TWO ESSAYS ON TURFGRASS SOD PRODUCER PREFERENCES FOR CERTIFICATION AND ROYALTY FEE STRUCTURES AND OKLAHOMA CITY COMMERCIAL BUSINESSES' WILLINGNESS TO PARTICIPATE IN OUTDOOR IRRIGATION WATER CONSERVATION PROGRAMS

By

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Major Field: AGRICULTURAL ECONOMICS

Abstract: In the first article, we surveyed turfgrass sod producers to determine their preferences for different sod cultivars contingent on certain traits and their price. Turfgrass breeders have developed turfgrass cultivars exhibiting traits for improved long-term maintenance, appearance, utility, and resistance to abiotic and biotic stressors. As universities seek to capture revenue to cover research costs, these cultivars are typically protected by intellectual property rights. Holders of these rights generally require producers to be licensed to produce and sell proprietary cultivars, as well as pay royalties, impacting the marketability of cultivars available for sale. An online turfgrass preference survey with sod producers using a discrete choice experiment was conducted in Spring 2015. The design incorporated attributes such as cultivar, certification agency, fee structure, maintenance reduction potential, and price per square foot. Results from the analysis indicated that producers preferred genetically modified breeds and fee structures that allow producers to share the market uncertainty with the breed developers.
In the second article, we dealt with understanding outdoor irrigation water conservation in the commercial sector. Periodic drought stress in Oklahoma has forced utilities departments, including Oklahoma City, to seek ways of conserving water in both the residential and non-residential sectors. Most of these efforts largely targeted the residential sector. In this study, we identified the willingness of commercial businesses in the Oklahoma City metro area to participate in water conservation methods such as installing soil moisture sensors, smart irrigation controllers for their businesses and participating in voluntary irrigation assessments. We conducted a mail survey of 2784 Oklahoma City Water Utilities' commercial customers in which we used data from contingent valuation questions to elicit the financial savings on water that would encourage participation in a landscape irrigation assessment or adoption of smart irrigation controllers. A subsample experimental group received detailed information about future block rate water price increases. The results of the study indicated that, at current water utilities price rates commercial businesses are unlikely to adopt these programs, but that including information about future price rate hikes may induce a subset of businesses to participate.

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CHAPTER I

TURFGRASS SOD PRODUCER PREFERENCES FOR CERTIFICATION AND ROYALTY FEE STRUCTURES

Abstract

Turfgrass breeders have developed turfgrass cultivars exhibiting traits for improved long-term maintenance, appearance, utility, and resistance to abiotic and biotic stressors. As universities seek to capture revenue to cover research costs, these cultivars are typically protected by intellectual property rights. Holders of these rights generally require producers to be licensed to produce, as well as pay royalties, impacting the marketability of cultivars available for sale. Therefore, turfgrass developers must identify producer demand for various turfgrass cultivars exhibiting certain traits and their marketability.

An online turfgrass preference survey with sod producers using a discrete choice experiment was conducted in Spring 2015. The design incorporated attributes such as cultivars, certification agency, fee structure, maintenance reduction potential, and price per square foot. Results from the analysis indicated that producers preferred genetically modified breeds and fee structures that allow producers to share the market uncertainty with the breed developers.

Background

The growth of the sod industry in the United States (US) can be largely attributed to the demand created by the lawn-care industry (Haydu, et al., 2006) and the combined economic impact was greater than $1.9 billion in 2002 (Haydu, et al., 2008). The nursery, greenhouse, floriculture, and sod sector of the US economy is a $14 billion industry in sales and contains more than 52 thousand commercial operations. Some 1,739 sod farms used 321 thousand acres of land for their operations and leading to a sales value of more than $1 billion by 2012 (United States Department of Agriculture, 2012). However, turfgrass maintenance requirements have become demanding due to increases in maintenance costs, homeowners' lack of time to invest in lawn care, and unpredictable weather conditions (Hodges, et al., 1994; Cisar, 2004). Therefore, turfgrass developers have sought ways to cultivate turfgrass with improved qualities, such as drought tolerance, salinity tolerance, and other attributes that reduce maintenance (Funk, et al., 1993; Casler, 2006). As a result, improved cultivars of turfgrass were and continue to be developed using a number of classic as well as advanced breeding, selection and developmental techniques.

Turfgrass cultivars with enhanced desirable characteristics (and/or that reduce undesirable characteristic) are often protected by intellectual property rights, and turfgrass producers are required to obtain licenses and incur royalty fees for the production and sale of these cultivars. Therefore, understanding the demand for these commodities is important for successful marketability of innovative cultivars and maintaining profitability. Hence, the objectives of this study were, (1) to understand what methods of licensing and royalty fee structures that turfgrass producers prefer, and (2) to

determine turfgrass producer preferences for turfgrass sod characteristics such as their marketable end price, genetic type, licensing, and maintenance requirements.

Improved turfgrass cultivars that enhance desirable qualities and/or reduce undesirable qualities have led to increased productivity in the US (Cisar, 2004) and these improved qualities are attained via hybridization or genetic engineering. The US has been generally receptive to the technology of genetic engineering compared to other parts of the world (Fernandez-Cornejo, et al., 2014; Wu, 2004), and has adopted genetically engineered varieties heavily in food and commercial crops such as corn, soy, and cotton (Fernandez-Cornejo, et al., 2014). Today, genetically engineered food crops are among the most common forms of major cash crops in the US. Genetically engineered food crops grown in the US are predominantly pesticide resistant and responsive to broad-spectrum systemic herbicides. The adoption of these crops has increased 87% since they were first commercialized 15 years ago (Wang and Brummer, 2012). However, the acceptability of genetic engineering in the turfgrass and horticulture industry has largely not been examined (Klingeman, et al., 2006). The debate on the introduction of a genetically engineered creeping bentgrass (*Agrostis stolonifera* L.) may be the exception (Cummins, 2005; Jones, 2005). Studies found that several years after contained experimentation of growing genetically engineered creeping bentgrass that is resistant to glyphosate; the surrounding area carried wild bentgrass varieties that exhibited traces of glyphosate resistance (Zapiola, et al., 2008). In 2007, Scotts Company LLC was ordered to pay a civil penalty for failing to conduct trials properly and ordered to conduct workshops with other developers of genetic cultivars on best management practices and technical guidance (United States Department of Agriculture, 2007).

In the US, certification of turfgrass can be conducted by two separate methods-state and private. These methods can work harmoniously; however, the two methods are not viewed as interchangeable by state statute. These methods are administered through state government recognized agencies or those not state administered which are privately structured inspections. Privately administered assurance is generally not recognized by state governmental agencies as being statutorily compliant (Martin, 2016).

The state government assurance method is administered by state agency members of the Association of Official Seed Certifying Agencies (AOSCA). In this method the assurance of trueness-to-type certification is provided after inspecting all aspects of the production process from ground preparation to harvest (Martin, 2014). According to Jahn et al. (2005), state operated certification systems' objectives are to attain market transparency, and consumer protection by signaling information to the consumer. The privately structured certification systems aim at quality control for the suppliers that produce for retailers. Sources also stress that the credibility of the certification agency is an important aspect of quality signaling, and point out that state certifications systems can achieve both objectives (Emmanuelle and Schilizzi, 2003).

Because certification signals quality and purity of the product, the certification process makes it necessary for producers to adhere to strict quality assurance regimes, which increase costs. This process includes documenting the generational advancement of plant propagules (sod, plugs, seed or sprigs) as to certification standard compliancy and inspection of fields for contaminants such as other plant species, weeds, and in some cases, other pests. Certification standards work in harmony with additional state and federal regulatory statutes, although different entities are associated with each part of the

process. Once pre-plant inspections are passed, proprietary compliance confirmed and plant propagule pedigree confirmed; the propagules are planted. Once planted, the assurance process continues through field inspection carried out by the state agency appointed compliance certifier. After the producer passes the field test, official tags or labels for the final produced sod can be obtained from the inspection agency ensuring the consumer the quality of the product on sale. Producers, after initial inspection, are required to maintain the same quality and purity standards to receive the certification for their final product (Barton, 1995; Oklahoma Crop Improvement Association, 2015).

As developing certified turfgrass cultivars is research, time, and funding intensive on the part of the breeder, obtaining proprietary protection of such cultivars and seeking royalty payments from producers allows returns to the investment incurred by the breeder. Royalty payments can be divided into three groups: lump sum, proportional, or a combination of the two. Literature on the pros and cons of lump sum royalties versus proportional sales payment, also known as a running royalty agreement, remains divided. Proponents for the "lump sum only" royalty payment suggest that economic losses are rare with these agreements compared to the alternative (Johnson, 2007). However, they also agree that a running royalty fee structure gives a signal to the buyer about the profitability of the innovation, by agreeing to share the market risk, while also reducing the need for the licensor to do market share analyses for the innovation (Johnson, 2007). Proponents for running royalties, oppose the lump sum payments structure based on the belief that it does not incentivize further development of the innovation as the licensor no longer shares the risk of market reception (Jensen and Thursby, 2001).

Determining producer preferences for different types of certification methods and royalty fee structures given other attributes such as price and breed. calls for a method that allows producers to choose from multiple attributes at different levels. Despite, being dominantly used in marketing research and transportation economics, a number of agricultural publications are available that utilized the discrete choice method to determine consumer preferences (Behe, 2006; Campbell, et al., 2004; Yue, et al., 2010; Hugie, et al., 2012; Lusk, 2011; Roe, et al., 2004). Discrete choice methodology allows individuals to make tradeoffs between multiple bundled attributes. After a series of choices over varied levels, the relative rankings of the attributes and the willingness to pay for them can be estimated as long as a payment vehicle, such as the price per square foot of produced sod, is included. This method is also preferred by researchers (compared to other methods such as contingent valuation) because it allows multiple attributes to be included and their levels to vary across these attributes (Lusk, 2011).

Materials and Methods

Because data for producer preferences of turfgrass given genetics, certification method, and fee structures were not available, a survey instrument was used. The survey was inspected and approved by the Oklahoma State University Internal Review Board (IRB) for Human Subjects Research. Data for this study was obtained from an online survey administered in Qualtrics in April 2015. The respondent pool was drawn from the directory of Turfgrass Producers' International, and local turfgrass producers' addresses that are available online. The email addresses collected represented all 50 states and comprised of 631 viable electronic mail addresses. The first email solicitation was sent

out on 6 April 2015. Two weeks after the first electronic mail survey was sent, a reminder electronic mail was sent to each of the respondents. A second remainder electronic mail was sent to all the respondents a month after the initial email. We also provided a monetary incentive for the respondents by advertising a chance to win three $50 awards if they completed the survey.

The survey consisted of a choice experiment with six choice sets, basic demographics of the producers, and questions concerning the producers' operation such as size, revenue, and location. In the conjoint choice experiment, turfgrass producers made choices between different turfgrass options based on price, cultivar, maintenance reduction, certification requirements, and fee structures. A brief definition of each attribute was provided to reduce bias in respondents' responses due to differing knowledge concerning the attributes. The definitions given in the survey were as follows:

- Genetically modified referred to a variety of turfgrass into which a gene from some other plant or species has been introduced to achieve desired characteristics.
- Traditional hybrid referred to a variety of turfgrass that exist as a result of cross between different genotypes of turf to achieve desired characteristics
- Certification/inspection by state was the certification and inspection of sod fields to ensure that they meet published standards and can be marketed as certified seed/sprigs/sod by a state authority
- Certification/inspection by sod license holder per contract is the certification and inspection by sod license holder per licensing agreement, but not through a government agency

- 10% maintenance reduction referred to a 10% reduction in irrigation, mowing, or chemical or fertilizer application

Each of these attributes was varied at different levels and was randomly assigned to each choice set. The differences in these levels allow for a complete specification of the possible attributes that make up the bundle of attributes that represents a marketable turfgrass sod cultivar. Statistical analysis of individual choices allows us to determine which attributes are preferred. A complete list of attributes is shown in Table 1-1.

The choice experiment in each survey included six randomly selected conjoint choice questions out of a pool of 30 questions. Each choice set had three options A, B, and C, of which, C was always the status quo or the "opt out." Options A and B each represented a set of attributes for a hypothetical turfgrass cultivar (Figure 1-1). Because the attribute levels were unbalanced (Table 1-1) and because a full factorial design cannot be used in a small survey, we developed a fractional factorial design that maximized the statistical performance of the analysis. This was achieved by maximizing the D-efficiency criteria. Therefore the design for the 30 choice questions was obtained from a full factorial design of 240 unique combinations, out of which 30×2[1] combinations were randomly generated[2] using a fractional factorial design with a D-efficiency of 94%.

We estimated the producers' stated preferences, or relative worth for each attribute, by using a conditional logistic model, as the respondent choses one option conditional on seeing two other options in a choice set. As a result, the dependent variable is a three by one binary vector where zeros represent the non-chosen alternatives

[1] Because the one question has two options and an "opt out" 60 combinations were needed
[2] Using the SAS 9.3 (July 2011) software

and "1" represents the chosen alternative. By making a choice over multiple choice sets, the estimation controls for the other attributes and estimates a coefficient for each attribute. Following Chung et al, (2009) the random utility for turfgrass producer *i* choosing the alternative *j* is represented by

$$U_{ij} = \beta X_{ij} + \varepsilon_{ij} \quad [1]$$

Where, U_{ij} is the utility of the i^{th} turfgrass producer choosing alternative *j*, βX_{ij} represents the observable utility of the i^{th} individual choosing j^{th} alternative and εij represents the random or unobservable utility (Chung, et al., 2009). In the observable utility portion, *Xij* indicates the attributes that are presented in the choice experiment and β stands for their corresponding parameters. The probability of the i^{th} turfgrass producer choosing the j^{th} alternative from a choice set of S_i can be denoted as:

$$P(j) = P(X_{ij}\beta + \varepsilon_{ij} \geq X_{ik}\beta + \varepsilon_{ik}; for\ all\ j, k \in S_i) \quad [2]$$

Using Eq.1 the observable utility of the i^{th} individual choosing the j^{th} alternative can be defined as $V_{ij}=X_{ij}\beta$ and can be elaborated as:

$$\begin{aligned} V_{ij} = {} & \beta\ Gentically\ engineered_{ij} + \beta\ State\ certification_{ij} \\ & + \beta\ Breeder\ certification_{ij} + \beta\ Fee1_{ij} + \beta\ Fee2_{ij} \\ & + \beta\ Fee4_{ij} + \beta\ Maintenance\ reduction_{ij} + \beta\ Price_{ij} \end{aligned} \quad [3]$$

Data was analyzed using STATA13 (June 2013) software package and the variables used for the conditional logistic model are presented in Table 1-2.

Following the conditional logistic analysis, we also calculate the producer's marginal willingness to produce. The producer's willingness to produce is similar to that of an individual's willingness to pay/accept. Both willingness to pay and willingness to

accept are welfare measures that determine an attribute's importance to a person when its quality improves or declines. Willingness to pay refers to the maximum a person is willing to incur for an improvement in the said attribute, while the willingness to accept refers to the minimum amount a person is willing to accept as compensation for a decline in the quality of the same attribute (Haab and McConnell, 2003). The willingness to produce values estimated in this model may be interpreted in terms of dollars per square foot. Following Haab and McConnell (2003) the derivation of willingness to produce and can be written as

$$WTP = -\frac{\beta_j}{\beta_{price}} \quad [4]$$

Where, β_j is the parameter estimate of a selected attribute, and β_{price} is the marginal utility of income/price.

Data and results

At the end of the survey collection period, the total number of surveys received was 48 accounting for a response rate of 7.61%, out of which only 17 surveys were complete. Therefore, the number of observations usable for the analysis of producer preferences counted 96. Given the low response rate, the results of the analysis cannot be considered truly representative, but provide insight into what motivates producer behavior.

The general observation from the data that we obtained from the completed surveys indicated that the respondents were mostly women, had some college education,

ages ranged between 26 and 62 years with a mean age of 46 years, and were dominantly white (Table 1-2). Close to 56 percent of the responding producers already produced proprietary varieties and pedigree varieties, and the businesses' revenue from turfgrass sales in 2014 ranged from less than $100 thousand to $6 million.

Conditional logit models (Table 1-3) indicated that respondents preferred genetically modified cultivars compared to traditional hybrid cultivars, and the results were significant at the 99% level of significance. The price coefficient was positive and significant indicating that the higher the price per square foot of turfgrass, the greater the likelihood of producers opting to produce, and this was significant at the 99% level. Producers also preferred paying a percentage on sales (fee structure 3) compared to fee structures 1, 2, and 4. These coefficients were significant at or greater than the 90% level of significance. In order to understand the relative preference for each of the fee structures compared to fee structure 3, a hypothesis test was conducted. The null hypothesis was defined as $H0: \beta Fee1 = \beta Fee2 = \beta Fee4$. The hypothesis test yielded a Chi2 test statistic of 0.15 with a corresponding p-value of 0.927. Because the p-value was greater than the critical value of 0.05 we could not reject the null hypothesis that the coefficients of fee structures 1, 2 and 4 are statistically different from each other.

Marginal willingness to produce estimates for each significant attribute were calculated (Table 1-4). These show how valuable each attribute or each level of a certain attribute was to the producer at the 90% confidence interval for the estimates using a non-parametric bootstrap method. Producers had to be compensated to choose a fee structure that was different than the one that was omitted (fee structure 3). The results show that producers had to be compensated in price per square foot to accept fee structures 1, 2 and

4. These findings make intuitive sense as fee structures other than structure 3 were more regimented. On average producers appeared willing to produce genetically modified cultivars for a dollar amount less than the farm gate price. Although the coefficients show producers' preferences when calculated using the price, the per square foot sod price estimates are not statistically significant at 90% level of confidence.

Conclusion

The results obtained from this research provide basic insight of sod producers' preferences for different attributes and potential pricing schemes for new turfgrass cultivars. The key findings of this study shed light on several questions for breeders and product developers: the turfgrass producers' preference for genetically engineered cultivars, and less restrictive licensing fee structures and lack of preference for certification of sod cultivars. These findings can guide breeders and extension specialists at universities to tailor their education and marketing programs to sod producers' interests or to fill knowledge gaps.

The analysis shows that producers preferred a fee structure that is proportional to sales compared to the fee structures that required minimum lump-sum payments. Presumably this is due to the producers wishing to share risk with breeders/developers. However, because the marginal willingness to pay estimates calculated from the coefficients are not statistically significant we refrain from making any broader conclusions about the exact price of sod per square foot at which producers are willing to adopt and sell a cultivar with a specific attribute. Producers' preferences for sharing the

revenue risks of marketability and profit might indicate that they believe there is uncertainty in the market at the introduction of a new turfgrass variety. This lack of certainty in the market for performance-trait enhanced cultivars suggests that there is room for research on consumer preferences, i.e. the end market, to reduce the risk that producers perceive when adopting new turfgrass cultivars into production. As producers can only adopt a handful of cultivars to grow in quantity, breeders may need to close that information gap prior to development. Turfgrass product developers, however, understand their repeat market in wholesale and should be involved in this development process so that they are able to maintain profit and sustain market share.

Although the low response rate for the survey is a challenge, the lack of responsiveness suggests that personal or face-to-face surveys may be a more effective, but costly, way of obtaining responses. Given that 60% of the respondents that initiated the survey did not complete the choice experiment we can postulate that internet surveys may not reach the exact personnel that are responsible for the making of decisions such as whether or not to produce a given cultivar of turfgrass.

