	0.000
	No Information	NIS12.01	0.000
	Desalinated	NIS11.03	0.000
	Recycled Effluent	NIS9.03	0.000
	Nontraditional (Desalinated and Recycled Effluent)	NIS10.03	0.000

Appendix A: Instructions for Experiments[iv]

Instructions:

Please read these instructions carefully and do not communicate with anyone while you are making your decisions.

- **You will earn $10 by participating in this experiment that you may keep and/or use to purchase produce. You may think of this money as a bank account from which you can withdraw money.**
- Depending on the decisions you make, you may receive a combination of cash and/or produce. Your decisions are just like the ones you make in a store: you either buy the produce at the listed price or you do not. Please remember that all decisions are real purchasing decisions.

Steps:

1. You will face a series of “options” where you have the opportunity to buy produce. For each option, decide if you want to buy the produce at the listed price by selecting ‘Yes’ or ‘No’.
2. Complete a short survey.
3. Roll a digital dice to determine which option will be selected. Only one option will be selected. This means that each decision you make is equally likely to be your final decision.
4. Receive cash and/or produce.

Consider the following examples:

- **Example 1:** If your decision is ‘Yes’ for an option that costs $3, and this option is randomly selected by the digital dice, you will receive the produce and $7 cash ($10 - $3 = $7).
- **Example 2:** If your decision is ‘No’ for an option, and this option is randomly selected by the digital dice, you will receive $10 and will not receive any produce.

Appendix B: Surveys

Survey B-1: Survey in Southwest, United States experiment[v]

Please answer the following questions:

1. What is your age?

2. What is your gender?
   - Male
   - Female
   - Prefer not to answer

3. Do you live in the United States?
   - Yes
   - No

4. What is your ZIP Code?

5. What is your profession?
   - Government
   - Education
   - Business
   - Agriculture
   - Student
   - Other (please specify)

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

7. How would you identify your ethnicity?

- Non-Hispanic White
- Hispanic or Latino
- Middle Eastern or Arab
- Black
- East Asian
- South Asian
- Pacific Islander
- Native American
- Other (please specify)

8. 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

9. What is the highest level of education that you have completed?

- Some high school
- High school graduate
- Some college
- Associate degree
- Bachelor's degree
- Graduate degree/Professional

10. How often do you consume the following produce:
    Clementines:
    times per month
    Almonds:
    times per month
    Baby carrots:
    times per month

11. Are you the primary shopper in your household?

- Yes
- No

12. What is the percentage of fresh foods compared to canned or frozen foods in your overall **fruit** consumption?

- Less than 20% fresh
- 20-50% fresh
- 50-80% fresh
- More than 80% fresh

13. What is the percentage of fresh foods compared to canned or frozen foods in your overall **vegetable** consumption?

- Less than 20% fresh
- 20-50% fresh
- 50-80% fresh
- More than 80% fresh

14. Do you grow your own food?

- Yes
- No

15. How important are the following food attributes to you?

Price: **3**

Not Important (1) Very Important (5)

I want the time it takes me to prepare my food to be as minimal as possible: **3**

Not Important (1) Very Important (5)

Organic: **3**

Not Important (1) Very Important (5)

I prefer to purchase foods that are GMO (Genetically Modified Organisms) free: **3**

Not Important (1) Very Important (5)

The type of water my produce is irrigated with: **3**

Not Important (1) Very Important (5)

Locally grown/produced: **3**

Not Important (1) Very Important (5)

16. What type of water do you typically drink?

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

17. Do you know where the water in your home comes from (private well, public well, municipal water supply)?

- Yes
- No

18. How concerned are you about water availability in the future in these areas?

Your Community: **3**

Not At All (1) Very Concerned (5)

Your State: **3**

Not At All (1) Very Concerned (5)

United States: **3**

Not At All (1) Very Concerned (5)

Globally: **3**

Not At All (1) Very Concerned (5)

19. How concerned are you about water availability **in your community** over these following time periods?

Present: **3**

Not At All (1) Very Concerned (5)

Next 10 years: **3**

Not At All (1) Very Concerned (5)

Next 50 years: **3**

Not At All (1) Very Concerned (5)

Beyond the next 50 years: **3**

Not At All (1) Very Concerned (5)

20. How concerned are you about climate change in these areas?

Your Community: **3**

Not At All (1) Very Concerned (5)

