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Are Consumers Willing to Pay More for Low-Input Turfgrasses on Residential Lawns? Evidence from Choice Experiments

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A choice experiment with real products was used to investigate consumer willingness to pay (WTP) for several low-input attributes of turfgrasses. The choice scenarios consisted of turfgrass plots, which varied in aesthetic quality characteristics and were labeled with differing levels of maintenance requirements (irrigation, fertilizer, etc.), shade adaptation, origin, and price. A mixed logit model was used to analyze the choice data and estimate consumer WTP. Our results suggest that low-input maintenance attributes significantly influence consumer choice behavior and identify a strong consumer preference for reduced irrigation and mowing requirements. The introduction of low-input turfgrasses could be a viable strategy for reducing the maintenance inputs and costs for residential lawn care.

Key Words: willingness to pay, choice experiment, low-input, home lawn, irrigation, mowing frequency, fertility requirement

JEL Classifications: Q13, Q58

Widespread urban development has led to substantial growth in lawn acreage and the subsequent increase in the amount of resource inputs (fertilizer, water, etc.) used for residential turfgrass management (Alig, Kline, and Lichtenstein, 2004). Fresh water conservation is a universal issue, and in the United States, turfgrass covers an area larger than that of any irrigated crop (Milesi et al., 2005). In addition to the impact of water use for irrigation, concerns have also arisen about the potential negative impacts of turfgrass management practices on the environment and human health such as the risks of pesticide exposure and fertilizer runoff (Milesi et al., 2005; Robbins and Brikenholtz, 2003; Robbins and Sharp, 2003). These concerns have prompted regulations on urban lawn care practices. A few examples of such regulations are statewide restrictions on the use of fertilizers containing phosphorous on home lawns (State of Minnesota, 2010; State of Wisconsin, 2011), pesticide bans on home lawns in numerous municipalities and provinces of Canada (Government of Quebec, 2006), and municipal water regulations (Boer and Ripp, 2008; MassDEP, 2010).

Despite potential drawbacks, healthy residential lawns provide important environmental benefits such as urban heat dissipation, water quality protection, erosion control, and carbon sequestration as well as functional and aesthetic benefits to society (Beard and Green, 1994; Krenitsky et al., 1998; McPherson, Simpson, and Livingston, 1989; Quian, Follett, and Kimble,

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2010). One potential strategy to reduce resource inputs without sacrificing the environmental and societal benefits provided by turfgrass is to use nontraditional, alternative grass species better adapted to low-maintenance conditions or low-input turfgrasses. Over the past few decades researchers have identified and developed alternative grass species suited for low-maintenance sites (Brilman and Watkins, 2003; Duncan, 2003; Engelke and Anderson, 2003; Hanna and Liu, 2003; Riordan and Browning, 2003; Ruemmele et al., 2003). There has also been interest in developing turfgrass varieties from grass species that are native to North America. Native grasses have evolved in environmental conditions specific to North America for a longer period of time compared to introduced, non-native grasses, and they may be better adapted to low-maintenance conditions (Johnson, 2008). The use of low-input turfgrass species on residential lawns could be a viable strategy to reduce the rising economic costs of maintenance inputs as well as satisfy public concerns about the environmental impacts of urban turfgrass management practices. Additionally, more stringent regulations on lawn care practices could further increase the demand for low-input turfgrasses.

Regardless of the advances in the development of low-input turfgrasses, production and availability remain limited across much of the United States. Several alternative, low-input turfgrass species, for example, colonial bentgrass (*Agrostis capillaris* L.) and hard fescue (*Festuca trachyphylla* [Hack.] Krujina), have provided acceptable quality and performance in regional trials throughout the U.S. Upper Midwest under little or no supplemental irrigation, fertility or pesticide applications, and reduced mowing regimes (Diesburg et al., 1997; Watkins et al., 2011). A few grass species native to North America, including tufted hairgrass (*Deschampsia caespitosa* [L.] P. Beauv.) and prairie junegrass (*Koeleria macrantha* [Ledeb.] Shult.), have also shown potential in regional trials for use as low maintenance turfgrasses (Mintenko, Smith, and Cattani, 2002; Watkins et al., 2011), yet Kentucky bluegrass (*Poa pratensis* L.) and perennial ryegrass (*Lolium perenne* L.), which are more resource-intensive to maintain, are still the most commonly used turfgrasses for residential lawns in the Upper Midwest (Christians, 2004). Little is known about consumer preference regarding alternative, low-input turfgrasses. Gaining information about the market potential of low-input turfgrasses could help bridge this gap between research progress and the turfgrass seed market.