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Table 1-1: Attributes and attribute levels used for the choice experiment in a survey of turfgrass sod producers of their preferences for certification and royalty fee structures

Attribute	Levels of variation
Breed	Genetically modified
	Traditional hybrid
Certification/Inspection	Yes, by state
	Yes, by sod license holder
	None
License fee structure	Annual flat rate payment with unlimited unit sales
	Annual fee plus percentage fee based on unit sales
	No minimum annual fee, pay percentage on units sold
	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be met
10% maintenance reduction	Yes
	No
Farm gate price $/sq.ft	0.15
	0.25
	0.35
	0.45
	0.55

Table 1-2: Description of variables utilized in the conditional logistic model in ascertaining a sod producer's utility when choosing a new sod cultivar to produce

Parameter	Description
Genetically modified	1 if genetically modified, 0 otherwise
Certification_state	1 if certification is done by state, 0 otherwise
Certification_breeder	1 if certification is by breed developer, 0 otherwise
Fee1	Fee structure 1: 1 if annual flat rate payment with unlimited unit sales, 0 otherwise
Fee2	Fee structure 2: 1 if annual fee plus percentage on unit sale, 0 otherwise
Fee3	Fee structure 3: 1 if fee based on percentage of sales, 0 otherwise
Fee4	Fee structure 4: 1 if fee based on annual fee plus percentage on sales with minimum sales payment, 0 otherwise
Maintenance	10% maintenance reduction attribute. 1 if a cultivar has a 10% maintenance reduction 0 otherwise
Price	Price is varied in 10 cent increments form 15 cents per square foot to 55 cents per square foot

Table 1-3: Main effects conditional logit estimation of turfgrass sod producers responses to the choice experiment conducted in a survey of turfgrass producers

Parameter	Coefficient	Standard error
Genetically modified	1.012***	0.365
Certification by state	0.718	0.483
Certification by breed developer	0.106	0.417
Annual flat rate & unlimited sales [Fee1]	-1.049*	0.568
Annual fee & percentage on sales [Fee2]	-1.359***	0.455
Annual fee, percentage on sales, & minimum on sales [Fee4]	-1.296**	0.539
10% Maintenance reduction	-0.158	0.350
Price	3.079***	0.992
Number of observations	96	
Log Likelihood	-136.645	

Note: *,**,*** indicate the 90, 95, and 99% significance levels respectively

Interactions between fee structure and those who have produced proprietary varieties were also tested but were not statistically significant.

Table 1-4: Marginal willingness to produce estimates in US dollars (USD 2014) per square foot of sod for sale calculated using the main effects conditional logistic estimates from a choice experiment of turfgrass producers

Parameter	WTP [$/sq. ft.]	Bootstrap std. errors	95% confidence interval		Comparison variable
Genetically modified	-0.329	0.341	-0.998	0.340	Traditional hybrid
Annual fee & unlimited sales [Fee1]	0.341	0.476	-0.591	1.273	Percentage on sales [Fee3]
Annual fee & percentage on sales [Fee2]	0.442	0.464	-0.468	1.350	Percentage on sales [Fee3]
Annual fee, percentage on sales, & minimum on sales [Fee4]	0.421	0.628	-0.810	1.652	Percentage on sales [Fee3]

Note: 250 bootstrap iterations

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	None	None	
License fee and royalty fee structure	No minimum annual fee, pay percentage on units sold	Annual fee plus percentage fee based on unit sales	
10% maintenance reduction	No	Yes	
Farm gate price per square foot	0.55	0.55	
	Option A	Option B	Option C
I would choose	○	○	○

Figure 1-1: Example from a discrete choice set used to assess the producer willingness to pay for a new cultivar of turfgrass in a survey of turfgrass sod producers of their preferences for certification and royalty fee structures

CHAPTER II

SAVE OR SQUANDER? AN ASSESSMENT OF OKLAHOMA CITY COMMERCIAL BUSINESSES' WILLINGNESS TO PARTICIPATE IN IRRIGATION WATER CONSERVATION METHODS

Abstract

Outdoor irrigation water conservation in the commercial sector has rarely been studied. Periodic drought stress in Oklahoma has forced utilities departments, including Oklahoma City, to seek ways of conserving water in both the residential and non-residential sectors. Most of these efforts largely targeted the residential sector. In this study we determined the willingness of commercial businesses in the Oklahoma City metro area to participate in water conservation methods such as installing soil moisture sensors, smart irrigation controllers for their businesses and participating in voluntary landscape irrigation assessments. We conducted a mail survey of 2784 Oklahoma City Water Utilities' commercial customers in which we used data from contingent valuation questions to elicit the financial savings on water utilities that would induce participation in a landscape irrigation assessment or adoption of smart irrigation controllers. A subsample experimental group received detailed information about future block rate water increases. The results of the study indicated that, at current water utilities rates

commercial businesses are unlikely to adopt these programs, but that including information about future rate hikes may induce a subset of individuals to participate.

Background

Worsening drought conditions alongside the growing demand for municipal water poses challenges in maintaining agricultural production, protection of natural water resources, and ensuring that metropolitan areas have adequate water resources to operate (Borisova, et al., 2011). As a result, city governments have tried to manage demand for water utilities by encouraging water conserving behavior and technology adoption by municipal clients.

Oklahoma has experienced periodic droughts for the last decade, with a historic peak in 2012 that forced city governments to consider water conservation a priority (South Central Climate Science Center, 2013; Arndt, 2002). By spring 2015, the conditions improved, but still remained abnormally dry and persistent areas of drought were projected in the Oklahoma panhandle and southwestern Oklahoma (Heim, 2015).

Since the beginning of 2012, the Oklahoma City Utilities Department (OKCUD) has actively sought ways to encourage its customers to conserve water. Mandatory water use restrictions in Oklahoma City include odd/even day watering, and additional restrictions depending on the capacity of Oklahoma City's water supply reservoirs (City of Oklahoma City, 2013). An inclining block rate pricing structure was implemented in the fall of 2014 (Crum, 2014; Boyer, et al., 2015). However, in Oklahoma City and elsewhere, education to encourage the adoption of irrigation water conservation and

water demand management has focused on the residential sector (St. Hilaire, et al., 2008; Boyer, et al., 2015), while outdoor irrigation water conservation in the non-residential sector has largely been neglected (Renzetti, 2015; Worthington, 2010). Therefore, this study analyzed how commercial businesses respond to contingent valuation (CV) questions regarding water savings that could be gained by adopting outdoor irrigation water conservation methods and technologies. We constructed hypothetical savings scenarios to quantitatively determine the savings level at which commercial businesses will install a soil moisture sensor (SMS), a smart irrigation controller (SIC) and undergo a landscape an irrigation assessment (LIA). For the purpose of this study, the conservation instruments were defined as follows:

- A SMS is an instrument that measures the level of moisture in the soil, so that how much watering is needed can be determined.
- A SIC is an instrument that automatically adjust irrigation run times in an irrigation system in response to weather conditions. SICs use sensor and weather information to manage watering times and frequency.
- A LIA will be conducted by a landscaping professional to identify ways to reduce the quantity of water used in irrigation, based on the watering needs of the landscape and plantings.

We also tested if the inclusion of more information on current and future water prices would change the likelihood of commercial businesses adopting these conservation methods.

A large body of literature has studied residential water conservation potential using non-market and market based tools. Market based tools refer to pricing or incentive policies that potentially encourage conservation behavior, such as increasing water rates or subsidies such as rebates (Adams, et al., 2009; Ghimire, et al., 2015). Non-price mechanisms are regulatory approaches and educational measures such as water usage feed-back, and mandatory restrictions on watering etc. A large part of these conservation efforts promoted water efficient appliances and feedback instruments (Lee, et al., 2013; Gracia-Valinas, et al., 2015; Woltemade and Fuellhart, 2013; Makki, et al., 2013; Hayden, et al., 2015; Boyer, et al., 2015).

How commercial customers respond to nudges to conserve water is termed price elasticity of demand, i.e., how much water demand would change given an increase in price. Larger elasticity coefficients suggest higher responsiveness and vice versa to price increases. According to Renzetti (2015) and Reynaud (2003), the non-residential water demand is inelastic although they are slightly larger compared to the residential sector. For example, Renzetti (2015) found that elasticity estimates for the commercial sector in the United States ranged between -0.234 and -1.33.

Price and non-price approaches for inducing water conservation have been widely applied by water managers with the belief that these incentives will work for the commercial sector, but little research on the commercial sector exists (The United States Environmental Protection Agency, 2016; California Urban Water Conservation Council, 2016; Water Services Association of Australia, 2008). Lee et al. (2011) found that the consumption of water was significantly reduced in households that installed high efficiency appliances. Several studies also found that technological treatments in

irrigation systems could reduce the amount of water used in landscape irrigation (Haley, et al., 2007; McCready, et al., 2009). Other approaches such as irrigation audits or assessments are also discussed in literature, available exclusively for commercial clients (Dallas Water Utilities, 2016; Austin Water, 2016) and for households (McCue, et al., 2007). McCue et al. (2007) observed that households that consumed more than 300 gallons per person per day were able to reduce their water use by 19% following an irrigation audit. A water demand management program in Sydney, Australia in 1977 utilized many of the above mentioned conservation programs including "industrial and commercial (water) audits" and "hotel (water) audits" among others, and required the participation of both the residential and non-residential sectors. The results of the project indicated that residential clients were more receptive to these conservation programs and found that "programs such as the industrial and hotel audits …. are underperforming" (White and Fane, 2007). Other technological studies in horticulture dealt with understanding the potential for conservation among different technological fixes such as rain sensors, SMSs, and SICs, etc. (Grabow, et al., 2013).

Materials and Methods

In determining the willingness of commercial businesses to participate in irrigation water conservation programs we make several hypotheses: (1) we assume that higher potential water savings would increase the willingness of the commercial business to adopt conservation technologies and participate in an irrigation assessment, that (2) higher water users are more likely to adopt conservation methods, (3) information on how water rates will change in the future will have a positive effect on adoption, and that (4)

perceptions of future drought will have a positive effect on the likelihood of adopting conservation technologies or irrigation assessments.

Data were collected via a mail survey of commercial customers of the OKCUD. The survey was administered in fall 2015. The OKCUD provided a list of 16,287 commercial client addresses and actual water use data for each of these businesses for the months between January 2011 and July 2015. After filtering missing water consumption data and incomplete information, 3,730 addresses remained. The survey was sent to 3000 randomly selected commercial businesses[3] in the Oklahoma City metropolitan area using the "Tailored Design Method" by Dillman (Dillman, 2000). The survey of commercial businesses in Oklahoma City yielded 381 responses out of 2,784 deliverable addresses, resulting in a response rate of 13.7%.

The survey consisted of three main sections: business demographics, the CV questions, and respondent demographics. The surveys were tracked using a unique identification number that was later used to append the actual water consumption data. The three contingent valuation questions asked each respondent to indicate their willingness to adopt a SMS, a SIC and their willingness to participate in a LIA. As shown

[3] The survey was sent in two waves. First for a sample of 2000 businesses, and later to an additional sample of 1000 businesses as we observed a stagnant response rate to the first wave of surveys. The first set of surveys in the initial wave was sent on 18th September 2015. Following this, a postcard reminder was sent to non-responses on 14th October 2015 and the postcard reminder gave the businesses the option of completing the survey online. On November 6th 2015 the final set of surveys were sent to non-responses in the initial wave. The second wave was started on 12th October 2015. We decided to not send businesses in the second wave a postcard reminder because we did not observe a significant difference in the response rate. Surveys for the non-responses in the second wave were sent on 16th November 2015.

in Figure 2-2, each of these questions carried a randomly assigned dollar amount of potential water savings and the cost of installation that was equal across all questions. The potential water savings were calculated based on actual water saving prospects for each conservation device. These savings ranged from 5% to 60% and were used in calculating 12 different savings levels[4].

In September 2014 the OKCUD introduced an inclining block rate water pricing structure from a uniform volumetric water rate structure for both residential and non-residential utilities customers (The City of Oklahoma City, 2014). As a result, commercial customers will pay a higher cost for the volume of water they use above their winter average. The sample was divided into two groups of which two thirds received a complete table of information on how water rates in the inclining block rate structure would change in the future as shown in Figure 2-1, while a third were assigned to a control group that did not receive this information.

Stated preference methods such as conjoint choice and contingent valuation are often used as the methodological approach for quantifying consumer choice for goods or environmental preferences (Yue and Tong, 2011; Lusk, 2011). In this study, a CV method is used to pose a hypothetical cost savings scenario to commercial water customers. A CV question asks respondents if they would accept or reject a scenario presented in the question if they have to pay or if they would be compensated a given dollar amount (King and Mazzotta , 2000; Koss and Khawaja, 2001; Blaine and Smith, 2006). We assume that the business maximizes utility by choosing one alternative over

[4] These potential water savings were provided by the Horticulture Department of Oklahoma State University

the other. The utility- U_{ij} of the i^{th} business choosing alternative j^{th} alternative can be written as (Haab and McConnell, 2003):

$$U_{ij} = \beta X_{ij} + \varepsilon_{ij} \quad [1]$$

Where, βX_{ij} represents the observable utility of the i^{th} individual choosing j^{th} alternative and ε_{ij} represents the random or unobservable utility. In the observable utility portion, X_{ij} indicates the dollar savings amounts businesses would save every summer and all other individual and firm specific characteristics. The corresponding parameter estimates are represented by β. Because the responses to the CV questions are binary j can only take two values: $j=1$ or $j=0$.

The logistic model is used to test the likelihood of businesses adopting or not adopting the SMS, SIC or the LIA. We can express the deterministic part of the utility $V_{ij} = \beta X_{ij}$ as introduced in Eq.1 and can be further elaborates as what follows:

$$
\begin{aligned}
V_{ij} = \ & \beta_0 + \beta\ Savings_{ij} + \beta\ Control_{ij} + \beta\ Adoption_{ij} \\
& + \beta\ Landscaped\ acreage_{ij} + \beta\ Industry\_office_{ij} \\
& + \beta\ Industry\_food_{ij} + \beta\ Industry\_helthcare_{ij} \\
& + \beta\ Industry\_construction_{ij} + \beta\ Industry\_construction_{ij} \\
& + \beta\ Industry\_other_{ij} + \beta\ College_{ij} + \beta\ Graduate_{ij} \\
& + \beta\ Income\ 1_{ij} + \beta\ Income\ 2_{ij} + \beta\ Years\ in\ business_{ij} \\
& + \beta\ Years\ at\ location_{ij} + \beta\ No.employees_{ij} \\
& + \beta\ Drought\ perceptions_{ij} + \beta\ Irrigation\ source_{ij} \\
& + \beta\ Appearence\_most_{ij} + \beta\ Efficiency\_most_{ij} \\
& + \beta\ Irrigation\ audit_{ij} + \beta\ Free\ education_{ij} + \beta\ Female_{ij} \\
& + \beta\ Decision\ maker_{ij} + \beta\ Age_{ij} + \beta\ Summer12_{ij} \\
& + \beta\ Summer13_{ij} + \beta\ Summer14_{ij}
\end{aligned}
\qquad [2]
$$

At the outset of the survey, we requested that the recipients of the surveys make sure that the decision-makers for the landscaping complete the surveys. This distinction was important to us for two reasons: firstly, because the non-decision maker's knowledge of the landscaping choices may be limited, resulting in a relatively higher degree of social desirability bias in the choices they make, and secondly, because we expect a relatively low level of hypothetical bias in responses from actual decision makers for the firm than otherwise.

The water use data for this study was provided by OKCUD, and was provided as monthly data for more than four years starting January 2011. The monthly data was used

to obtain estimates of irrigation water use. Because separate irrigation water consumption records are not available to the utility or for our study except for a few businesses, the irrigation water use is calculated by finding the difference between average summer monthly consumption (June, July, and August) and the average monthly winter water consumption (December, January, and February). The OKCUD uses this to set the base rate up to the monthly average winter consumption (Ghimire, et al., 2015). In some cases, these irrigation water consumption estimates may be exaggerated because certain business operations' water use that strictly only operate in the summer may entirely be calculated as irrigation. To avoid this overestimation, any businesses with zero water usage records in the winter season were culled from the survey sample. A similar method was utilized by Hermitte and Mace (2012) where they assumed the lowest water usage in a given calendar year to be the best estimate of indoor water consumption from a series of data pertaining to residential water usage in Texas, and counted any additional water utility use as outdoor consumption. This method however, may overestimate indoor water use and may underestimate outdoor water use (Hermitte and Mace, 2012). Data for the survey and the monthly water consumption data were joined for this analysis.

Data and Results

Ninety nine percent of the businesses that responded to the survey have been in business for longer than 5 years, and 97% were at their current location in Oklahoma City for more than 5 years. This indicates that when the drought was in its peak in 2012, these firms were in business and may have been aware of the supply shortage and water pressure problems in Oklahoma City during the drought. Because 84% of the businesses

depend on city water utilities for their irrigation supply, we postulate that OKCUD has significant market power in nudging businesses towards conservation, but as the model estimate shows (discussed in the next section), not at current prices and estimated conservation savings. The survey solicited information about the size of landscaped area maintained. Because larger landscapes need more irrigation, water savings were more likely to be attractive for business with larger landscaped areas. More than 90% of businesses in the sample had less than one acre of landscaping to maintain. In the residential sector, perception and attitudes of homeowners significantly affect conservation adoption (Domene and Saurai, 2006; Boyer, et al., 2015). We wanted to test attitudinal effects on adoption by the commercial sector. We also asked businesses to indicate the most and least important attribute of their landscape. A majority indicated that appearance of the landscape is the most important attribute; while only 2% of the responding businesses indicated that water efficiency in their landscaping is the most important attribute. In addition, we asked respondents to indicate their perceptions on the likelihood of Oklahoma going into another drought within the next three years. Close to 70% of the respondents thought that it is very likely or somewhat likely for Oklahoma to go into drought within the next three years, while 22% were unsure of either. Six and three percent of the respondents respectively thought that Oklahoma going into drought was somewhat unlikely or not likely at all.

Summary statistics of the demographics of individual respondents are reported in Table 2-1. The average age of the respondents was 54 years, and the majority of the respondents were male. The sample was also highly educated with more than 50% of the respondents having at least a college degree.

First, we estimated three logistic models of willingness to adopt the SMS, SIC, and LIC given the randomly assigned bids. Post logistic estimation, we tested for overall model significance using a Likelihood Ratio (LR) test. Results of the LR test are reported in Table 2-3. The SMS model did not significantly explain the determinants of adoption, thus only the results for the other two models are reported in Table 2-4. For this LR test, the null hypothesis is H_0: all coefficients are equal to zero, i.e. the model is not predictive of the willingness of commercial businesses to install a SMS, SIC, or participate in a LIA. With the probabilities associated with the LR test less than the critical value of 0.05 we could reject the null hypothesis for the logistic models estimated for SIC and LIA. We conclude the SIC and LIA models explain potential adoption behavior, but cannot say that for the SMS model. Because the probability associated with the LR test is greater than the critical value of 0.05 we could not reject the null hypothesis for the logistic model estimated for the SMS and was dropped from further analysis. Table 2-4 reports the logistic models for SIC and LIA and their robust standard errors[5]. The odds ratios for the logistic equations shown in Table 2-5 report the odds of a respondent accepting the savings amounts over the odds of a respondent rejecting the savings amount presented in the CV questions in installing a SIC or participating in a LIA.