Your State: **3**

Not At All (1) Very Concerned (5)

United States: **3**

Not At All (1) Very Concerned (5)

Globally: **3**

Not At All (1) Very Concerned (5)

21. How concerned are you about climate change **in your community** over these following time periods?

Present: **3**

Not At All (1) Very Concerned (5)

Next 10 years: **3**

Not At All (1) Very Concerned (5)

Next 50 years: **3**

Not At All (1) Very Concerned (5)

Beyond the next 50 years: **3**

Not At All (1) Very Concerned (5)

22. Before this survey had you ever heard of:

Recycled produced water

- Yes
- No

Recycled black water

- Yes
- No

Recycled gray water

- Yes
- No

23. What percentage of the produce that **you typically buy** do you think is irrigated with:

Recycled gray water:
%

Recycled black water:
%

Recycled produced water:
%

24. Do you reuse or recycle water at home?

Yes

No

Don't Know

25. Compared to conventional water, the standards for these types of water should be (where **3** means the same standards as conventional water):

Recycled produced water

3

Greatly lower(1) Greatly higher(5)

Recycled black water

3

Greatly lower(1) Greatly higher(5)

Recycled gray water

3

Greatly lower(1) Greatly higher(5)

26. I trust these groups to test and monitor recycled irrigation water:

The federal government:**3**

Strongly Disagree (1) Strongly Agree (5)

My state government:**3**

Strongly Disagree (1) Strongly Agree (5)

My local government:**3**

Strongly Disagree (1) Strongly Agree (5)

Individual farmers:**3**

Strongly Disagree (1) Strongly Agree (5)

Non-profit environmental groups:**3**

Strongly Disagree (1) Strongly Agree (5)

Public wastewater treatment plants:**3**

Strongly Disagree (1) Strongly Agree (5)

For-profit wastewater treatment plants:**3**

Strongly Disagree (1) Strongly Agree (5)

Survey B-2: English version of survey in Israel experiment

Please answer the following questions:

1. What is your age?
2. What is your gender?
    a. Male
    b. Female
    c. Prefer not to answer
3. Do you live in Israel?
    a. Yes
    b. No
4. What is your postal code?
5. What is your profession?
    a. Government
    b. Military
    c. Education
    d. Business
    e. Agriculture
    f. Student
    g. Other (please specify)
6. Are you:
    a. Politically liberal
    b. Politically moderate
    c. Politically conservative
    d. Other (please specify
7. How would you identify your ethnicity?
    a. Jewish
    b. Arab
    c. Other
8. Which category best describes your household income (before taxes) in 2015?
    a. Less than NIS40,000
    b. NIS40,000-NIS79,999 (39,999)
    c. NIS80,000-NIS119,999 (39,999)
    d. NIS120,000-NIS179,999 (59,999)
    e. NIS180,000-NIS239,999 (59,999)
    f. NIS240,000-NIS299,999 (59,999)
    g. NIS300,000-NIS359,999 (59,999)
    h. NIS360,000-NIS559,999 (199,999)
    i. NIS560,000-NIS759,999 (199,999)
    j. NIS760,000-NIS959,999 (199,999)
    k. NIS960,000 and above

9. What is the highest level of education that you have completed?
    a. Primary school
    b. Some secondary school
    c. Secondary school graduate
    d. Some college credit
    e. Associate degree
    f. Bachelor's degree
    g. Graduate degree/Professional
10. Do you have a child/children under 18 years old in your household?
    a. Yes
    b. No
11. How often do you consume the following produce:
    a. Clementines: _____ times per month
    b. Dates: _____ times per month
12. Are you the primary shopper in your household?
    a. Yes
    b. No
13. What is the percentage of fresh foods compared to canned or frozen foods in your overall **fruit** consumption?
    a. Less than 20% fresh
    b. 20-50% fresh
    c. 50-80% fresh
    d. More than 80% fresh
14. What is the percentage of fresh foods compared to canned or frozen foods in your overall **vegetable** consumption?
    a. Less than 20% fresh
    b. 20-50% fresh
    c. 50-80% fresh
    d. More than 80% fresh
15. Do you grow your own food?
    a. Yes
    b. No
16. How important are the following food attributes to you?
    a. Price: Not Important (1) Very Important (5)
    b. I want the time it takes to prepare my food to be as minimal as possible: Not Important (1) Very Important (5)
    c. Organic: Not Important (1) Very Important (5)
    d. I prefer to purchase foods that are GMO (Genetically Modified Organisms) free: Not Important (1) Very Important (5)
    e. The type of water my produce is irrigated with: Not Important (1) Very Important (5)
    f. Locally grown/produced: Not Important (1) Very Important (5)
17. What type of water do you typically drink?
    a. Bottled Water
    b. Tap Water
    c. Filtered Water
    d. Other (Please specify)