Previous research shows there is market potential for environmentally friendly goods and services (Engel and Poetschke, 1998; Guagnano, Dietz, and Stern, 1994; Hu, Woods, and Bastin, 2009; Laroche, Bergeron, and Barbaro-Forleo, 2001; Schegelmilch, Bohlen, and Diamantopoulos, 1996; Straughan and Roberts, 1999; Yue et al., 2010). Although most research indicates that consumers who are willing to pay a price premium for environmentally friendly products share similar attitudes, environmental concerns vary widely among consumers (Gladwin, Kennely, and Krause, 1995; Purser, Park, and Montuori, 1995). Consumers often respond differently to new ideas and products, and it is necessary to conduct valid research to explore how consumers will react to a new product, in this case, low-input turfgrasses for residential lawns. To our knowledge, little research has been done in this area. Helfand, Sik Park, and Nassauer (2006) found that consumers were willing to pay a premium for environmentally friendly landscapes with differing levels of native plantings compared with a traditional monoculture lawn, but there has been no information published on consumer preferences for maintenance attributes of turfgrasses or on potential barriers to consumer adoption of low-input turfgrasses.

Several questions arose when considering the market potential of low-input turfgrasses: 1) Will consumers be willing to pay premiums for low-input turfgrasses? 2) If yes, what are the premiums? 3) Will the premiums they are willing to pay be the same for different low-input characteristics such as reduced water use, reduced fertilizer use, etc.? 4) If not, which characteristics glean higher premiums? To answer these questions, we conducted a survey with homeowners in the Minneapolis—St. Paul, MN, metropolitan area. The main component of the survey was a choice experiment to investigate consumer preference and estimate willingness to pay (WTP) for several low-input attributes (e.g. water use) as well as aesthetic attributes, origin, and shade adaptation of turfgrasses. Choice experiments have been used to identify consumer preference and WTP for various attributes of novel products (Brooks and Lusk, 2010; Mtimet and Albisu, 2006) as well as for genetically modified, organic, natural, and locally grown products (Burton and Pearse, 2002; Carlsson, Frykblom, and Lagerkvist, 2007; Hu et al., 2004; Onken, Bernard, and Pesek, 2011). The results presented in this study provide important implications and insights about the market potential of low-input turfgrass species to plant breeders and professionals in the Upper Midwest turfgrass seed industry.

In the following section we describe the methodology including the product attributes, sampling methods, choice experiment, questionnaire, and statistical models used for the study. In the next section we present the results, specifically the WTP estimates. The article then concludes with the discussion and implications of our findings.

Table 1. Turfgrass Attributes and the Attribute Categories Tested in This Study

Attributes	Category
Texture	Fine
	Coarse
Color	Dark green
	Light green
Weed presence	Yes
	No
Native	Native (U.S.)
	Nonnative
Shade adaptation	Sun
	Sun or shade
Irrigation requirement	Low (less than once a week)
	Medium (1–2 times a week)
	High (3–5 times a week)
Fertility requirement	1 lb nitrogen/1000 ft^{-2} per year
	2 lbs nitrogen/1000 ft^{-2} per year
	3 lbs nitrogen/1000 ft^{-2} per year
Mowing requirement	Once a month
	Every other week
	1–2 times per week
Price	\$5 per 1000 ft^2
	\$10 per 1000 ft^2
	\$15 per 1000 ft^2
	\$20 per 1000 ft^2