Model 1 – Willingness to install a SIC

In Model 1 the coefficient for 'savings,' was not statistically significant. The lack of significance of this coefficient means that we cannot calculate the savings level at

[5] Robust standard errors correct for unequal variances in residuals that affect the standard errors of the coefficient and subsequent inferences derived using these incorrect standard errors.

which an average commercial business would be persuaded to make a shift from not installing the SIC to installing a SIC. However, other variables were significant and can provide insight into business firm behavior. The control group that did not see additional information on water rate changes in the future indicated by the variable 'control,' was statistically significantly less likely to adopt a SCI at 95% level of confidence. For each business that installs a SIC in the non-control group, the odds of installing a SIC in the control group was 3 in 10. 'Adoption' indicated businesses that have already taken steps to conserve water and was statistically significant at 95% level of confidence. The associated odds ratio suggested that this group was 6 times more likely to install a SIC for their businesses than those who had not taken steps to conserve water on site.

Businesses that maintained a ¼ acre or more of land were also more likely to adopt a SIC compared to businesses with less than ¼ acre of landscaping at 99% level of confidence. The odds of installing a SIC was 4 times more for businesses with ¼ acre or more of landscaping than otherwise. 'Food,' 'healthcare' and 'other' industry categories were significantly less willing to install SICs for their businesses, compared to industry category 'home and landscape.' These coefficients were significant at 90% level of confidence. The odds of installing a SIC for the 'food,' 'healthcare' and 'other' industry categories respectively was 1 in 100, 2 in 10, and 8 in 100. With a negative and significant coefficient for 'years at location,' businesses that have been located in Oklahoma City for longer are less likely to install a SIC. The odds ratio of installing a SIC was 0.95 for each additional 'year at location' and is significant at 95% level of confidence. The variable 'number of employees' was used as a proxy for the size of the business. This variable was positive and significant at 95% level of confidence,

suggesting that larger businesses are more likely to install SICs. ‘Summer14’ actual water usage series was negative and significant at 95% level of confidence in the SIC model indicating that higher users of water in 2014, still a drought year, were less likely to install a SIC.

Respondent characteristics applicable to Model 1 indicated that persons with graduate degrees were significantly more likely to be willing to install a SIC for their business at 90% level of confidence. Where, a graduate degree increased the odds of installing a SIC by more than 4 times. Female respondents were less likely to be willing to install a SIC for the business compared to males and was statistically significant with a 90% level of significance. Where, the odds of a female respondent installing a SIC was 3 in 10.

Model 2 – Willingness to participate in a LIA

In Model 2, the variable ‘savings’ was not statistically significant and prevented us from calculating the savings level at which businesses would make a shift towards conducting a LIA. However, a number of other variables were significant in the model that can provide insight into firm behavior. ‘Adoption’ was statistically significant at 99% level of confidence and indicated that business that have already taken steps to conserve water were more likely to conduct a LIA, where the odds of participating in a LIA was 6 times greater. The variable ‘years in business’ was positive and significant at 95% level of confidence indicating that older businesses were more likely to conduct a LIA. However, ‘years at location’ variable was negative and significant at 99% level of

confidence, and indicated that businesses located in Oklahoma City for longer were less likely to conduct LIAs. 'Free education' was positive and significant at 99% level of confidence suggesting that businesses who indicated their willingness to participate in free education programs on water conservation conducted by OKCUD were more likely to conduct a LIA for their business. The corresponding odds ratio indicated that among those who would participate in free educational programs, the odds of conducting a LIA was 10 times higher.

Conclusion

The objective of this study was to identify savings levels at which commercial businesses would increase their conservations by installing smart irrigation controllers and conducting landscape irrigation audits to identify areas of overuse. The lack of statistical significance of the variable – 'savings' indicated that the dollar amounts of water bill savings at current water utility rates were insufficient to induce these businesses to install a SIC or participate in a LIA. However, if the variable 'savings' had been significant in the models we would be able to summarize the proportion of business that indicated their willingness to install a SIC or participate in a LIA and calculate an average savings level at which commercial businesses would have been able to be persuaded to install a SIC or participate in a LIA. Because current water rates are not high enough per 1000 gallons for these businesses to be concerned, the savings levels calculated using these low water prices are insufficient to encourage conservation. Nonetheless, this study found evidence to suggest that the prospect of water being more expensive in the future could make statistically significant differences in firms' adoption

decisions. Therefore, we believe that already slated yearly rate increases by the OKCUD may eventually persuade commercial businesses to pay more attention to conserving water onsite. Furthermore, rebates for professionally installed water fixtures would result in a shorter payback time for SIC in terms of savings. If the water utility is forced to add supply or larger pipeline capacity to meet summer irrigation demand, rebates sufficient to induce SIC adoption that are less (a benefit) than the cost of new pipelines make sense in benefit cost terms.

Among other important aspects, the analysis in this study found evidence to suggest the need for better targeting of water conservation policies at the firm level. Targeting businesses on both ends of the spectrum is most likely to yield results. With a majority of firms in the sample maintaining less than a quarter acre of land and these firms being less likely to install SICs, it is important to target these firms also in irrigation water demand management efforts as their cumulative summer consumption is important, particularly for decreasing pressure problems during drought. It is also important to understand why older businesses are less likely to install SICs for their businesses and are less likely to participate in LIAs. In the residential sector, residents in older buildings are less likely to adopt conservation tools, because their infrastructure does not allow large scale physical changes (Boyer, et al., 2015). If this true for the non-residential sector as well, utilities departments could target their efforts towards newer businesses that are more likely to adopt new technologies when first installing irrigation systems. Furthermore, the concern over appearance first and the relative savings last (discussed in the Results section above) shows that OKCUD must work to combat the perception that water conservation will result in unattractive landscapes. One avenue for future research

would be to examine whether decreases in costs in addition to water savings might be the nudge that induces firms to adopt smart controllers and irrigation assessments.

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Table 2-1: Summary statistics of persons that responded to a survey of commercial businesses' willingness to participate in irrigation water conservation in Oklahoma City, OK

Demographic attribute	n	Freq.	Percentage share [%]	Mean	St.Dev	Min	Max
Gender	229						
Male		147	64.19			0	1
Female		82	35.81			0	1
Education	230						
High-school diploma		13	5.65			0	1
Some college		56	24.35			0	1
College graduate		99	43.04			0	1
Some graduate		10	4.35			0	1
Graduate degree		52	22.61			0	1
Decision-maker for the firm	227						
Yes		197	86.78			0	1
No		30	13.21			0	1
Ownership of the business	232						
Owner		139	59.91			0	1
Otherwise		93	40.09			0	1
Age	230			54	12	22	85

Table 2-2: Independent variables and their descriptions used in logistic regression analyses to determine the willingness of commercial businesses to install soil moisture sensors, smart irrigation controller and participate in landscape irrigation assessments.

Variable	Variable Description	n	Avg.	St.Dev.	Min.	Max.
Control	Control group (did not see how water rates would increase in future)=1; otherwise=0	249			0	1
Adoption	Water conservation onsite=1; otherwise=0	249			0	1
Landscaping acreage	¼ ace of landscaping or more=1; less than ¼ acre of landscaping=0	249			0	1
Industry- ABCEI	Businesses that operate largely within an office setting such as banks, schools, and legal etc.=1; otherwise=0	249			0	1
Industry- FM	Businesses in food, travel and restaurant =1; otherwise=0	249			0	1
Industry- G	Businesses in healthcare=1; otherwise=0	249			0	1
Industry- HL	Businesses in landscaping and real-estate=1; otherwise=0	249			0	1
Industry- DJ	Businesses in construction/ manufacturing =1; otherwise=0	249			0	1

Industry- KNO	Miscellaneous businesses=1; otherwise=0	249			0	1
<College degree	Less than college degree=1; Otherwise=0	249			0	1
College degree	College degree or greater=1; otherwise=0	249			0	1
Graduate degree	Graduate degree=1; otherwise=0	249			0	1
< $100,000	Annual income <$100,000=1; otherwise=0	249			0	1
$100,000 to $10Mn	$100,000<Annual income <$10Mn	249			0	1
>$10Mn	Annual income >$10Mn	249			0	1
Years in business	Number of years in business	249	36.09	23.2	3	125
Years at location	Number of years at location	249	21.19	15.14	1	100
Number of employees	Number of employees	249			0	1
Drought perceptions	OK likely to go into drought within the next 3 years=1; otherwise=0	249			0	1
Irrigation source	Irrigation source OKC utilities=1; otherwise=0	249			0	1
Appearance_most	Most important landscaping attribute is appearance=1; otherwise=0	249			0	1
Efficiency_most	Most important landscaping attribute is water	249			0	1

	efficiency=1; otherwise=0					
Irrigation audit	Will participate in a landscape irrigation audit=1; otherwise=0	249			0	1
Free education	Will participate in free education programs=1; otherwise=0	249			0	1
Female	Gender female=1; otherwise=0	249			0	1
Decision-maker	Decision-maker for the business landscaping=1; otherwise=0	249			0	1
Age	Age of the respondent	249			0	1
Summer12	Average summer water use in 2012. Measured in thousands of gallons.	249	57.76	327.32	1.25	5101.25
Summer13	Average summer water use in 2013. Measured in thousands of gallons.	249	49.17	246.24	1	3795.50
Summer14	Average summer water use in 2014. Measured in thousands of gallons.	249	45.62	128.56	1	1800.50

Table 2-3: Likelihood Ratio (LR) tests for the logistic regression models estimated to determine willingness to install soil moisture sensors (SMS), smart irrigation controllers (SIC) and participating in landscape irrigation assessments (LIA) of firms responding to a survey of commercial businesses' willingness to participate in irrigation water conservation in Oklahoma City, OK

Model description	Model 1: SMS	Model 2: SIC	Model 3: LIA
LR Chi2 test statistic	9.96	113.05***	70.23***
Probability associated with the LR test statistic	0.13	0	0
No. observations	112	201	175
Degrees of freedom used for the calculation of the LR Chi2 test statistic	6	28	27

Notes:

***, **, and * respectively indicate statistical confidence at 99%, 95% and 90%

Table 2-4: Logistic regression results estimated to determine willingness to install smart irrigation controllers (SIC) and participating in landscape irrigation assessments (LIA) of firms responding to a survey of commercial businesses' willingness to participate in irrigation water conservation in Oklahoma City, OK

Variable	Model 1: SIC Coefficient	Robust Standard Error[a]	Model 2: LIA Coefficient	Robust Standard Error[a]
Savings	0.00	0.00	0.00	0.00
Control	-1.26**	0.52	0.18	0.41
Adoption	1.87**	0.74	1.85***	0.59
Landscaping acreage	1.63***	0.54	0.40	0.44
Industry- ABCEI	-1.26	0.83	-0.71	0.90
Industry- FM	-5.07***	1.43	-1.57	0.97
Industry- G	-1.58*	0.93	-0.48	0.90
Industry- DJ	-0.85	0.73	-1.27	0.79
Industry- KNO	-2.48***	0.86	-1.30	0.78
College degree	-0.54	0.61	-0.29	0.46
Graduate degree	1.31*	0.73	-0.37	0.59
$100,000 to $10Mn	1.45*	0.82	0.81	0.72
>$10Mn	1.32	0.99	0.68	0.88

Years in business	-0.01	0.02	0.03 **	0.01
Years at location	-0.05 **	0.02	-0.05 ***	0.02
Number of employees	0.01 **	0.00	0.00	0.00
Drought perceptions	1.20 **	0.55	0.60	0.44
Irrigation source	1.21 **	0.59	0.82	0.53
Appearance_most	1.56 **	0.58	0.17	0.42
Efficiency_most	1.06	0.99	0.09	0.78
Irrigation audit	2.08 **	0.85	[b]	[b]
Free education	0.75	0.60	2.34 ***	0.56
Female	-1.07 *	0.60	0.61	0.46
Decision-maker	-1.02	0.77	-0.74	0.63
Age	0.00	0.02	0.03 *	0.02
Summer12	0.01	0.01	-0.01 *	0.01
Summer13	0.00	0.01	0.00	0.01
Summer14	-0.02 **	0.01	0.01	0.01
Intercept	-1.66	2.19	-3.50	1.59
No. observations	201		185	
Pseudo R2	0.48		0.28	
Wald Chi2 statistic [c]	45.89		54.82	

Prob> Wald Chi2	0.02	0.00

Notes:

***, **, and * respectively indicate statistical confidence at 99%, 95% and 90%

[a] Robust standard errors: calculate standard errors that are corrected for unequal variances in the error residuals

[b] Omitted: Indicates that a variable was omitted by the statistical package due to lack of variation within groups

[c] Wald Chi2: The Wald Chi2 test tests if the overall model is statistically significant

Table 2-5: Odds ratio calculations derived for the logistic regression results estimated to determine the willingness to install smart irrigation controllers (SIC) and participating in landscape irrigation assessments (LIA) of firms responding to a survey of commercial businesses' willingness to participate in irrigation water conservation in Oklahoma City, OK

Variable	Model 1 SIC Odds Ratio	Robust Standard Errors	Model 2 LIA Odds Ratio	Robust Standard Errors
Savings	1.00	0.00	1.00	0.00
Control	0.28**	0.15	1.20	0.49
Adoption	6.49**	4.78	6.37***	3.78
Landscaping acreage	5.13***	2.76	1.49	0.66
Industry- ABCEI	0.28	0.23	0.49	0.44
Industry- FM	0.01***	0.01	0.21	0.20
Industry- G	0.21*	0.19	0.62	0.56
Industry- DJ	0.43	0.31	0.28	0.22
Industry- KNO	0.08***	0.07	0.27	0.21
College degree	0.58	0.35	0.75	0.35
Graduate degree	3.70*	2.71	0.69	0.41
$100,000 to $10Mn	4.26*	3.47	2.25	1.62

>$10Mn	3.76	3.73	1.98	1.74
Years in business	0.99	0.02	1.03**	0.01
Years at location	0.95**	0.02	0.95***	0.01
Number of employees	1.01**	0.00	1.00	0.00
Drought perceptions	3.31**	1.82	1.83	0.80
Irrigation source	3.35**	1.98	2.27	1.20
Appearance_most	4.74**	2.75	1.18	0.49
Efficiency_most	2.90	2.88	1.10	0.86
Irrigation audit	8.00**	6.76	[a]	[a]
Free education	2.12	1.27	10.37***	5.80
Female	0.34*	0.20	1.83	0.84
Decision-maker	0.36	0.28	0.48	0.30
Age	1.00	0.02	1.03*	0.02
Summer12	1.01	0.01	0.99*	0.01
Summer13	1.00	0.01	1.00	0.01
Summer14	0.98**	0.01	1.01	0.01
Intercept	0.19	0.42	0.03**	0.05

Notes:

***, **, and * respectively indicate statistical confidence at 99%, 95% and 90%

[a] Omitted: Indicates that a variable was omitted by the statistical package due to

lack of variation within groups

The City of Oklahoma City moved to a "two-tier" water rate October 2014 to reflect increasing costs to supply water and to encourage conservation. As a result, businesses will experience a 15% higher cost for the volume of water they use above their average winter consumption. The second tier price per thousand gallons reflects the actual cost to customers of providing additional water when it is at peak demand in the summer.

Following is a table of OKC non-residential and irrigation water rates [US $ per 1000 gallons]

Tier	Until Sep. 30 2015	Oct. 1 2015 – Sep. 30 2016	After Oct. 1 2016
Tier 1	$2.71	$2.76	$2.81
Tier 2	$3.12	$3.26	$3.40

Tier 2 is paid per 1000 gallons of water used by the individual businesses above its own average winter water use (From December to February).

Figure 2-1: Additional information on how water utilities rates would increase in the future provided to an experimental group in a survey of commercial businesses' willingness to participate in irrigation water conservation in Oklahoma City, OK.

18. **Smart irrigation controllers** are devices that automatically adjust irrigation run times in response to changes in weather. They use sensors and weather information to manage watering times and frequency. The cost of a smart irrigation controller will be approximately $400 a unit and the cost of labor would be approximately $90 an hour. Would you consider installing a **smart irrigation controller** for your business's irrigation system, if it could save you $354.68 for the months of June, July, and August each year?

☐Yes ☐No

Figure 2-2: Example of a contingent valuation question for a smart irrigation controller presented in a survey of commercial businesses' willingness to participate in irrigation water conservation in Oklahoma City, OK.

APPENDICES

List of attachments in order of appearance

1. IRB approval for the survey of sod producers of their preferences for turfgrass sod cultivars' licensing requirements and royalty fee structures
2. The survey of sod producers of their preferences for turfgrass sod cultivars' licensing requirements and royalty fee structures was administered via Qualtrics.com
3. The report submitted to the City of Oklahoma City and the survey of commercial businesses' willingness to participate in irrigation water conservation in Oklahoma City, Oklahoma

IRB approval for the survey of sod producers of their preferences for turfgrass sod cultivars' licensing requirements and royalty fee structures

Oklahoma State University Institutional Review Board

Date:	Thursday, March 26, 2015
IRB Application No	AG1516
Proposal Title:	Certification and licensing method preferences of sod grass producers
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 3/25/2018

Principal Investigator(s):

Tracy Boyer
321 Ag Hall
Stillwater, OK 74078

Deshamithra Jayasekera
321 Ag. Hall
Stillwater, OK 74078

Ben Tong
415 Ag Hall
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☐ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1.Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title, PI advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms
2.Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3.Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
4.Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Dawnett Watkins 219 Cordell North (phone: 405-744-5700, dawnett.watkins@okstate.edu).

Sincerely,

Hugh Crethar, Chair
Institutional Review Board

Certification and Licensing method preferences of sod grass producers

This survey is being conducted by researchers in the department of Agricultural Economics at Oklahoma State University to determine your preferences for different sod varieties based on their licensing fee structures, certification and inspections requirements, and their potential to reduce maintenance burden.

Developers of new sod varieties most know what attributes are valued most by sod producers, in order to provide them with improved varieties that will work better for them and their potential buyers in the future. Therefore, our goal is to improve communication between breeders and sod producers.

Your response to the survey is voluntary; your responses will be kept anonymous and it will not take more than 30 minutes to fill it out. Once you have completed the survey, we will enter you into a drawing for one of three, $50 prizes. Your information provided for this raffle draw will not be linked to your survey responses.

Link to the Survey
<e-mail link here>

If the link does not directly take you to the survey, cut and past the following link into your browser,
<Web link here>

Thank you for your time!

Benjamin Tong
Deshamithra Jayasekera
Research Assistants, Agricultural Economics, Oklahoma State University

Advisor information- Tracy Boyer, Associate Professor, Agricultural Economics, Oklahoma State University

Introduction

Participant Information

Project Title: Certification and Licensing Method Preferences of Sod Grass Producers
Investigators: Dr. Tracy Boyer, Benjamin Tong, and Deshamithra Jayasekera Oklahoma State University

Purpose: This study is aimed at identifying preferences of sod producers' given various characteristics of Turfgrass /Sod for current and future turfgrass improvement efforts. The responses will be used to inform researchers in the USDA-SCRI funded turfgrass research project.