18. How concerned are you about water availability in the future in these areas?
    a. Your community: Not Concerned at all (1) Very Concerned (5)
    b. Israel: Not Concerned at all (1) Very Concerned (5)
    c. Globally: Not Concerned at all (1) Very Concerned (5)
19. How concerned are you about water availability **in your community** over these time periods?
    a. Present: Not Concerned at all (1) Very Concerned (5)
    b. Next 10 years: Not Concerned at all (1) Very Concerned (5)
    c. Next 50 years: Not Concerned at all (1) Very Concerned (5)
    d. Beyond the next 50 years: Not Concerned at all (1) Very Concerned (5)
20. How concerned are you about climate change in these areas?
    a. Your community: Not Concerned at all (1) Very Concerned (5)
    b. Israel: Not Concerned at all (1) Very Concerned (5)
    c. Globally: Not Concerned at all (1) Very Concerned (5)
21. How concerned are you about climate change **in your community** over these time periods?
    a. Present: Not Concerned at all (1) Very Concerned (5)
    b. Next 10 years: Not Concerned at all (1) Very Concerned (5)
    c. Next 50 years: Not Concerned at all (1) Very Concerned (5)
    d. Beyond the next 50 years: Not Concerned at all (1) Very Concerned (5)
22. Before this survey had you ever heard of:
    a. Desalinized water:
        i. Yes
        ii. No
    b. Recycled wastewater:
        i. Yes
        ii. No
23. Compared to conventional water, the standards for these types of water should be (where 3 means the same standards as conventional water):
    a. Desalinized water: Greatly lower (1) Greatly higher (5)
    b. Recycled wastewater: Greatly lower (1) Greatly higher (5)
24. I trust these groups to test and monitor recycled irrigation water:
    a. The Israeli government: Strongly Disagree (1) Strongly Agree (5)
    b. My local government: Strongly Disagree (1) Strongly Agree (5)
    c. Non-profit environmental groups: Strongly Disagree (1) Strongly Agree (5)
    d. Public wastewater treatment plants: Strongly Disagree (1) Strongly Agree (5)
    e. For-profit wastewater treatment plants: Strongly Disagree (1) Strongly Agree (5)

Appendix C: Robustness Test of Age Variable

Table C-1. Using Unedited Age Variable with No Limit on Maximum Age

		Combined U.S. and Israel		U.S.		Israel	
		Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Price	-0.102***	0.009	-0.728***	0.041	-0.479***	0.079
Treatment	*(B) Benefits*	0.083	0.161	0.239	0.217	-0.166	0.288
	(C) Risks	-0.083	0.163	-0.008	0.219	-0.196	0.311
	(D) Both Benefits & Risks	-0.014	0.163	-0.081	0.220	0.089	0.300
Produce	*Clementines*	-0.473***	0.081	0.850***	0.108	-7.237***	1.258
	Almonds	-0.244***	0.062	0.774***	0.093		
	Grapes	-0.050	0.077	0.568***	0.100		
Water Type	*No Information*	-0.055	0.086	-0.040	0.106	-0.257	0.165
	Nontraditional	-1.563***	0.100				
	Recycled Gray			-1.338***	0.137		
	Recycled Black			-2.845***	0.174		
	Recycled Produced			-1.782***	0.148		
	Desalinated					-0.723***	0.207
	Recycled Effluent					-1.677***	0.256
Region	*U.S.*	-1.825***	0.197				
	MidAtlantic			-0.210	0.180		
Demographics	*Female*	0.071	0.116	0.133	0.158	0.192	0.216
	Age	0.000	0.001	0.000***	0.000	-0.001	0.001
	Primary Shopper	0.116	0.135	0.035	0.182	0.283	0.263
	Salary	0.036	0.025	0.107***	0.033	-0.048	0.045
	Grows Food	0.349***	0.125	0.425***	0.153	0.662*	0.374
Education	*Some College*	0.199	0.194	0.501*	0.291	0.259	0.355
	Associate Degree	0.284	0.231	0.482	0.334	0.417	0.440
	Bachelor's Degree	0.473***	0.173	0.787***	0.278	0.556*	0.287
	Graduate Degree	0.734***	0.181	1.351***	0.273	-0.350	0.359
Heard About	*Nontraditional*	0.273**	0.118				
	Recycled Gray			0.467**	0.197		
	Recycled Black			-0.097	0.184		
	Recycled Produced			-0.150	0.160		
	Desalinated					-0.035	0.336
	Recycled Effluent					0.021	0.304
Total N		8,531		6,915		1,616	
Groups		663		461		202	