Methodology

Product Attributes

Presurvey focus groups conducted in April 2010 helped identify a key set of nine turfgrass attributes to include in the study (Table 1). Aesthetic quality is important to homeowners, and the three aesthetic attributes included in the study were color, texture, and weed infestation. Many home lawns have a significant amount of shaded area; thus, shade adaptation was included in the set of attributes. Consumers have shown interest in native plants for landscaping (Helfand, Sik Park, and Nassauer, 2006), so origin was also included as an attribute, which was defined as being native to the United States or nonnative. Each of the aesthetic attributes, shade adaptation, and origin had two categories. The focus groups also helped identify three turfgrass maintenance practices of foremost importance to homeowners, specifically irrigating, fertilizing, and mowing. Therefore, these three maintenance attributes were included in the choice experiment, and each had three input categories corresponding to low, moderate, and high. Price points were determined based on turfgrass seed prices obtained from consulting with various seed sales professionals in the Minneapolis—St. Paul, MN, metropolitan area. To reduce error in participant estimation, price was given as the cost to seed an area 1,000 ft^2, and prices ranged between \$5.00 and \$20.00 with \$5.00 as the incremental interval.

Lusk and Schroeder (2004) demonstrated that marginal WTP was equivalent between hypothetical and nonhypothetical experiments when real products were used. To capture the effects of aesthetic characteristics on consumer choice behavior, we gave participants the opportunity to see and evaluate actual turfgrass plots instead of seed. Although showing a sample turfgrass plot is not typical for turfgrass varieties in retail stores, plots of new varieties are commonly tested in various public displays. Although consumers purchase seed, the turfgrass is the ultimate product that determines the demand for new turfgrass varieties (McCluskey et al., 2007). Therefore, having participants evaluate turfgrass plots allowed us to evaluate the market potential for several novel, low-input turfgrass varieties.

The choice experiment was conducted on field plots at the Turfgrass Research, Outreach, and Education Center at the University of Minnesota in St. Paul, MN, in June 2010. The turfgrass field plots (1.52 m × 0.91 m each) were seeded in August 2009; each species was seeded at the recommended seeding rate; and typical turfgrass establishment procedures were followed. The following six turfgrass species from the field plots were used in the study: colonial bentgrass, hard fescue, tufted hairgrass, prairie junegrass, perennial ryegrass, and Kentucky bluegrass. Additionally, multiple cultivars of each species were available for the choice experiment. The six different species and the multiple cultivars of each provided the necessary combinations of aesthetic attributes.

Sampling Methods

Participants were recruited by placing an advertisement in 13 local newspapers in and around the Minneapolis—St. Paul, MN, metropolitan area including both urban and suburban communities and also from www.minneapolis.craigslist.org. Participants were compensated $30.00 each for their time. To ensure that the sample was representative of the consumer market, only those consumers who had a home lawn and only members of the household who were able to make lawn care decisions and purchases were allowed to participate. One hundred thirty-six people participated in the experiment and 128 provided enough information for analysis. There were five separate sessions of the choice experiment and each session included between 20 and 30 participants.

Choice Experiment

The choice experiment was conducted to elicit consumer preference and WTP for the nine turfgrass attributes. Participants were presented with a series of choice scenarios, which consisted of adjacent or nearly adjacent turfgrass plots. To lessen the cognitive burden on participants, only two turfgrass plots were included in each scenario. The two turfgrass plots in each scenario varied in aesthetic quality. For example, if Plot A was dark green, fine in texture, and had weeds, then Plot B was light green, coarse in texture, and had no weeds. The two plots in each scenario also varied in shade adaptation and origin, levels of maintenance inputs, and price, which were displayed on labels in front of each turfgrass plot. Participants were asked to choose which alternative (i.e. turfgrass plot) in each choice scenario they would rather purchase. They were also given the option to choose "neither" (i.e. the opt-out alternative) for each scenario, indicating they would not purchase either alternative. The opt-out alternative was included in the experimental design to make the choice situation more realistic (Carlsson, Frykblom, and Lagerkvist, 2007). When an opt-out alternative is a viable option in the real choice situation, failure to allow for nondemanders could result in overestimates of participation (Ryan and Skatun, 2004). An example of one choice scenario is shown in Table 2.