Procedure: Proceeding with survey questions will imply your consent to participate in this study. Section I includes general questions about your business/facility and demographics (for example, employment, location of facility, gender, age, education, etc.), and Section II has different scenario questions seeking your preferences of turf characteristics and license terms.

Risks of Participation: The risks associated with this study are *minimal*. The risks are not greater than those ordinarily encountered in daily life. Moreover, you may skip any survey items that you perceive as threatening or discomforting; you may also stop at any time.

Benefits: This research will aid in the understanding and prioritizing turfgrass improvement research to meet sod producers' needs and preferences.

Compensation: You will be eligible to enter into a drawing for one of three $50 prizes when you complete this survey. If you wish to enter into our drawing, in which you have a 3/500 chance of winning $50, you will be asked at the end of completion to email a separate email address. Your email cannot be traced to your individual responses in this survey.

Confidentiality: The researchers will not access your name, email or your IP address. Once the data is collected from your responses, it will be downloaded to a secure Oklahoma State University server. At no point will a data file be constructed in which your name or any other identification information is linked to your responses. In addition, access to this data will only be given to the researchers working for this project. The data will only be reported in aggregate. Potential publishable reports/papers will only have summary statistics of the aggregate data and any analysis output; neither can be traced back to the individual respondent.

Contacts: If you have any questions or concerns about this project, please contact Dr. Tracy Boyer, 405-744-6169, tracy.boyer@okstate.edu. If you have any questions about your rights as a research volunteer, you may contact the Oklahoma State University Institutional Review Board (IRB) Chair, Dr. Hugh Crethar, 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu.

Participant Rights: Your participation in this research is *voluntary*. You can discontinue the survey at any time without reprisal or penalty.

Informed Consent: Please Indicate that you are 18 years and above, you are aware that your answers will remain anonymous and your participation in this survey is completely voluntary.

Yes

No

Section I: Facility/Business and Demographics

Please answer the following questions pertaining to your business/facility which you own or in which you are employed.

The survey of sod producers of their preferences for turfgrass sod cultivars' licensing requirements and royalty fee structures was administered via Qualtrics.com

Introduction

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Project Title: Certification and Licensing Method Preferences of Sod Grass Producers
Investigators: Dr. Tracy Boyer, Benjamin Tong, and Deshamithra Jayasekera at Oklahoma State University

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- ○ Yes
- ○ No

Section I: Facility/Business and Demographics

Please answer the following questions pertaining to your business/facility which you own or in which you are employed.

How many years has your company been in the sod production business?

Zip code of primary production operation

How many acres of sod did you have in **PRODUCTION** in 2014?

Are you currently growing or have you ever grown propriety varieties (Example - Covered by utility, Plant patent or plant variety protection certificate) of sod?

- ○ Yes, I currently grow proprietary varieties
- ○ I have grown proprietary varieties in the past, but not now
- ○ I have never grown proprietary varieties

Do you grow or have grown varieties in Certified pedigree stock production (Example - includes inspection by an independent agency to assure that the production field of material is genetically true to type)?

- ○ Yes, I currently grow varieties in Certification
- ○ I have grown varieties in Certification in the past, but not now
- ○ I have never grown varieties in Certification

What percentage of your total production is for each of these major grass types (enter percentage for those that apply?(Answers must sum to 100%).

Bermuda	0
Buffalo	0
Centipede	0
Creeping Bentgrass	0
Seashore Paspalum	0
St. Augustine	0
Tall Fescue	0

Zoysia	0
Other	0
Total	0

What is the average price($)/sq. ft. to landscaper (FOB at farm/farm gate price) for each of these major grass types?

- ☐ Bermuda
- ☐ Buffalo
- ☐ Centipede
- ☐ Creeping Bentgrass
- ☐ Seashore Paspalum
- ☐ St. Agustine
- ☐ Tall Fescue
- ☐ Zoysia
- ☐ Other

How many people work for you in a **TURF-RELATED CAPACITY** in each of the following categories?

- ☐ Full Time
- ☐ Part Time
- ☐ Seasonal

Rank the importance of the items with 1 as most important and 7 as least important (Like a football team) to your production of sod. You may **drag and drop them** in order with the touch screen or the mouse.

- Fertilizer
- Pest control
- Weed control
- Water
- Mowing
- Improving production cycle
- License fee

To whom do you sell your sod? (Please specify percentages for those that apply. Answers must sum to 100%.)

Farm-to-farm	0
Broker (calls & arranges sales)	0
Re-wholesaler (takes delivery/redistributes)	0
Commercial or residential developers	0
Independent retail garden centers	0
Big box store garden centers	0
Landscape services (installation/maintenence)	0
Golf courses and/or sports/athletic fields	0
Homeowners	0
Total	0

Did your broker purchase any sod from another producer for resale in 2014?

- ○ Yes
- ○ No

If yes please indicate quantity and price

- ☐ Quantity (sq.ft)
- ☐ Price ($) (total price)

What percent of your total market is located in each of the following distances from your operation? (Answers must sum to 100%.)

Within 50 miles (%)	0
50-100 miles (%)	0
Over 100 miles (%)	0
Total	0

Rate each of the following factors impacting your business, using a scale of 1 to 4 scale, with 1=not important; 2=minor important; 3=important; and 4=very important (check in appropriate column).

	(1) Not Important	(2) Minor Important	(3) Important	(4) Very Important
Weather uncertainity	○	○	○	○
Land	○	○	○	○
Market demand	○	○	○	○
Labor	○	○	○	○
Water supply	○	○	○	○
Debt capital	○	○	○	○
Equity capital	○	○	○	○
Own managerial expertise	○	○	○	○
Competition / price undercutting	○	○	○	○
Environmental regulations	○	○	○	○

Please rank the 3 most serious problems facing your individual business. (Mark only 1 per column.)

	Most Serious	Second Most Serious	Third Most Serious
Financial pressures (e.g. fuel costs, insurance costs, labor costs, taxes, etc.)	○	○	○
Labor issues (e.g. deficient production skills, inability to hire enough workers, etc.)	○	○	○
Market-related pressure (e.g. distribution/delivery problems, fly-by-night competition, consumer knowledge/awareness, etc.)	○	○	○
Production-related (e.g. weeds, mole crickets/insects, weather, maintenance of sod in field, etc.)	○	○	○
Regulatory/Environmental (e.g. loss of methyl bromide, water restrictions on producers/consumers, dealing with government agencies, etc.)	○	○	○

Which category best describes your total Turf sales in 2014? (Choose your appropriate range)

- ○ Less than $100,000; please specify the amount (rounded to the nearest thousand).
- ○ $100,000 – $249,999
- ○ $250,000 – $499,999
- ○ $500,000 – $999,999
- ○ $1,000,000 – $1,999,999
- ○ $2,000,000 – $3,999,999
- ○ $4,000,000 – $5,999,999
- ○ $6,000,000 – $7,999,999
- ○ $8,000,000 – $9,999,999
- ○ $10,000,000 or more; please specify the amount (rounded to the nearest million).

Do you consider or think it is important to consider any of the following attributes of sod grass when you are making a purchase?

- ☐ Winter kill reduction
- ☐ Shade Tolerence
- ☐ Salinity Tolerence
- ☐ Drought tolerence

Block 4

Section II: Choice Experiment

We are now going to ask you six **DIFFERENT** questions about your preference for burmuda or zoysia turf characteristics. Each questions is going to ask you to choose 1 of 3 options for sod/turf grass purchase per square foot. Turf attributes vary for option A and B, you can also choose option C, no purchase.

Some definitions of terms used in the survey are given below for clarification

Genetically modified - refers to a variety of turf grass into which a gene from some other plant species has been introduced to achieve desired characteristics

Traditional hybrid – a variety of turf grass that exists as a result of a cross between different genotypes of turf to achieve desired characteristics

Certification/Inspection by State - certification and inspection of sod fields to ensure that they meet published standards and can be marketed as certified seed/sod/sprigs by a state authority

Certification/Inspection by sod license holder per contract - certification and inspection by sod license holder per licensing agreement, but not through a government agency

10% maintenance reduction – 10% reduction in irrigation, mowing, or chemical or fertilizer application

Block 2

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	None	None	
License fee and royalty fee structure	No minimum annual fee, pay percentage on units sold	Annual fee plus percentage fee based on unit sales	
10% maintenance reduction	No	Yes	
Farm gate price per square foot	0.55	0.55	

	Option A	Option B	Option C
I would choose	○	○	○

Click to write the question text

- ○ Click to write Choice 1
- ○ Click to write Choice 2
- ○ Click to write Choice 3

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C

Breed/Variety	Traditional hybrid	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	None	Yes, by sod license holder per contract	
License fee and royalty fee structure	No minimum annual fee, pay percentage on units sold	Annual flat rate payment with unlimited units sales	
10% maintenance reduction	Yes	No	
Farm gate price per square foot	0.35	0.15	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	None	Yes, by sod license holder per contract	
License fee and royalty fee structure	Annual fee plus percentage fee based on unit sales	Annual flat rate payment with unlimited units sales	
10% maintenance reduction	No	Yes	

maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	None	None	
License fee and royalty fee structure	Annual flat rate payment with unlimited unit sales	No minimum annual fee, pay percentage on units sold	
10% maintenance reduction	No	Yes	
Farm gate price per square foot	0.15	0.15	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Genetically modified	If A and B are the only
Certification/Inspection	None	Yes, by state	
		Annual minimum fee plus	

Farm gate price per square foot	0.25	0.35	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	None	Yes, by state	
License fee and royalty fee structure	Annual fee plus percentage fee based on unit sales	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	
10% maintenance reduction	Yes	Yes	
Farm gate price per square foot	0.45	0.55	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers'

License fee and royalty fee structure	Annual flat rate payment with unlimited unit sales	percentage on unit sales, but a minimum sales payment must be paid	options, I would NOT produce a new sod variety
10% maintenance reduction	Yes	No	
Farm gate price per square foot	0.25	0.35	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by sod license holder per contract	Yes, by state	
License fee and royalty fee structure	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	Annual fee plus percentage fee based on unit sales	
10% maintenance reduction	Yes	Yes	
Farm gate price per square foot	0.25	0.15	

	Option A	Option B	Option C

I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

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Breed/Variety	Traditional hybrid	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by sod license holder per contract	Yes, by State	
License fee and royalty fee structure	No minimum annual fee, pay percentage on units sold	Annual flat rate payment with unlimited unit sales	
10% maintenance reduction	Yes	Yes	
Farm gate price per square foot	0.55	0.25	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Traditional hybrid	
10% maintenance reduction	Yes	No	
Farm gate price per square foot	0.15	0.45	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

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Breed/Variety	Traditional hybrid	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by sod license holder per contract	Yes, by sod license holder per contract	
License fee and royalty fee structure	Annual flat rate payment with unlimited unit sales	Annual fee plus percentage fee based on unit sales	
10% maintenance reduction	No	No	
Farm gate price per square foot	0.45	0.25	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers'

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Certification/Inspection	Yes, by sod license holder per contract	Yes, by state	
License fee and royalty fee structure	Annual fee plus percentage fee based on unit sales	No minimum annual fee, pay percentage on units sold	
10% maintenance reduction	No	No	
Farm gate price per square foot	0.35	0.55	

	Option A	Option B	Option C
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Breed/Variety	Traditional hybrid	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by sod license holder per contract	None	
License fee and royalty fee structure	Annual fee, plus percentage fee based on unit sales	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	

maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by state	None	
License fee and royalty fee structure	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	
10% maintenance reduction	No	Yes	
Farm gate price per square foot	0.35	0.25	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Traditional hybrid	
		Yes, by sod license holder per	

Certification/Inspection	Yes, by state	contract	If A and B are the only options, I would NOT produce a new sod variety
License fee and royalty fee structure	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	Annual fee plus percentage fee based on unit sales	
10% maintenance reduction	No	No	
Farm gate price per square foot	0.15	0.55	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

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Breed/Variety	Traditional hybrid	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by state	Yes, by sod license holder per contract	
License fee and royalty fee structure	No minimum annual fee, pay percentage on units sold	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	

10% maintenance reduction	No	Yes	
Farm gate price per square foot	0.25	0.45	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

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License fee and royalty fee structure	No minimum annual fee, pay percentage on units sold	No minimum annual fee, pay percentage on units sold	
10% maintenance reduction	Yes	No	
Farm gate price per square foot	0.15	0.35	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

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Breed/Variety	Traditional hybrid	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by state	None	
License fee and royalty fee structure	Annual fee, plus percentage fee based on unit sales	Annual fee plus percentage fee based on unit sales	
10% maintenance reduction	Yes	No	
Farm gate price per square foot	0.55	0.35	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Traditional hybrid	Genetically modified	If A and B are the only options, I would NOT
Certification/Inspection	Yes, by state	Yes, by sod license holder per contract	
License fee and royalty fee	Annual flat rate payment with	No minimum annual fee, pay	

structure	unlimited unit sales	percentage on units sold	produce a new sod variety
10% maintenance reduction	Yes	Yes	
Farm gate price per square foot	0.45	0.45	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

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Breed/Variety	Genetically modified	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	None	Yes, by state	
License fee and royalty fee structure	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	Annual flat rate payment with unlimited unit sales	
10% maintenance reduction	No	No	
Farm gate price per square foot	0.55	0.45	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	None	Yes, by sod license holder per contract	
License fee and royalty fee structure	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	No minimum annual fee, pay percentage on units sold	
10% maintenance reduction	Yes	No	
Farm gate price per square foot	0.25	0.25	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Genetically modified	
Certification/Inspection	None	Yes, by sod license holder per contract	If A and B are the only options, I would NOT produce a new sod variety
License fee and royalty fee structure	No minimum annual fee, pay percentage on units sold	Annual fee plus percentage fee based on unit sales	
10% maintenance reduction	No	Yes	
Farm gate price per square foot	0.35	0.35	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	None	None	
License fee and royalty fee structure	Annual fee plus percentage fee based on unit sales	Annual fee plus percentage fee based on unit sales	
10% maintenance reduction	Yes	No	
Farm gate price per square foot	0.45	0.25	

	Option A	Option B	Option C
Breed/Variety	Genetically modified	Genetically modified	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by sod license holder per contract	None	
License fee and royalty fee structure	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	Annual flat rate payment with unlimited unit sales	
10% maintenance reduction	Yes	Yes	
Farm gate price per square foot	0.45	0.35	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by sod license holder per contract	None	
License fee and royalty fee structure	No minimum annual fee, pay percentage on units sold	No minimum annual fee, pay percentage on units sold	
10% maintenance reduction	No	No	
Farm gate price per square foot	0.25	0.45	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Genetically modified	If A and B are the only options, I would NOT
Certification/Inspection	Yes, by sod license holder per contract	Yes, by sod license holder per contract	
License fee and royalty fee	No minimum annual fee, pay	Annual minimum fee plus percentage on unit sales, but a	

structure	percentage on units sold	minimum sales payment must be paid	produce a new sod variety
10% maintenance reduction	Yes	Yes	
Farm gate price per square foot	0.15	0.55	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

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Certification/Inspection	Yes, by sod license holder per contract	Yes, by sod license holder per contract	
License fee and royalty fee structure	Annual flat rate payment with unlimited unit sales	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	
10% maintenance reduction	No	No	
Farm gate price per square foot	0.55	0.35	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by state	Yes, by state	
License fee and royalty fee structure	Annual fee plus percentage fee based on unit sales	Annual flat rate payment with unlimited unit sales	
10% maintenance reduction	No	Yes	
Farm gate price per square foot	0.15	0.25	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by state	Yes, by sod license holder per contract	
License fee and royalty fee structure	Annual fee plus percentage fee based on unit sales	No minimum annual fee, pay percentage on units sold	
10% maintenance reduction	Yes	Yes	

I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by state	Yes, by state	
License fee and royalty fee structure	No minimum annual fee, pay percentage on units sold	Annual minimum fee plus percentage on unit sales, but a minimum sales payment must be paid	
10% maintenance reduction	No	No	
Farm gate price per square foot	0.45	0.15	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Farm gate price per square foot	0.55	0.15	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Traditional hybrid	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by state	Yes, by state	
License fee and royalty fee structure	Annual flat rate payment with unlimited unit sales	Annual fee plus percentage fee based on unit sales	
10% maintenance reduction	Yes	Yes	
Farm gate price per square foot	0.35	0.45	

	Option A	Option B	Option C
I would choose	○	○	○

Options A and B represent two different sets of sod/turf Bermuda or Zoysia marketing characteristics and reductions in buyers' maintenance such as weed control, mowing, and fertilizer. Which option out of A, B or C would you be most likely to produce?

Attribute	Option A	Option B	Option C
Breed/Variety	Genetically modified	Genetically modified	If A and B are the only options, I would NOT produce a new sod variety
Certification/Inspection	Yes, by state	None	
License fee and royalty fee structure	Annual flat rate payment with unlimited unit sales	Annual flat rate payment with unlimited unit sales	
10% maintenance reduction	Yes	No	
Farm gate price per square foot	0.25	0.55	

	Option A	Option B	Option C
I would choose	○	○	○

Block 5

Please answer the following questions pertaining to your demographic information.Please remember this survey is confidential and none of you answers will be revealed as an individual.

What is your highest level of education?

- ○ <12th grade
- ○ H.S. diploma
- ○ Some college
- ○ B.S./B.A. or higher graduate

Do you have an associate's/bachelor's degree in any of the following (please select all that apply)?

- ○ Turfgrass management
- ○ Horticulture
- ○ Landscape architecture
- ○ Plant and soil science
- ○ Other (Please specify) _____

What is your gender?

- ○ Male
- ○ Female

What is your age in years?

_____

Which category best describes your race?

- ○ White
- ○ Black/African American
- ○ Native American
- ○ Asian
- ○ Other _____

Block 3

Thank you for participating in this survey!
If you have further questions about the survey please email Dr.Tracy Boyer, Associate Professor, Agricultural Economics, Oklahoma State University at tracy.boyer@okstate.edu or by phone: 405-744-6169.

Please email <turfgrass.survey@gmail.com> your contact information if you wish to enter into the draw of $50. Your survey responses will not in any way be linked to your email address provided for the purpose of the raffle draw.

Powered by Qualtrics

The report submitted to the City of Oklahoma City and the survey of commercial businesses' willingness to participate in irrigation water conservation in Oklahoma City, Oklahoma

This report was submitted on February 2016 to the City of Oklahoma City along with a power point presentation of the findings.

Oklahoma City Commercial Business Water Conservation Study

February 15, 2016

Prepared for the Oklahoma City Water Utilities

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1 Introduction

Recent drought stress in Oklahoma contributed to the Oklahoma City Utilities Department's water resource pricing changes, and efforts to educate its residents about water scarcity and the importance of conservation. These efforts mainly targeted municipal households. This study seeks to understand Oklahoma City (OKC) businesses' willingness to participate in outdoor water conservation efforts given potential water savings from the adoption of smart meters, soil moisture sensors, and/or irrigation assessments.