***Significant at the 1% level **Significant at the 5% level *Significant at the 10% level

Table C-2. Using Edited Age Variable with No Limit on Maximum Age

		Combined U.S. and Israel		U.S.	
		Coeff.	S.E.	Coeff.	S.E.
	Price	-0.102***	0.009	-0.728***	0.041
Treatment	*(B) Benefits*	0.084	0.160	0.239	0.217
	(C) Risks	-0.072	0.162	-0.008	0.219
	(D) Both Benefits & Risks	-0.014	0.162	-0.081	0.220
Produce	*Clementines*	-0.474***	0.081	0.850***	0.108
	Almonds	-0.244***	0.062	0.774***	0.093
	Grapes	-0.053	0.077	0.568***	0.100
Water Type	*No Information*	-0.058	0.086	-0.040	0.106
	Nontraditional	-1.563***	0.100		
	Recycled Gray			-1.338***	0.137
	Recycled Black			-2.845***	0.174
	Recycled Produced			-1.782***	0.148
Region	*U.S.*	-1.816***	0.195		
	MidAtlantic			-0.210	0.180
Demographics	*Female*	0.078	0.116	0.133	0.158
	Age	0.000***	0.000	0.000***	0.000
	Primary Shopper	0.121	0.136	0.035	0.182
	Salary	0.037	0.025	0.107***	0.033
	Grows Food	0.343***	0.124	0.425***	0.153
Education	*Some College*	0.205	0.196	0.501*	0.291
	Associate Degree	0.277	0.231	0.482	0.334
	Bachelor's Degree	0.467***	0.173	0.787***	0.278
	Graduate Degree	0.729***	0.180	1.351***	0.273
Heard About	*Nontraditional*	0.279**	0.117		
	Recycled Gray			0.467**	0.197
	Recycled Black			-0.097	0.184
	Recycled Produced			-0.150	0.160
Total N		8,531		6,915	
Groups		663		461	

***Significant at the 1% level **Significant at the 5% level *Significant at the 10% level

[i] This study is part of the larger efforts of the CONSERVE project (a Center of Excellence designated by the USDA at the nexus of sustainable water reuse, food, and health, headquartered at the University of Maryland) to fund research investigating consumer perceptions of the use of nontraditional water in agricultural production. The novelty of this work is our examination of consumer perceptions in two countries (United States and Israel) that are heterogeneous in terms of the impacts of drought and how consumers respond to different types of nontraditional water.

[ii] The mean price in the United States experiments was a 2015 food inflation adjustment of the 2013 national mean price for each type of produce. In the experiment conducted in Israel, the mean price was calculated from prices at several Eilat grocery stores.

[iii] The programming software used for the survey required having a default age of 0 instead of a blank space (see Appendix B). Most participants deleted the 0 and correctly entered their age but some did not, instead they added numbers to the 0 already there (e.g., when entering age 63, a participant wound up reporting an age of 630). Since their intentions were clear, we edited the age field to remove the excess 0 for two United States participants and twenty Israel participants. We also excluded four participants in the United States sample who entered characters that could not be deciphered as an age. A robustness check of these measures determined that the edits and exclusions did not alter the results of the variables of interest (the results for equation 3 are reported in Appendix C).

[iv] The instructions for the United States and Israel experiments were identical, other than the Israeli experiment being translated into Hebrew and the participant payment being NIS40 instead of $10.

[v] The Mid-Atlantic Survey was identical except for the following: Question 10 asked about grapes instead of clementines; it did not include Question 23.

The Department of Applied Economics and Statistics
College of Agriculture and Natural Resources
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