The goal of this project is to determine Oklahoma City metro area businesses' willingness to participate in outdoor water conservation programs. In doing so we have two specific objectives that we attempted to achieve:

- To assess Oklahoma City businesses' interest for smart irrigation technologies (soil moisture sensors and smart irrigation controllers)
- To determine Oklahoma City businesses' willingness to participate in landscape irrigation assessments

2 Methodology

A survey instrument was used to obtain commercial water customers' characteristics and willingness to adopt outdoor irrigation conservation technologies/assessment. Three willingness to adopt questions were posed for smart irrigation controllers, soil moisture sensors, and irrigation audits. These individual questions had randomly assigned 'bids' that represented the range of water savings that were possible for each device at current OKC commercial irrigation rates. Each customer was asked if his or her business would adopt that technology given the savings for each technology or audit. Using those audits, the willingness to adopt at current prices was obtained (See Appendix I for an example survey).

Data Collection

The data and business address file provided by OKC Utilities department contained 27,706 addresses, of which only 3,730 contained complete information.

- 2,000 businesses out of the 3,730 viable addressed were randomly sampled. Two thirds of these addresses received the OKC water conservation potential assessment survey and information on how future water rate changes would take place. The remaining one third

of the respondents were treated as a control group because they received the same survey but did not receive additional information on how rates would change in the future. This stage of the survey was completed and mailed on September 18th, 2015.

- Due to a low response rate, an additional one thousand surveys were sent to a second randomly drawn sample using the same treatment methodology on October 12th, 2015.
- We sent a reminder postcard to each of the businesses that had not responded to the survey approximately two weeks after the initial mailing of the surveys. The postcard also included an online link as an alternative method of completing the survey.
- According to standard survey practice to maximize response rates (Dilman 1978), follow-up postcards and replacement surveys were sent within 2 and 4 weeks of non-response.
- The total number of viable addresses totaled 2,784. The total response rate for the surveys was about 13.7% with 381 completed responses.

3 Summary Statistics and Survey Results

3.1 Section I: Commercial Business Characteristics

Number of years in business

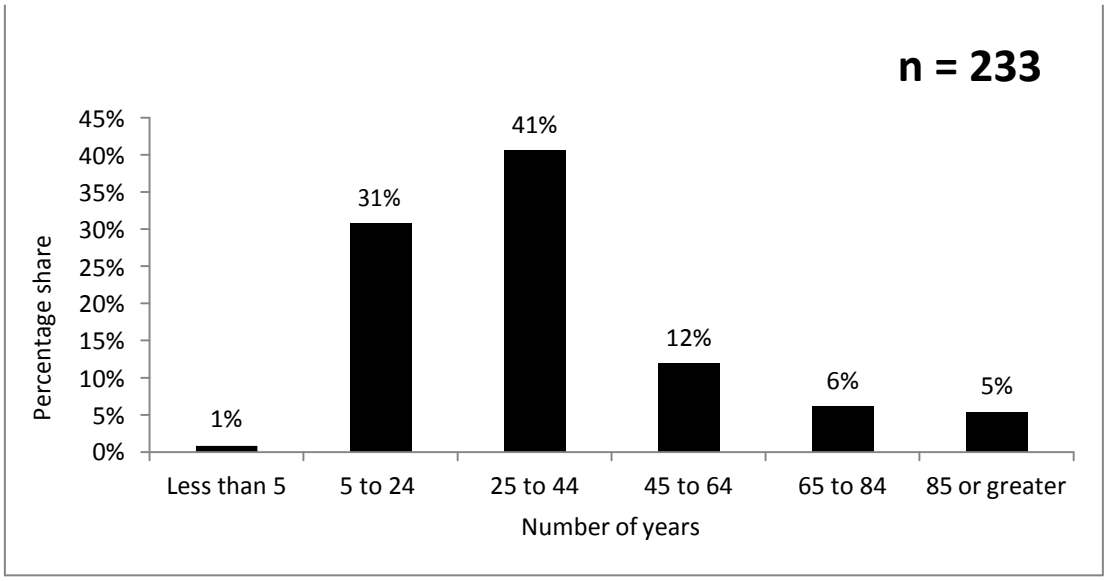


Figure 1: Number of years in business. Source: Question number 3

- On average a responded firm has been in business for about 36 years with a standard deviation of 24 years.
- More than 40% of all firms have been in business for 25 to 44 years.
- 5% were in business for more than 85 years.
- Maturity of the business in an indicator of how responsive businesses are to physical changes in operations and behavioral changes in personnel.

Number of years at the current address

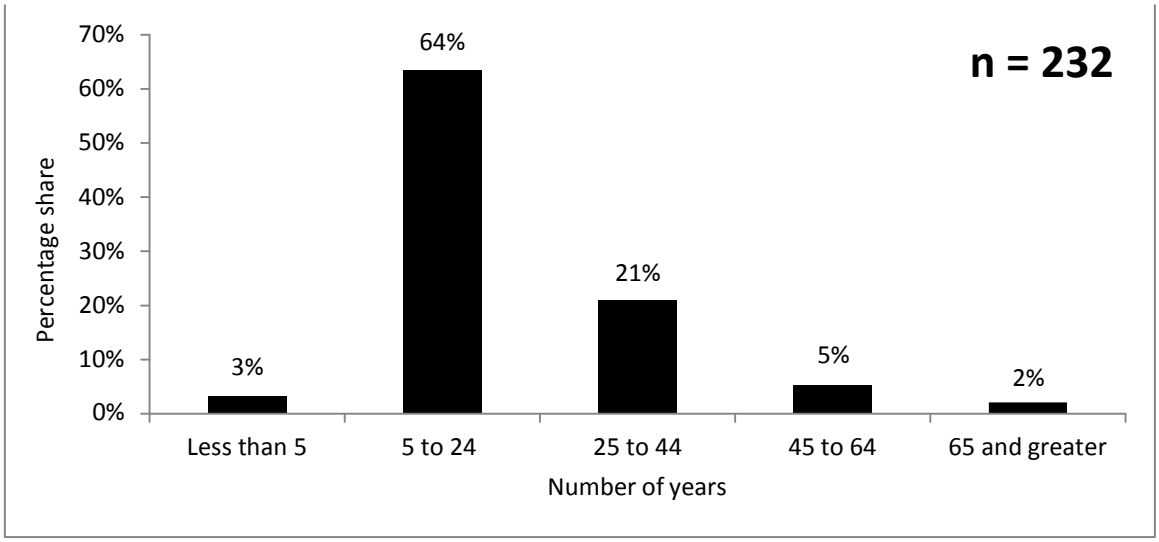


Figure 2: Number of years at the current address. Source: Question number 4

- On average the businesses have been in OKC for 21 years with a standard deviation of 16 years.
- More than half of all businesses that responded to the survey have been in the OKC metro area for 5 to 24 years.
- Therefore, most businesses could have experienced the periodic droughts that OKC suffered in recent years.

Business or institutional status

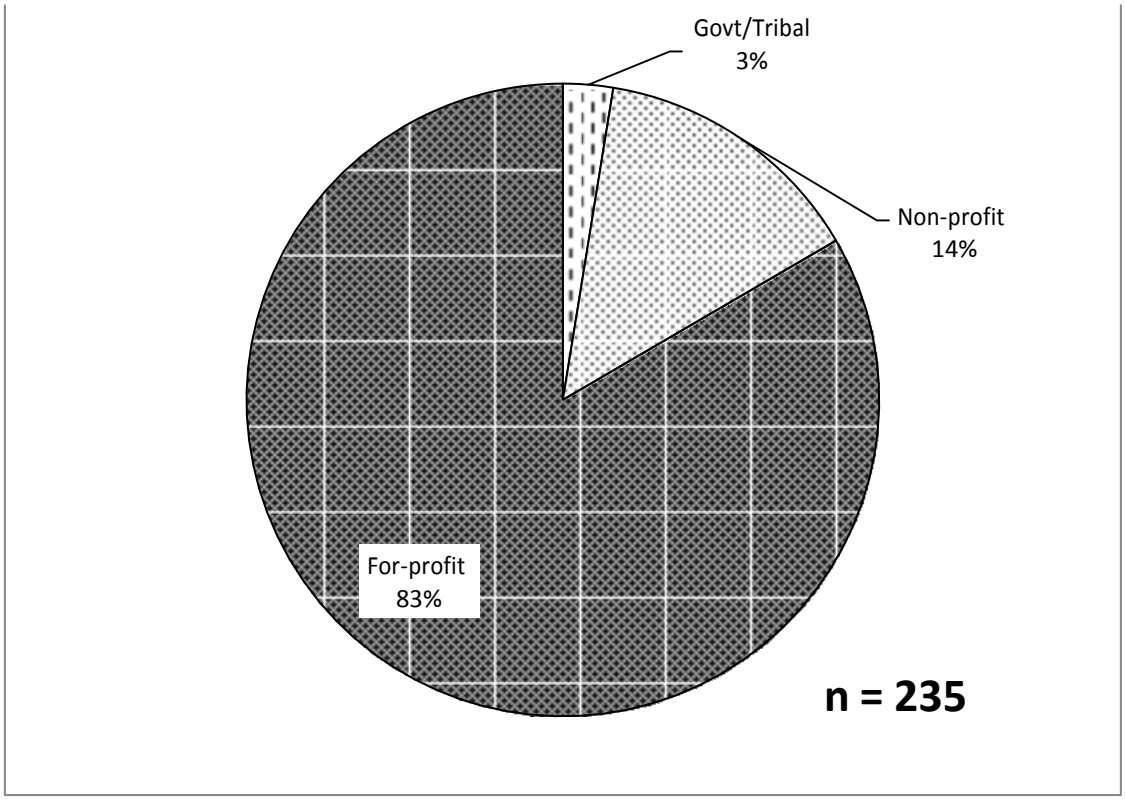


Figure 3: Business or institutional status. Source: Question number 5

- Most businesses were for-profit firms. This could indicate that there is potential for OKC Utilities to influence their water consumption behavior.
- Non-profit sector mainly involved religious institutions, healthcare, and educational establishments.

Breakdown of businesses by sector

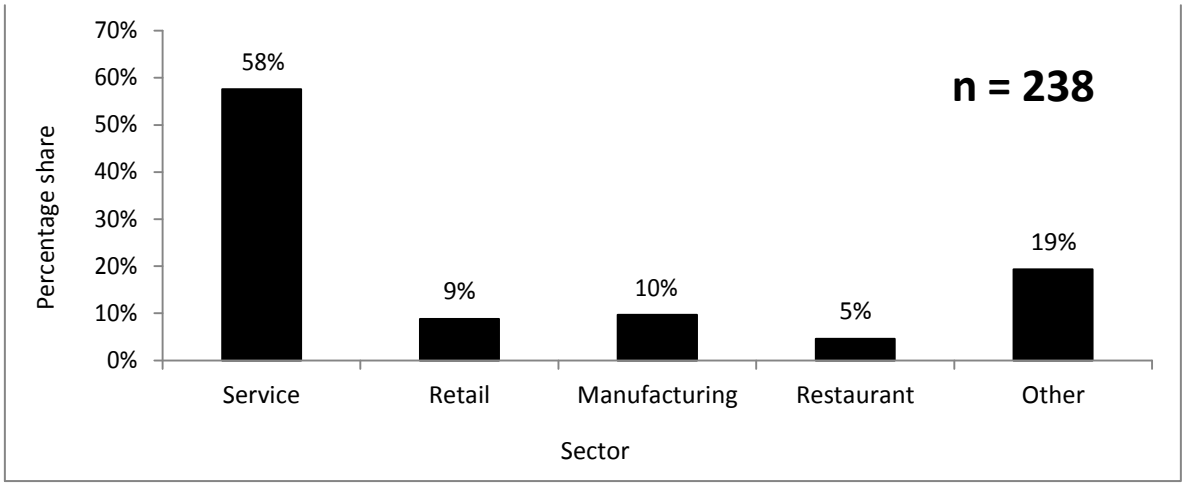


Figure 4: Sectoral divide of the responded businesses. Source: Question number 6

- 58% of businesses that responded to the survey were in the services sector.
- "Other" mainly included religious institutions.

Breakdown of businesses by industry category

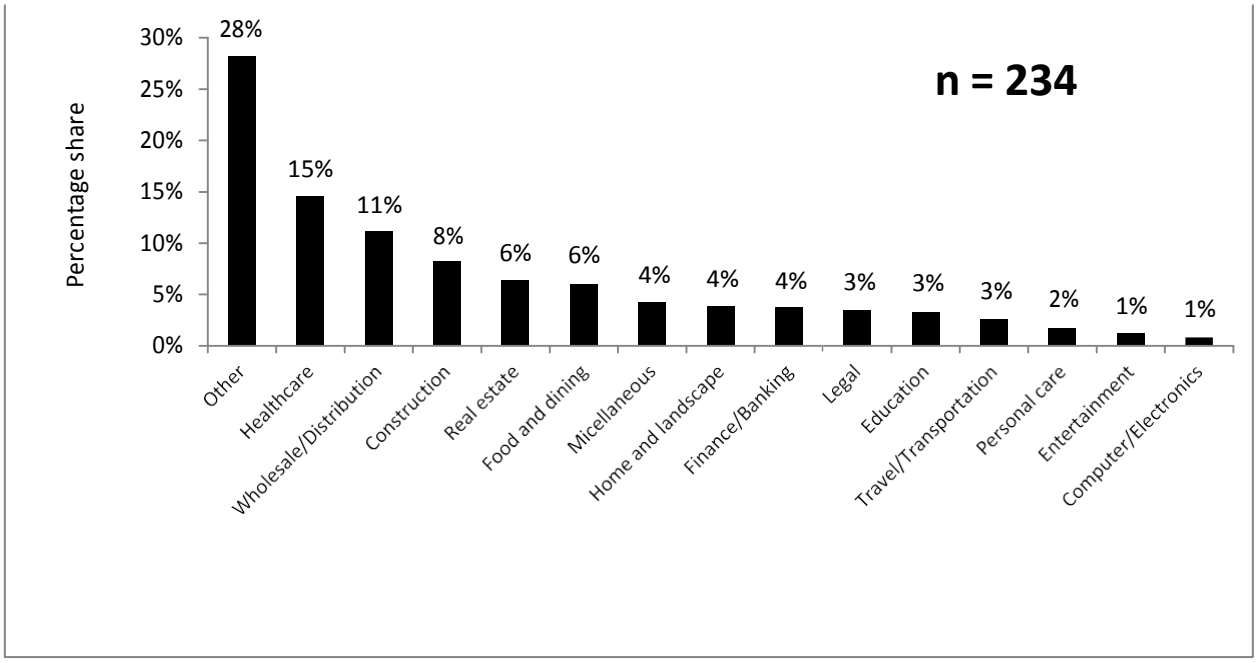


Figure 5: Industry divide of the respondents. Source: Question number 7

- Highest identified industry category of respondents was “Healthcare”.

Number of employees in the firm

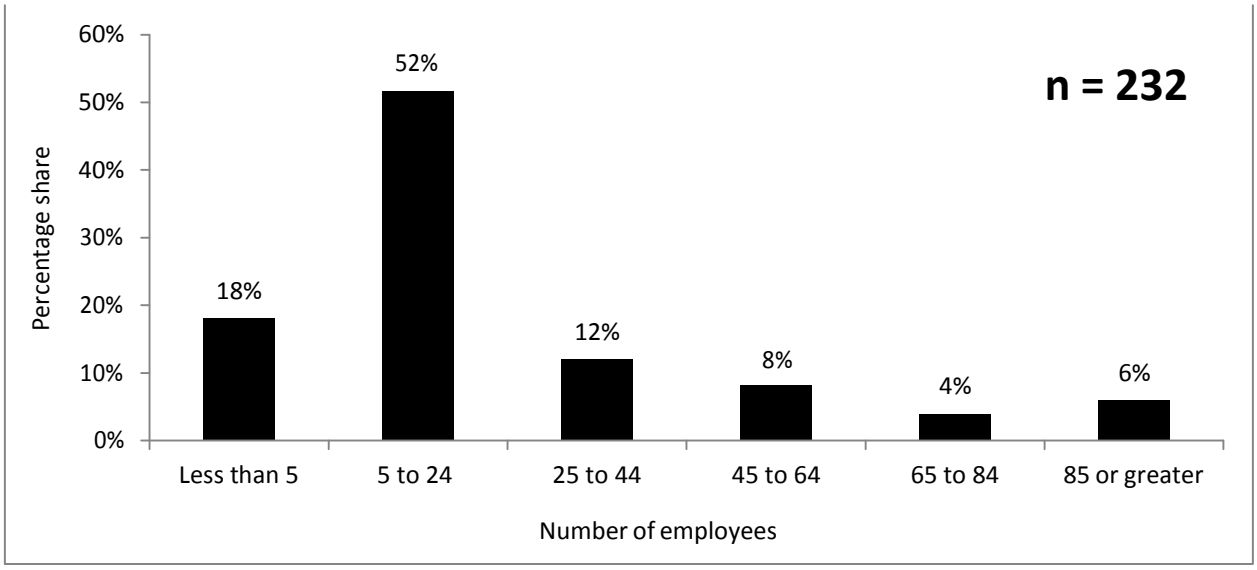


Figure 6: Number of employees employed. Source: Question number 8

- The number of employees includes the respondent as well.
- The average number of employees per business was 40 persons.
- 52% of businesses that responded to the survey had 5 to 24 employees.
- 18% of businesses had less than 5 employees, suggesting that they are small-scale businesses.

Annual revenue of the firm

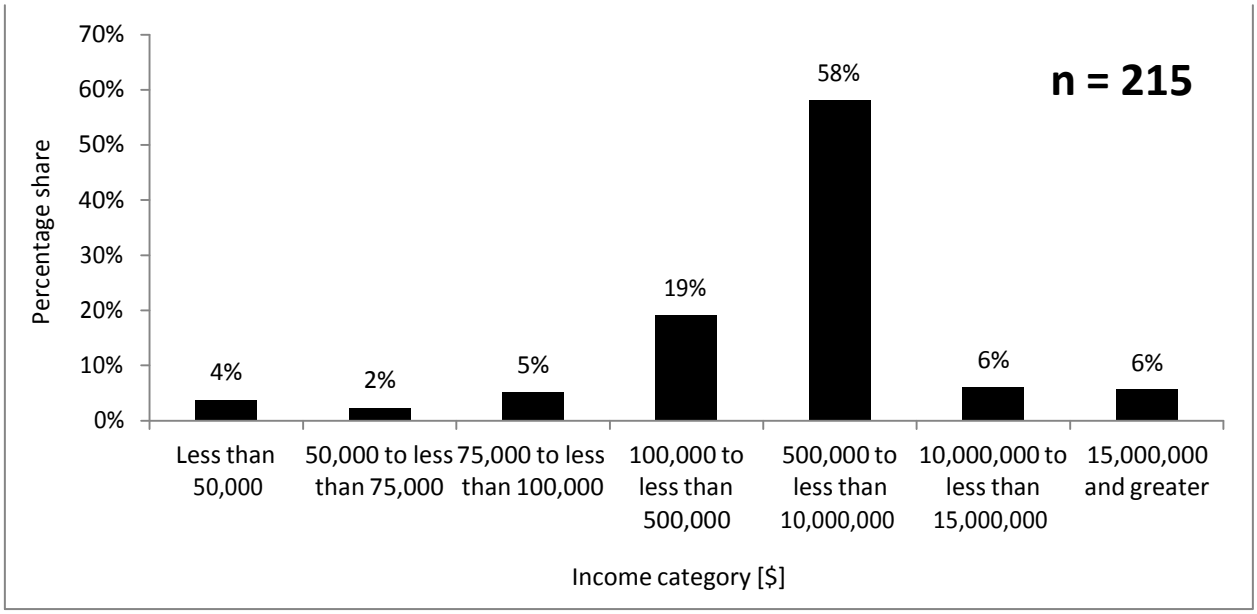


Figure 7: Percentage share of respondents in each revenue category. Source: Question number 9

- 58% of all the businesses that responded to the survey recorded their annual revenue was between $500 thousand to $10 million.
- 6% of the businesses had annual revenues over $15 million.

Area of landscaping owned and/or maintained by the business

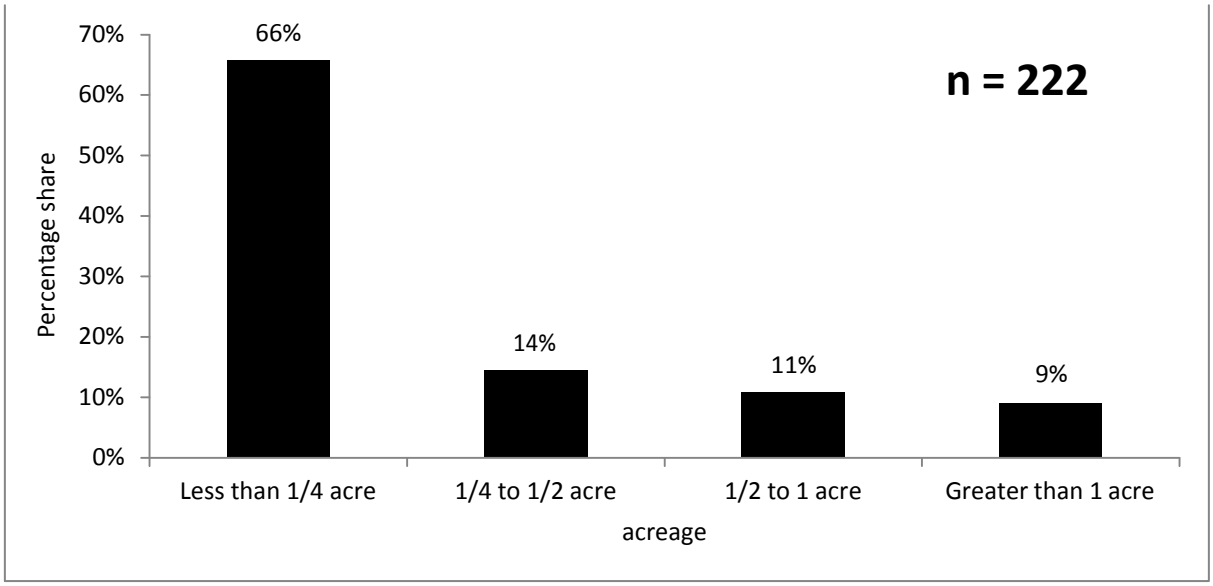


Figure 8: Landscape acreage maintained by commercial businesses. Source: Question number 14

- 66% owned or maintained less than ¼ acre of landscaping each.
- Only 9% had more than one acre of land with landscaping. This is an indication as to how much irrigation businesses need.
- Greater irrigation needs indicate higher water utilities costs, thereby making potential irrigation water conservation methods attractive for businesses with larger landscaped areas.

3.2 Section II: Survey Respondent Characteristics[1]

Variable		Mean	S. Deviation	Sample size
Age		54.32 years	11.85 years	223
Gender				222
	Male	63.96 %		
	Female	36.04 %		
Educational Attainment				223
	Some High School	0.00 %		
	High School Diploma	05.83 %		
	Some College	24.22 %		
	College Degree	43.05 %		
	Some Graduate	04.48 %		
	Graduate Degree	22.42 %		
Decision Maker for the Firm				220
	Yes	86.36 %		
	No	13.64 %		

- The average age of the respondent was 54.32 years, with a standard deviation of 11.85 years.
- 64% of all respondents were male.
- 86% of all respondents were in charge of making landscaping and irrigation decisions for the company.
- The sample that responded to the survey is relatively educated, such that 43% of all respondents had a college degree. 24.22% of all respondents had some college education, and 22.42% of respondents had graduate educational qualifications.
- We expect education to be positively correlated with adoption decisions.

[1] Although, the survey is geared towards understanding firm level conservation behavior, the commercial businesses' attitude towards conservation depends heavily on the demographics and attitudes of the decision maker for the business' landscaping and irrigation. In the instructions,

we requested that decision makers of the businesses' landscaping complete the survey.

3.3 Section III: Potential for Water Conservation

Primary source of irrigation water supply

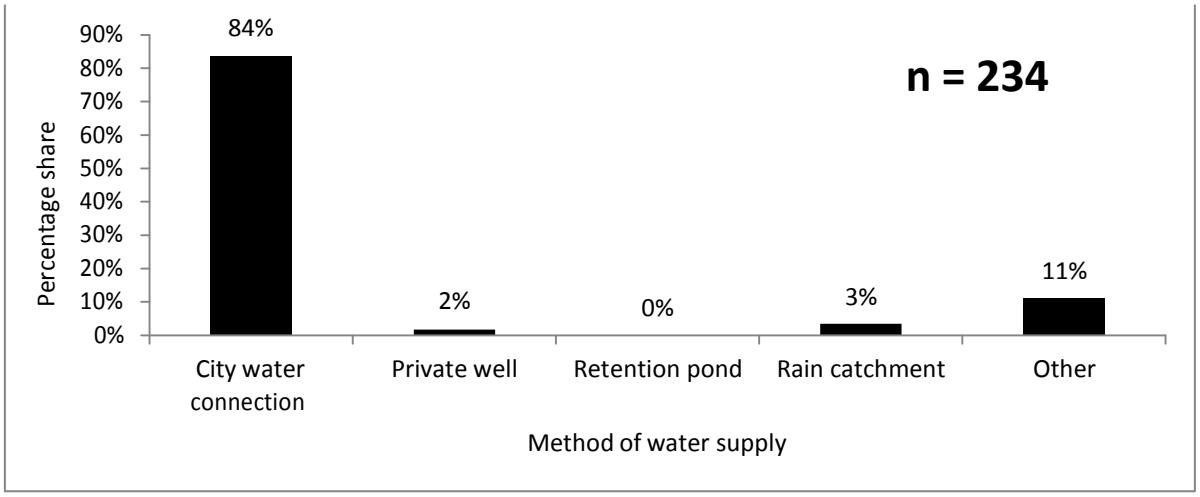


Figure 9: Primary source of irrigation water supply for the businesses. Source: Question number 12

- 84% of businesses had a city water connection.
- This may indicates the potential for managing water demand by OKC Utilities.

Most important landscape attribute for the business

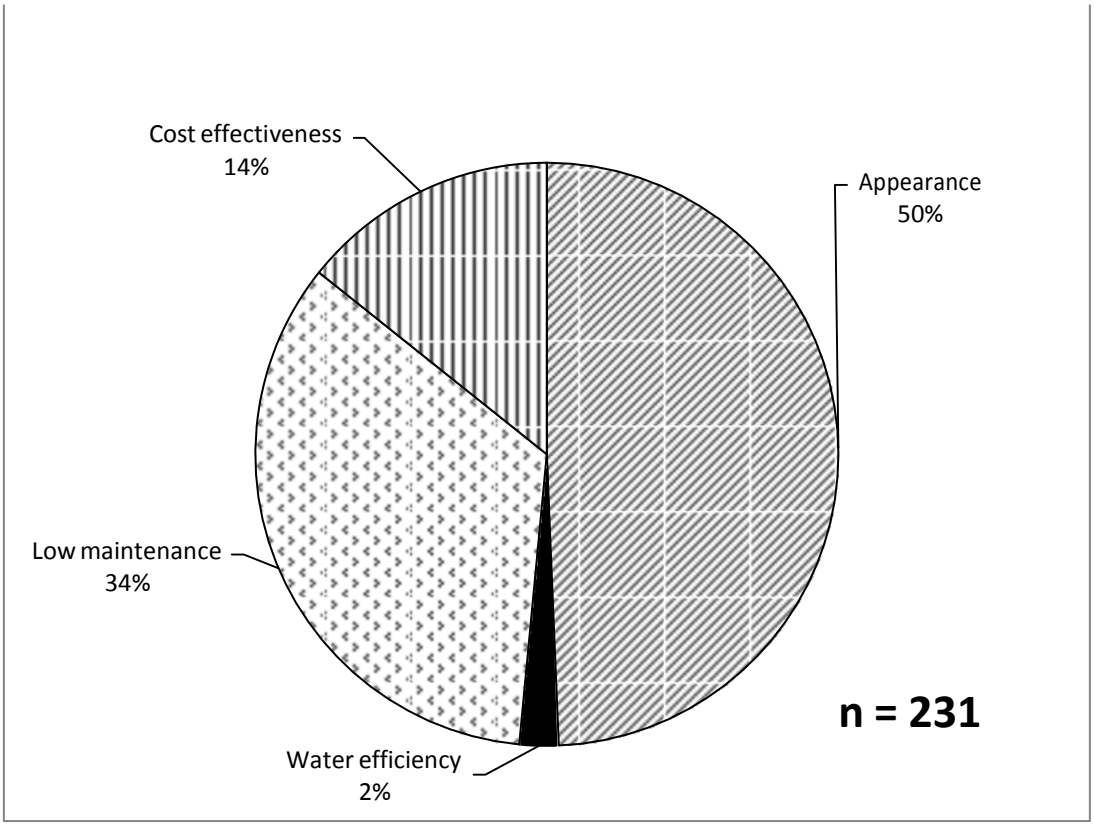


Figure 10: Most important landscape attribute for the company. Source: Question number 10

- Appearance of the landscape was the most important aspect with a 50% share.
- Only 2% said that water efficiency of the landscape was important for their landscaping.

Least important landscape attribute for the business

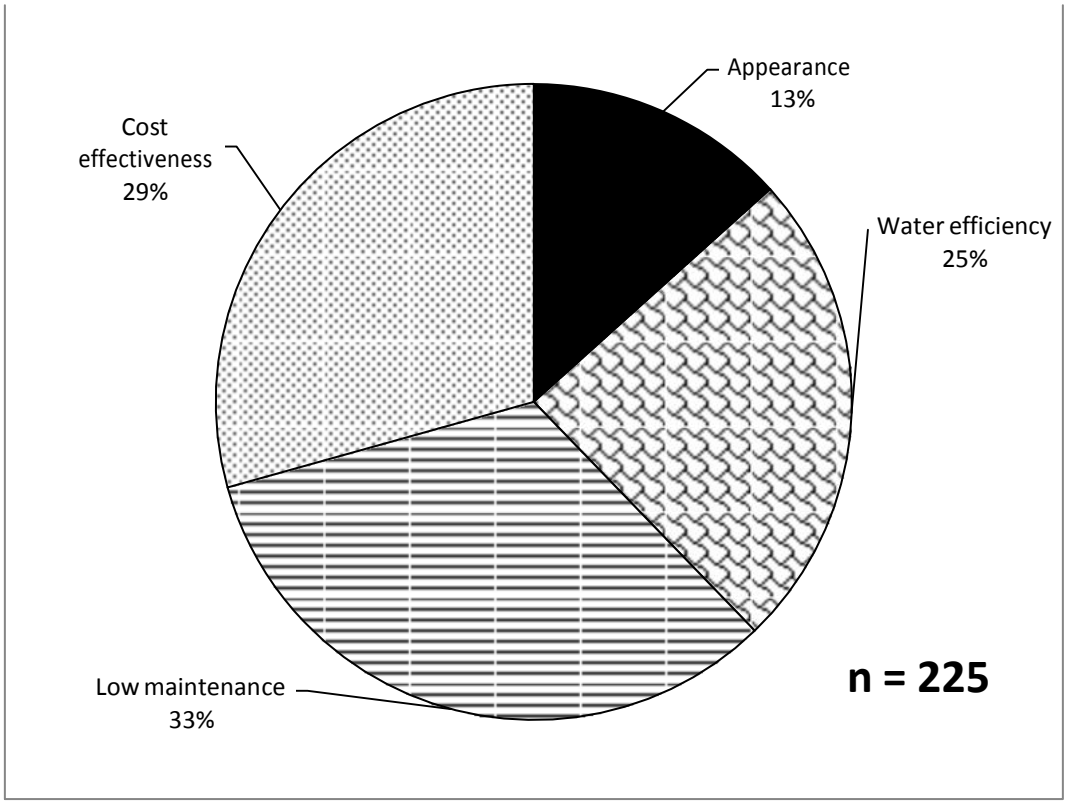


Figure 11: Least important landscape attribute for the company. Source: Question number 11

- The least important attributes were almost equally distributed among the choices.
- 25% of the businesses said that water efficiency of their landscaping is the least important attribute.

Self-identified watering issues at the commercial business

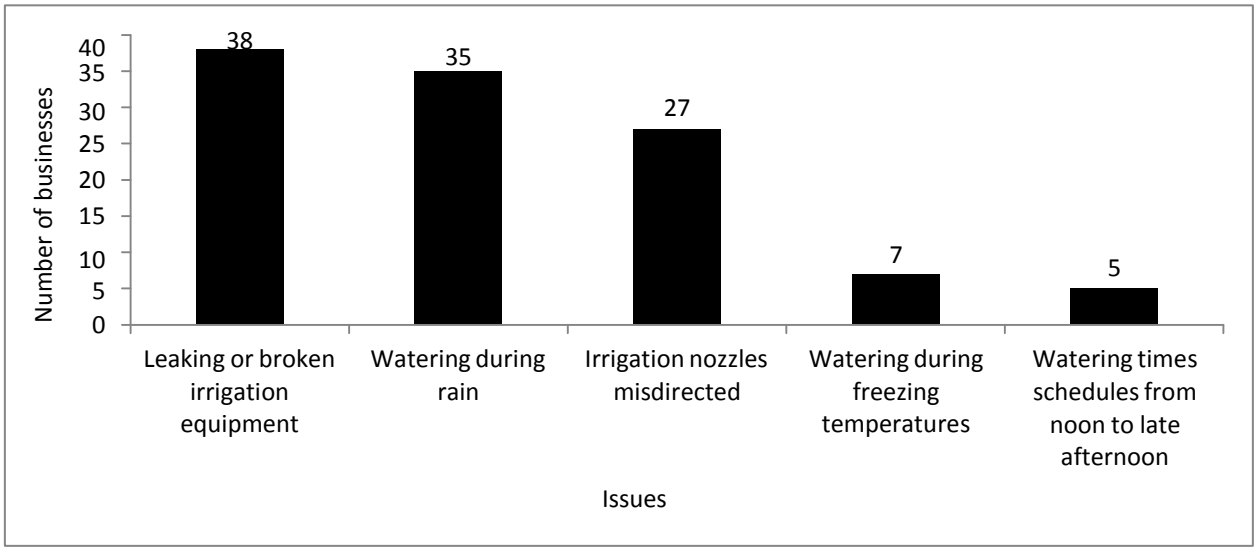


Figure 12: Watering issues at the commercial business. Source: Question number 13

- The bars in the graph indicate counts – the number of businesses that indicated an irrigation system failure. Each business could check more than one issue they self-identified.
- Only about 15% of the businesses identified that they had at least one of the above mentioned watering issues.
- Most common concern was broken or leaking irrigation equipment.

Business that have already taken action to conserve water on–site

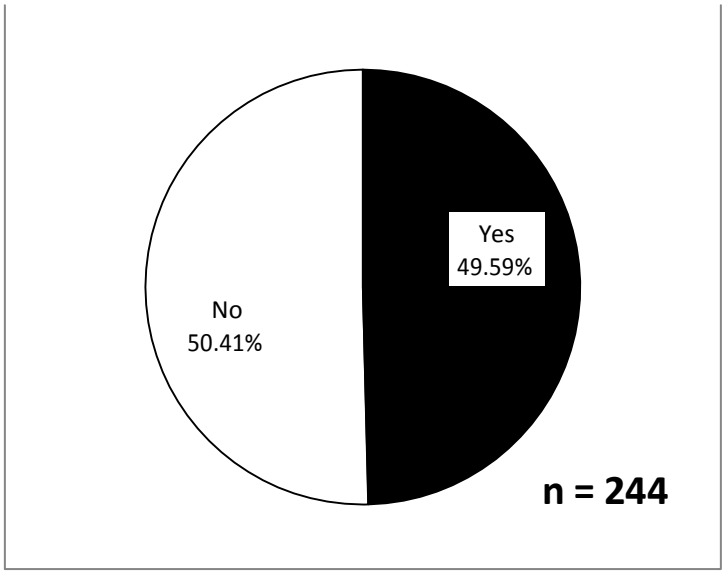


Figure 13: Businesses that have already taken actions to conserve water on-site. Source: Question number 22

- 121 businesses said that they have already taken action to conserve water on-site

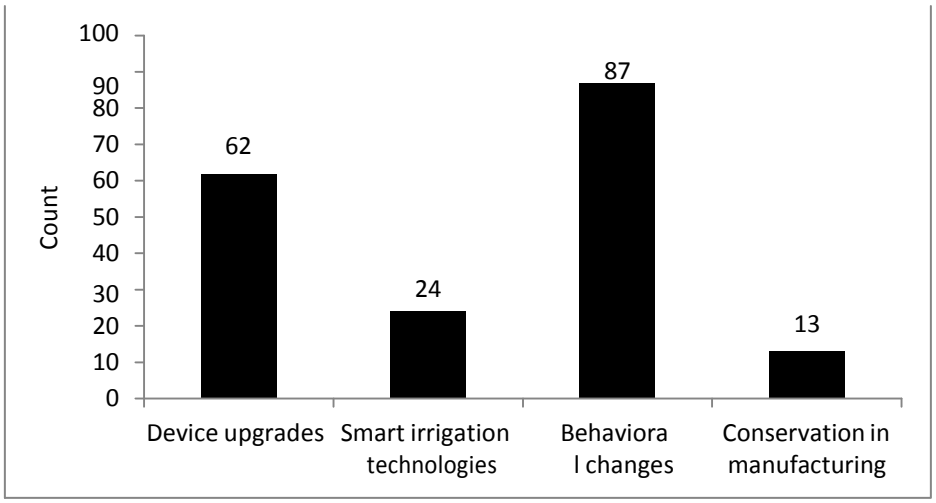


Figure 14: Methods of conservation by businesses that have already taken action to conserve water on-site

- 87 businesses out of the 121 indicated they are already actively conserving water said that they made behavioral changes.
- The second most popular method of water conservation was device upgrades such as installing low-flow toilets and other water saving appliances.

The breakdown of who maintains landscape areas the businesses own or manage

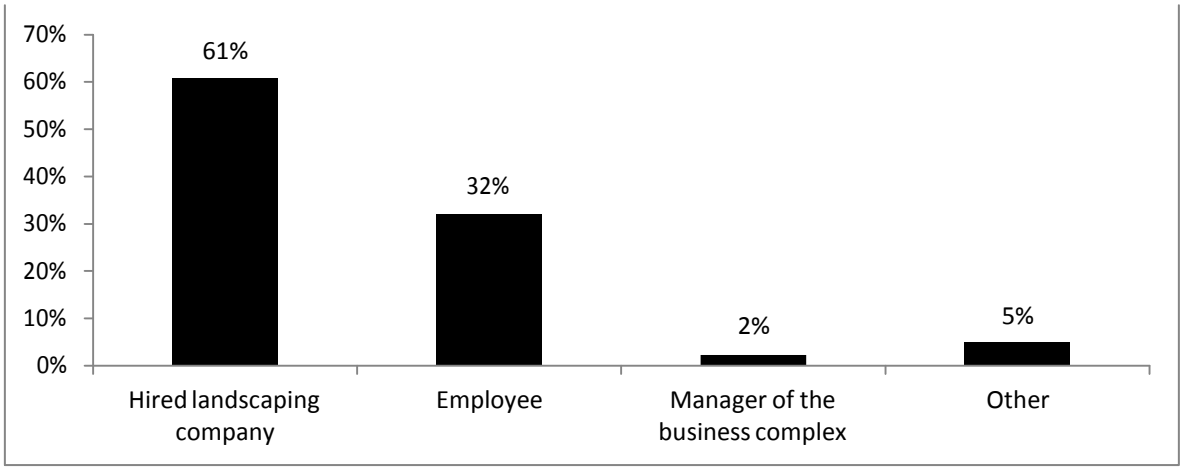


Figure 15: Breakdown of who maintains the landscape areas the individual businesses own or manage. Source: Question number 15

- Hired landscaping companies maintained their landscape for 61% of all the businesses that responded to the survey.
- 32% of the remaining businesses' landscape maintenance were done by an employees.

Willingness to undergo a landscape irrigation audit for the business

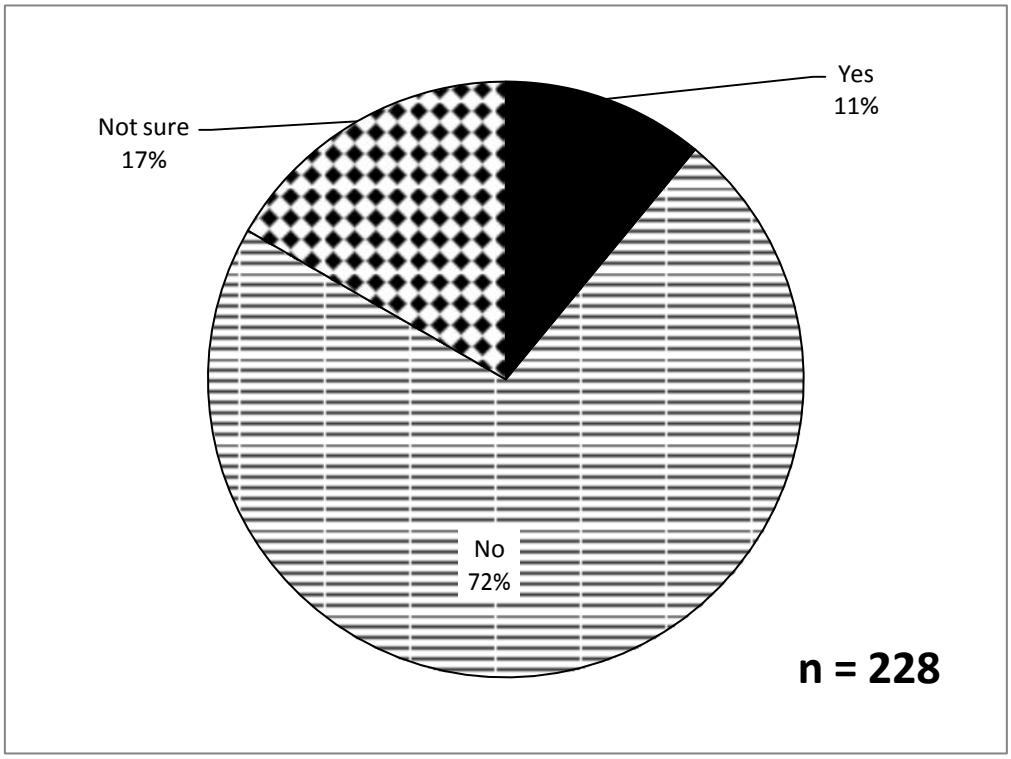


Figure 16: Businesses' willingness to undergo a landscape irrigation audit. Source: Question number 16

- 72% or 165 businesses refused to conduct a voluntary landscape irrigation audit.
- Only 11% (25 businesses) confirmed that they would consider conducting an audit.
- 17% or 38 of the businesses were not sure if they would conduct an audit.

Willingness to participate in free education programs to increase outdoor water efficiency

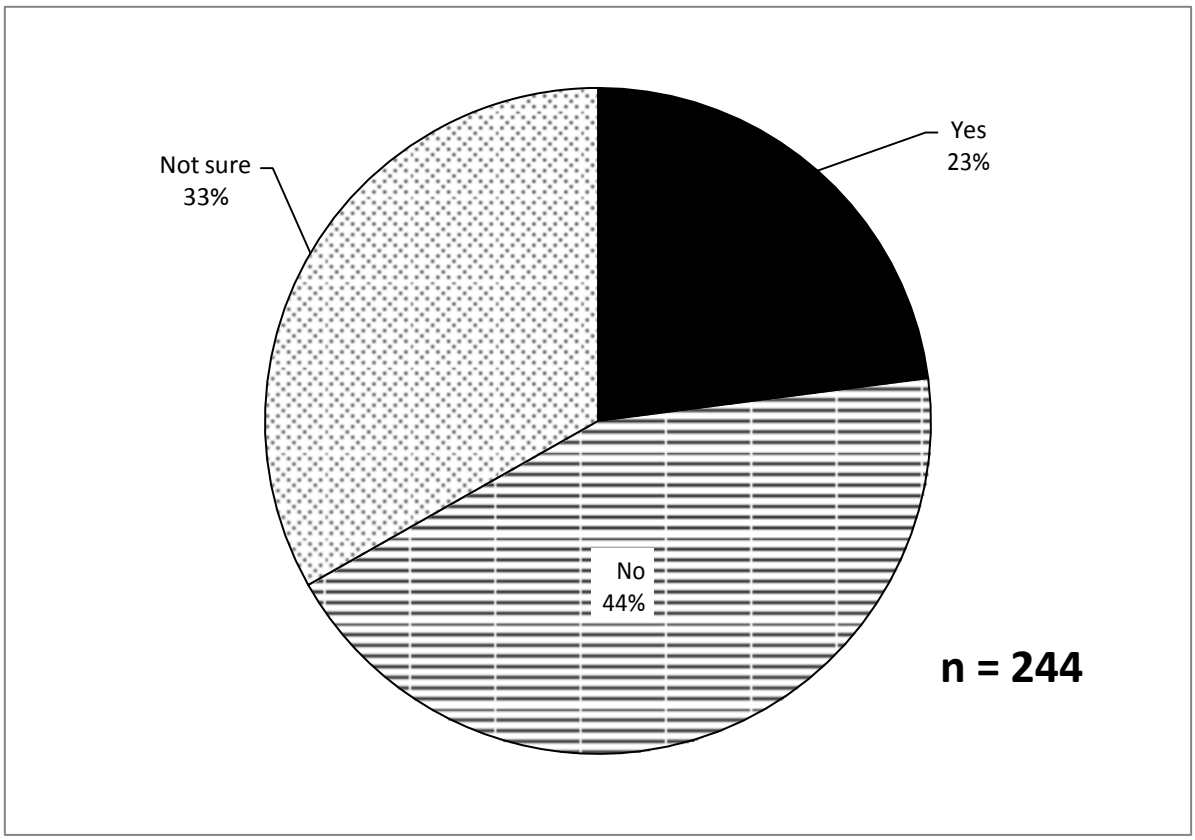


Figure 17: Willingness to participate in free education program(s) to increase outdoor water efficiency. Source: Question number 23

- 44% of the respondents said they would not participate in education programs even if these program(s) were conducted free of charge.

Likelihood of Oklahoma going into drought within the next three years

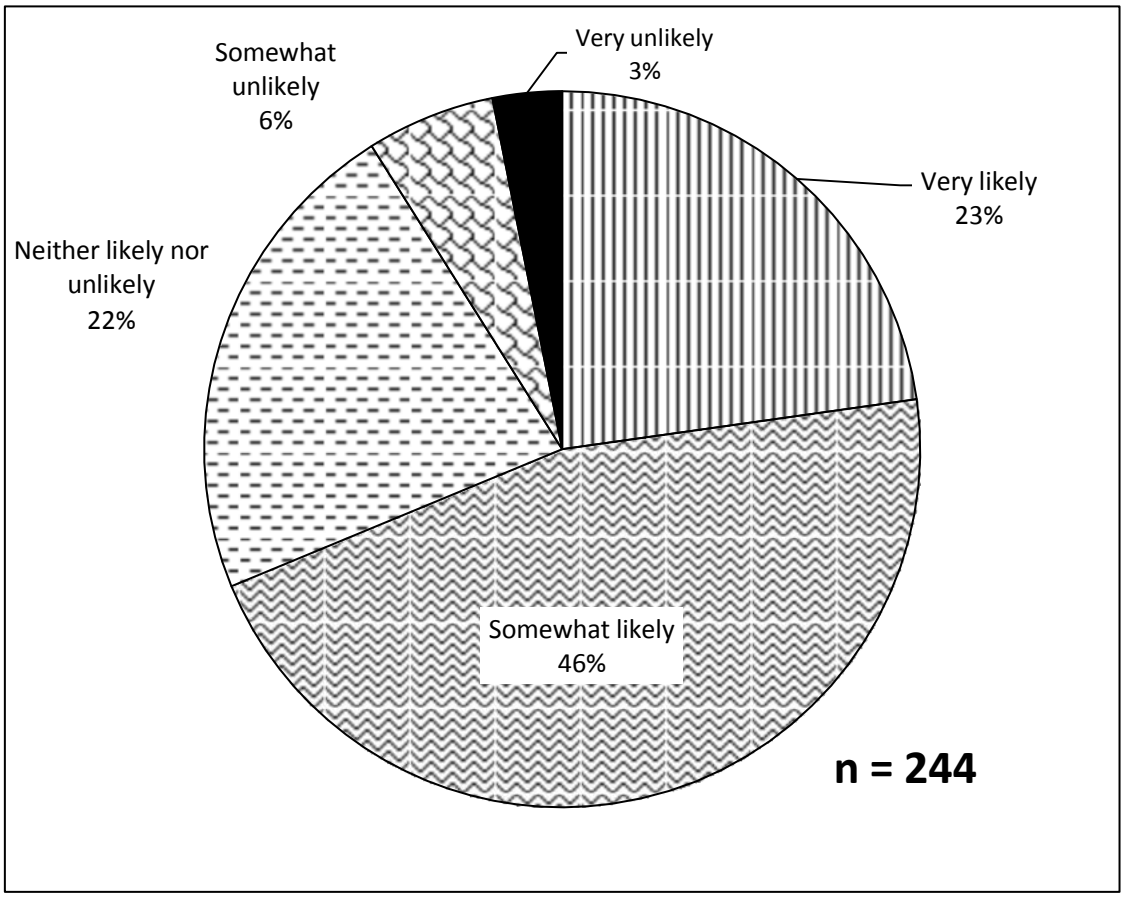


Figure 18: Likelihood of Oklahoma going into drought within the next three years. Source: Question number 24

- This question asked about the respondents' opinions on the likelihood of drought in Oklahoma in the next three years.
- Because most respondents were also the landscaping decision makers for the firm, we can assume that most of these responses are opinions are of the decision makers.
- Personal opinion of the likelihood of drought could be an important indicator of how businesses make decisions about adopting water conservation tools.
- 69% of the respondents thought that Oklahoma is likely to be in drought.
- Only 9% thought that drought conditions were unlikely.

4 Estimating Willingness to Adopt Commercial Irrigation Water Conservation

Based on the current water rates applicable for commercial businesses, and percentage of water savings attributable to any of the conservation methods posed in the survey, we calculated 12 levels of potential savings. These 12 potential summer monthly water savings amounts were randomly assigned to each of the three questions (Smart Irrigation Controller, Soil Moisture Sensor, and Irrigation Audit) in each survey. Thus each survey had a unique combination of monetary savings at current water prices. Respondents were asked to indicate whether the firm would adopt the suggested conservation methods or not. In addition, to differentiate the likelihood of a business opting to adopt or reject these water conservation methods, we solicited responses to other factors such as firm revenue, landscaped area, the size of the firm, and the demographic factors of the responder.

We also divided our sample into two treatment groups to identify if the provision of complete information on current and future water rate increases would affect the likelihood that respondents would say yes to the water savings bid presented. Two thirds of the sample received an information table on how water rates for their businesses would change in the subsequent years. The remaining one third of the sample did not receive this information and acted as the control group.

Each of the water savings bid questions for commercial businesses' willingness to adopt irrigation water conservation were conducted using the contingent valuation method. Contingent valuation method is commonly used to value ecosystem and environmental services (King and Mazzotta 2000). This method is categorized as a "stated preference" method, because the form of the question is such that it asks people to state their preference directly as opposed to deriving it from observed behavior.

Data obtained from the survey was used to estimate a logit model in the following form-

$$Adoption\ decision_{i\,j} = \beta_0 + \beta_{Bid}X_1 + D_{Control}X_2 + \beta_{Demographics}X_x$$

Where the variable "adoption decision" is a binary entry with either 0 or 1 for the i^{th} business and j^{th} conservation method: 1 = adoption and 0 = otherwise. β_0 is the constant term in the equation, β_{Bid} is the dollar amount each of these business would save due to adopting the j^{th} conservation method, and $D_{control}$ is the dummy variable that indicates 1 if the business saw complete future rate information, 0 otherwise. X_x indicates all other demographic factors pertaining to the business and the respondent. A complete list of variables used and their hypothesized relationship to the adoption decisions are presented in Table 1.

Table 1: Variables used in the logistic regressions, descriptions, and their hypothesized relationship to the adoption decision

Variable	Variable Description	Hypothesized Relationship
Adoption Decision	Adoption decision is a binary entry with either 0 or 1 for the i^{th} business and j^{th} conservation method: 1 = adoption and 0 = otherwise.	
Bid	The bid is the dollar amount each of these businesses would save due to adopting the j^{th} conservation method Bid amounts used in the survey in $ - 50.67, 101.34, 152, 202.67, 253.34, 304.01, 354.68, 405.34, 456.01, 506.68, 557.35, and 608.02	Positive
Control	Control is a binary entry that indicates which control category each business was assigned to: 1 = did not see how water rates would increase in future, 0 = saw how water rates would increase in future.	Negative
Adoption	Adoption is a binary variable that indicates if businesses have already adopted irrigation conservation technologies such as rain sensors, and/or soil moisture sensors. 1 = adopted, 0 = have not adopted	Positive
Land Area	Land area is a categorical variable that indicates how much landscaped land the business owns or maintains	Positive
Years at Address	Number of years at the current address	Positive
No. Employees	Number of employees	Positive
Irrigation[2] '13	Average difference between summer and winter water consumption in 2013	Positive
Irrigation[2] '14	Average difference between summer and winter consumption in 2014	Positive
Education Level	Level of education of the person responding to the survey	Positive
Gender	Gender of the respondent 1= female, 0 = male	Positive
Perceptions	Indicates the perceptions on the likelihood of having prolonged drought by persons who make landscaping decisions for the business. 1 = drought likely, 0 = otherwise	Positive

[2] Irrigation water consumption is assumed to be the difference between summer and winter water consumption.

4.1 Willingness to Participate in Outdoor Irrigation Water Conservation

In the survey, we asked businesses if they would consider installing a soil moisture sensor, a smart irrigation controller, or if they would consider conducting an irrigation audit contingent on how much the business could save in their summer water bill each year. The responses obtained from this survey were then utilized to estimate the logit model discussed in the section above. Models 1, 2, and 3 respectively assess the willingness of commercial businesses to adopt a soil moisture sensor for the business, a smart irrigation controller for the business, and the willingness to conduct an irrigation assessment.

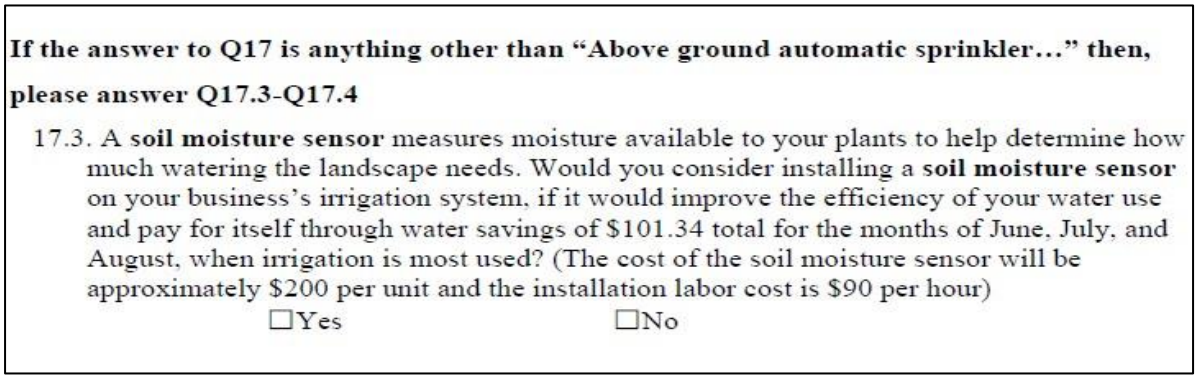
Table 2: Logit Results (Dependent variable is 1=adopt, 0=otherwise)

Variable	Model 1 Soil Moisture Sensor Coefficient	St.Error		Model 2 Smart Irrigation Controller Coefficient	St.Error		Model 3 Irrigation Assessment Coefficient	St.Error	
Summer Savings (Bid)	0.006	0.004		0.000	0.001		0.000	0.001	
Control	#			-1.236	0.460	***	-0.088	0.334	
Adoption	3.628	2.312		1.846	0.541	***	1.993	0.522	***
Acreage									
1/4 to 1/2 Acres	2.056	1.288		1.439	0.543	***	0.899	0.457	**
1/2 to 1 Acre	-0.422	1.917		1.420	0.619	**	0.777	0.550	
1 or Greater	1.462	1.865		1.361	0.625	**	-0.246	0.640	
Annual revenue $									
100,000 to 10,000,000	-2.765	1.311	**	1.303	0.889		0.226	0.557	
10,000,000 and Greater	-0.316	2.119		1.469	1.037		0.533	0.710	
Education									
Less Than College Degree	-1.487	1.381		-1.743	0.574	***	-0.574	0.451	
Less than Graduate Degree	-3.451	2.009	*	-1.291	0.484	***	-0.470	0.421	
Number of Years at Address	-0.113	0.065	*	-0.050	0.018	***	-0.026	0.012	**
Number of Employees	0.013	0.014		0.004	0.003		0.001	0.001	
Perceptions	3.050	1.654	*	0.520	0.408		0.640	0.329	**
Gender				-0.774	0.471		0.084	0.345	
Irrigation '13	0.040	0.044		0.001	0.002		-0.010	0.008	
Irrigation '14	-0.022	0.040		0.001	0.007		0.010	0.008	
Intercept	-3.047	2.332		-0.921	1.095		-0.451	0.768	
N	113			199			207		
LR Chi2	27.760		**	70.48		***	40.190		***
Pseudo R2	0.442			0.296			0.142		

Notes: *, **, and *** indicate 10%, 5% and 1% level of significance respectively
Omitted in model 1 due to lack of variation within the variable

4.1.1 Willingness to Adopt a Soil Moisture Sensor for the Business

Soil moisture sensors are used to determine if the landscaping needs water, or how much watering it requires. This allows significant water savings because watering is done strictly based on need.



If the answer to Q17 is anything other than "Above ground automatic sprinkler…" then, please answer Q17.3-Q17.4

17.3. A **soil moisture sensor** measures moisture available to your plants to help determine how much watering the landscape needs. Would you consider installing a **soil moisture sensor** on your business's irrigation system, if it would improve the efficiency of your water use and pay for itself through water savings of $101.34 total for the months of June, July, and August, when irrigation is most used? (The cost of the soil moisture sensor will be approximately $200 per unit and the installation labor cost is $90 per hour)

☐Yes ☐No

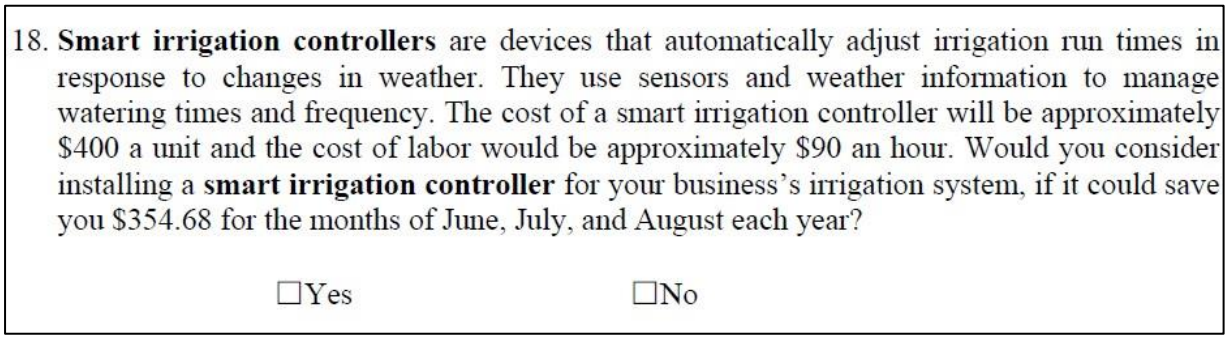
Figure 19: Contingent valuation question for the soil moisture sensor

Businesses belonging to the income category "$100,000 to $10 million" compared to businesses in the income category "less than $100,000" were less likely to adoption a soil moisture sensor, and this relationship was statistically significant. Compared to respondents with graduate degrees, those that did not have graduate degrees (but had a bachelor's degree) were significantly less likely to adopt the soil moisture sensor. Similarly, the negative and statistically significant relationship between the adoption decision and "number of years at the current address" indicates the longer businesses were operating in Oklahoma City, the less likely they are to adopt this conservation tool. However, decision makers for the firm that also indicated that Oklahoma is likely to go into drought were significantly more likely to choose to install a soil moisture sensor, compared to those who did not.

The variable "control" was omitted in the analysis due to the lack of variation within the group. If sufficient variations are lacking within a group, the software cannot calculate the differences in behaviors.

4.1.2 Willingness to Install a Smart Irrigation Controller

Smart irrigation controllers utilize an array of tools such as soil moisture sensors, rain sensors, temperature of the location, evapotranspiration at location, and use weather data to make estimates of how much water the landscaping needs. This further enhances the potential to conserve water because the estimates account for almost all weather aspects that determine watering needs at a given location.


18. **Smart irrigation controllers** are devices that automatically adjust irrigation run times in response to changes in weather. They use sensors and weather information to manage watering times and frequency. The cost of a smart irrigation controller will be approximately $400 a unit and the cost of labor would be approximately $90 an hour. Would you consider installing a **smart irrigation controller** for your business's irrigation system, if it could save you $354.68 for the months of June, July, and August each year?

☐Yes ☐No

Figure 20: Contingent valuation question for the smart irrigation controller

It is significantly less likely for businesses that did not see the changes in the rate structure to opt for the adoption of a smart irrigation controller, and businesses that already have adopted water conservation practices are more likely to positively respond to adopting a smart controller. Compared to businesses with less than one quarter acre of landscaping, businesses that maintained more than ¼ acre of landscaped area were significantly more likely to opt for the adoption of the controller. With regards to education, responders with "less than college degree" and "less than graduate degree" compared to those with "graduate degrees" were significantly less likely to install a smart controller. Similar to the model explaining the willingness to install soil moisture sensors, the longer the business has been in Oklahoma City less likely they were to install smart irrigation controllers.

4.1.3 Willingness to Participate in a Landscape Irrigation Assessment

A landscape irrigation assessment is aimed at giving customers expert advice on making their landscape irrigation more efficient.

20. Consider that your business has the opportunity to participate in a pilot program for commercial businesses to register for a voluntary **landscape irrigation assessment.** This landscape irrigation assessment would be conducted by a landscaping professional to identify ways to reduce the quantity of water used in irrigation, based on the water needs of the landscape and plantings. The assessment would include an inspection to reveal changes necessary to make your system operate efficiently. Once the business has made the recommended changes, your business would be certified as an "Oklahoma City water wise" firm.

    If you could save $50.67 of your summer water usage, by making the changes recommended by the landscape irrigation assessment, would your business be willing to become a "Water Wise" certified business?

    ☐Yes ☐No

Figure 21: Contingent valuation question for the landscape irrigation assessment

Logistic regression results indicate that businesses who have already adopted water conservation tools are more likely to consider a landscape irrigation assessment. Businesses with landscaped areas between ¼ and ½ acres were more likely to opt for the assessment compared to those who had less than ¼ acre of land. Number of years at the current location was negatively related and is statistically significant, indicating that businesses that had been in Oklahoma City for longer are less likely to participate in the assessment. However, perceptions on the likelihood of drought in Oklahoma by decision makers in the business were positively and significantly related to the choice of conducting a landscape irrigation assessment at the given level of cost savings.

4.2 Calculating Willingness to Pay Values for the Conservation Tools

The summer cost savings was not statistically significant for any of the three models. Therefore, we concluded that at current rates and current ranges of potential savings, there is no willingness to adopt these three conservation methods.

Nonetheless, the logit model identified several important factors that could determine the responsiveness of businesses in adopting irrigation water conservation methods such as the area of landscaping maintained by the firm, education level of the respondent, and attitude towards drought.

Graduate degree holders in the sample were more likely to adopt water conservation tools suggested in the survey. This finding is also consistent with the initial hypothesis that greater education is positively correlated with greater responsiveness to irrigation water conservation. It can be hypothesized that higher education results in greater access to information, thus making respondents more informed about situations such as drought and the importance of conservation.

Businesses that had already installed soil moisture sensors, and/or rain sensors are more likely to respond positively to additional conservation efforts.

Another variable that continued to remain significant is acreage of landscaping owned or maintained by the business. The greater the area of landscaping the higher the propensity for businesses to adopt tools like soil moisture sensors, smart controllers, or to participate in irrigation assessment to save water costs they would otherwise incur.

In the logistic models, the number of years the business has been in business is negatively significant to the businesses' responsiveness to conservation efforts. We hypothesize that these businesses may not have plans to overhaul their current practices or change existing infrastructure.

5 Summary Points

- A majority of the businesses used an OKC Utilities water connection for their irrigation needs. Without alternatives for supply such as retention ponds, higher prices may have an eventual impact on businesses with larger landscapes.

- Businesses considered "appearance" to be the most important factor to be considered in their landscape. Thus, continued education on the availability of aesthetically pleasing landscaping choices that are also water conserving will be needed, should there be future supply constraints.

- Most businesses that responded to the survey had less than ¼ acre of landscaping. Therefore, they might be reluctant to install large scale technological fixes. As a result, the only effective method of getting businesses to conserve water may be to increase water rates.

- Half of the respondents to the survey indicated they conserved water on site, both indoors and outdoors.

- About 13% of businesses indicated they already have adopted irrigation water conservation tools such as soil moisture sensors, and/or rain sensors. These businesses are more likely to respond positively to additional conservation calls by OKC utilities.

- Only 8% of all businesses that responded to the survey opted to install a soil moisture sensor at the given rate of saving in their water bill out of the 115 businesses who responded to that question.

- Only 27% of the businesses opted to install a smart irrigation controller for their business at the given rate of savings in their water bill out of 208 people who responded to the survey.

- Forty three percent of the businesses that responded to the survey chose to participate in a landscape irrigation assessment if they could save the presented amount on their water bill out of the 215 businesses who responded to that question.

- We can only hypothesize that if the water price were to rise significantly or businesses were paid to install soil moisture sensors or smart irrigation meters and/or undergo irrigation assessments, we would be able to estimate a new model with significant values at which businesses would adopt these tools.

6 Bibliography

Dilman, D. *Mail and telephone surveys: The total design method.* New York: John Wiley, 1978.

King, Dennis M, and Marisa J Mazzotta. "Contingent Valuation Method." *Ecosystem Valuation.* 2000. http://www.ecosystemvaluation.org/contingent_valuation.htm (accessed December 21, 2015).

7 Appendix – Sample Survey Complete with Future Water Rate Changes

15617 - 2585

Oklahoma City Commercial Business Water Conservation Survey 2015

We value your input!

This survey is being conducted by Oklahoma State University for the Oklahoma City Water Utilities Department to understand your water usage and conservation practices. Your answers will help the Oklahoma City Utilities Department effectively target their conservation efforts. We would like the person who is in charge of hiring, supervising, or paying for the landscaping at this business to complete the survey.

Your participation in this survey is voluntary and your answers will remain anonymous, confidential, and will only be known by the principal investigators. You may choose to stop at any point. Data will only be released in aggregate in which no individual firm's responses can be identified. This survey will only take about 20 minutes to complete. This Survey has been reviewed and approved by Oklahoma State University, and The Oklahoma City Utilities Department.

If you have any questions or concerns about this project, please contact Dr.Tracy Boyer at (405)-744-6169 or tracy.boyer@okstate.edu

Informed Consent

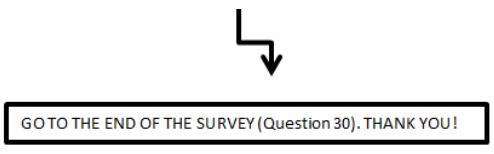
1. Please answer YES to indicate that you are above 18 years of age, understand that your answers will remain confidential, and that your participation in this survey is voluntary

☐Yes ☐No

Background

2. Does your business own or maintain landscaped areas?

☐Yes ☐No



3. For how long has your company been in business?

   _____ Years

4. For how long has your business been at the current address?

   _____ Years

5. Please select for which of the following categories your commercial establishment belongs to?

   ☐Government/Tribal ☐Non-Profit ☐For-profit

6. Please choose to which sector your business belongs, out of the following.

   ☐Service ☐Manufacturing ☐Restaurant
   ☐Retail ☐Other [Please specify] ----------

7. What type of business below best describes your firm? Please choose one from the following list

   ☐Banking/finance ☐Food and dining ☐Personal care
   ☐Education ☐Healthcare ☐Real estate
   ☐Computer/electronic ☐Home and landscape ☐Travel and transportation
   ☐Construction ☐Legal ☐Miscellaneous
   ☐Entertainment ☐Manufacturing/wholesale and distribution ☐Other [Please specify] ----------

8. How many employees does your business employ, including yourself?

   _____ Employees

9. What is the closest approximation of your business's total **annual** revenue? Please remember, this information will remain anonymous.

   ☐ Less than $50,000 ☐$50,000 to less than $75,000
   ☐$75,000 to less than $100,000 ☐$100,000 to less than $500,000
   ☐$500,000 to less than $10,000,000 ☐$10,000,000 to less than 15,000,000
   ☐$15,000,000 or greater

10. What do you think is the **most** important attribute to your firm regarding your business's landscape? Check one.

☐Appearance
☐Water efficiency
☐Low maintenance
☐Low cost/ cost effectiveness

11. What do you think is the **least** important attribute for your firm regarding your business's landscape? Check one.

☐Appearance
☐ Water efficiency
☐Low maintenance
☐Low cost/ cost effectiveness

12. What is the **primary** source of your irrigation water supply? Check one.

☐City water connection
☐Private well
☐Retention pond
☐Water catchment from rain/rain barrels
☐Other [Please specify]

---

13. In observing the landscape maintenance at your business, have you often noticed any of the following issues? Check all that apply.

☐Irrigation nozzles are misdirected toward concrete or asphalt surfaces
☐Watering during rain events
☐Watering turf during November through January or during freezing temperatures
☐Watering times are scheduled from noon to late afternoon
☐Leaking or broken irrigation equipment

14. How many acres of irrigated landscape area does your company manage and irrigate at your main location?

☐Less than ¼ acre	☐Greater than ¼ acre to less than ½ acre
☐Greater than ½ acre to less than 1 acre	☐Greater than 1 acre

15. Who maintains your business's landscaping?

☐A hired landscaping company
☐Maintained by an employee of your company employed for this purpose
☐Manager of the commercial complex/strip mall
☐Other [Please specify]
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Research Questions

The City of Oklahoma City moved to a "two-tier" water rate October 2014 to reflect increasing costs to supply water and to encourage conservation. As a result, businesses will experience a 15% higher cost for the volume of water they use above their average winter consumption. The second tier price per thousand gallons reflects the actual cost to customers of providing additional water when it is at peak demand in the summer.

Following is a table of OKC non-residential and irrigation water rates [US $ per 1000 gallons]

Tier	Until Sep. 30 2015	Oct. 1 2015 – Sep. 30 2016	After Oct. 1 2016
Tier 1	$2.71	$2.76	$2.81
Tier 2	$3.12	$3.26	$3.40

Tier 2 is paid per 1000 gallons of water used by the individual businesses above its own average winter water use (From December to February).

16. A landscape irrigation audit is an assessment conducted by a landscape professional that will identify ways to reduce the quantity of water used for irrigation, based on the water needs of the landscape and plantings. Would you be interested in conducting a landscape irrigation audit for your business?

☐Yes ☐No ☐I don't know

17. Which of the following watering techniques do you predominantly use in your landscaped area? (Below on left)

☐Above ground automatic sprinkler or a drip irrigation system →

☐Manual connection sprinkler

☐Soaker hose or flood irrigation (leave hose on ground)

☐Spray by hand as needed

☐Do not water the landscape

☐Other watering method [Please specify]

If the answer to Q17 is "Above ground automatic sprinkler or a drip irrigation system" then, please answer Q17.1 and Q17.2

17.1. Is there a rainfall sensor system installed on your business's irrigation system to prevent it from operating during rain events?

☐Yes ☐No ☐I don't know

17.2. Is there a soil moisture sensor system installed on your business's irrigation system to determine when to provide additional watering?

☐Yes ☐No ☐I don't know

If the answer to Q17 is anything other than "Above ground automatic sprinkler…" then, please answer Q17.3-Q17.4

17.3. A **soil moisture sensor** measures moisture available to your plants to help determine how much watering the landscape needs. Would you consider installing a **soil moisture sensor** on your business's irrigation system, if it would improve the efficiency of your water use and pay for itself through water savings of $304.01 total for the months of June, July, and August, when irrigation is most used? (The cost of the soil moisture sensor will be approximately $200 per unit and the installation labor cost is $90 per hour)

☐Yes ☐No

17.4. How sure are you of your answer above on a scale of 1 to 5, if 1 is 'not at all sure' and 5 is 'very sure'?

☐1- Not at all sure
☐2- Somewhat unsure
☐3- Somewhat sure
☐4- Quite sure
☐5- Very sure

18. **Smart irrigation controllers** are devices that automatically adjust irrigation run times in response to changes in weather. They use sensors and weather information to manage watering times and frequency. The cost of a smart irrigation controller will be approximately $400 a unit and the cost of labor would be approximately $90 an hour. Would you consider installing a **smart irrigation controller** for your business's irrigation system, if it could save you $456.01 for the months of June, July, and August each year?

☐Yes ☐No

19. How sure are you of your answer above (Q18) on a scale of 1 to 5, if 1 is 'not at all sure' and 5 is 'very sure'?

☐1- Not at all sure
☐2- Somewhat unsure
☐3- Somewhat sure
☐4- Quite sure
☐5- Very sure

20. Consider that your business has the opportunity to participate in a pilot program for commercial businesses to register for a voluntary **landscape irrigation assessment.** This landscape irrigation assessment would be conducted by a landscaping professional to identify ways to reduce the quantity of water used in irrigation, based on the water needs of the landscape and plantings. The assessment would include an inspection to reveal changes necessary to make your system operate efficiently. Once the business has made the recommended changes, your business would be certified as an "Oklahoma City water wise" firm.

    If you could save $304.01 of your summer water usage, by making the changes recommended by the landscape irrigation assessment, would your business be willing to become a "Water Wise" certified business?

☐Yes ☐No

21. How sure are you of your answer above on a scale of 1 to 5, if 1 is 'not at all sure' and 5 is 'very sure'?

☐1- Not at all sure
☐2- Somewhat unsure
☐3- Somewhat sure
☐4- Quite sure
☐5- Very sure

22. Has your business taken action to conserve water on site?

☐Yes ☐No

If answer is YES to Q22 then please answer Q22.1 –

22.1. In which ways, if any, has your business taken action towards water conservation in the last 4 years? Check all that apply.

☐Device upgrades such as low-flow toilets and water efficient appliances

☐Adopting smart irrigation technologies

☐Behavioral changes such as running faucets less in break room, and using a broom instead of spraying water to clean sidewalks etc.

☐Reduced water usage in manufacturing processes

23. If the Oklahoma City Utilities Department were to have a free education program(s) for managers of commercial property landscapes about how to increase outdoor water efficiency; would you consider sending an employee to participation a program?

☐Yes ☐No ☐Not sure

24. In the Oklahoma City metro area, what do you think is the likelihood of prolonged drought over the next three years?

☐ Very likely
☐ Somewhat likely
☐ Neither likely nor unlikely
☐ Somewhat unlikely
☐ Very unlikely

Demographic Information

Please note that your answers will be confidential and not revealed except in aggregate.

25. How old are you?

_____ Years

26. What is your gender?

☐Female ☐Male

27. What is your highest level of education?

☐Some high school
☐High school graduate
☐Some college
☐College degree
☐Some graduate education
☐Graduate degree (MSc. MA, or PhD)

28. Are you the person who makes decisions or recommendations about the direction of landscape care for your company?

☐Yes ☐No

29. What is your position in the firm, for which you are answering this survey?

☐Owner
☐Manager
☐Accountant
☐Secretary/administrative assistant
☐Landscape manager
☐Maintenance professional
☐Service manager
☐Other [Please specify]
_____

30. Do you have any comments to share with us about this survey or Oklahoma City Utilities conservation efforts?

Thank you for your time!

If you any have questions regarding this survey, please contact Dr. Tracy Boyer, Associate Professor in Agricultural Economics, Oklahoma State University at tracy.boyer@okstate.edu or (405)744-6169.

VITA

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