Because it was not practical to ask each participant to choose from all possible scenarios, a fractional factorial design was developed to minimize scenario number and maximize profile variation. The design was developed based on four principles: 1) level balance (levels of an attribute occurred with equal frequency); 2) orthogonality (the occurrence of any two levels of different attributes were uncorrelated); 3) minimal overlap (cases in which attribute levels did not vary within a scenario were minimized); and 4) utility balance (the probabilities of choosing alternatives within a scenario were as similar as possible) (Louviere,

Table 2. An Example of the Choice Scenarios[a]

Consider a situation where you are provided two turfgrass choices. From the following pairs of turfgrasses, please choose which turfgrass you would prefer to purchase (you may choose "neither" if you would not purchase either).

Scenario 1	Alternative A	Alternative B	Alternative C
Price:	\$5.00/1000 ft^2	\$10.00/ 1000 ft^2	
Mowing requirement:	Every other week	Once a month	
Fertilizer requirement:	3 lbs nitrogen/1000 ft^2 per year	1 lb nitrogen/1000 ft^2 per year	Neither A nor B
Shade adaptation:	Sun	Sun or shade	
Irrigation requirement:	Less than once a week	1–2 times a week	
Origin:	Nonnative	Native (U.S.)	
Choose only one option.	☐	☐	☐

[a] Although aesthetic attributes were not labeled, alternatives in each scenario also varied in color, texture, and weed infestation.

Hensher, and Swait, 2000). After four clearly dominating alternatives were eliminated,[1] the resulting fractional factorial design consisted of a set of 16 scenarios to evaluate. For further discussion of fractional factorial designs, see Louviere, Hensher, and Swait (2000). The choice scenarios were designed using JMP® eight software (SAS Institute Inc., Cary, NC).

Before the experiment began, pricing was explained to participants as the price to seed 1000 ft^2, and an area adjacent to the experiment equivalent to 1000 ft^2 was marked off for participants to use as a reference during the experiment. To avoid order effects, turfgrass plots were presented in the field so that participants could start from any scenario and walk around freely while completing the choice experiment. The turfgrass plots were labeled clearly to ensure that participants matched the correct plots with each choice scenario in the survey. First, a practice round of choice scenarios was conducted to familiarize participants with the experiment, but in the practice round, neither the maintenance information nor origin was labeled on the turfgrass plots. Therefore, in the practice round participants made their choice based solely on the difference in turfgrass appearance, shade adaptation, and price. Labels including information about maintenance requirements and origin were then added to the turfgrass plots before the formal choice experiment was conducted. In the formal experiment, participants made their choice based not only on the appearance, shade adaptation, and price of a turfgrass alternative, but also based on maintenance requirements (irrigation, fertilizer, and mowing requirement) and origin (U.S. native or nonnative).

Questionnaire

After completing the choice experiment, participants were asked to fill out a short questionnaire, which included questions regarding demographics, home lawn characteristics, current maintenance practices as well as attitudes about low-input lawn care. The questionnaire was designed to identify potential relationships between participant demographics or attitudes and stated preferences as well as potential barriers to consumer acceptance of low-input turfgrasses.

Statistical Model

A mixed logit model was used to estimate the probability of a consumer's choice of certain turfgrasses and the WTP for different attributes.

[1] In the choice experiments, there were two alternatives (A or B) and one opt-out option (neither). If A is a dominating alternative, that means A is strictly better than B. For example, alternative A has a low irrigation requirement, low mowing requirement, low fertilizer requirement, and is dark green, fine textured, has no weeds, and it only costs \$5, but B has a high irrigation requirement, high mowing requirement, high fertilizer requirement, and is light green, coarse-textured, has weeds, and it costs \$15. It is obvious that participants would choose alternative A. In this case, it is hard to estimate which particular attribute(s) drive participants' decisions. Therefore, these dominating alternatives should be eliminated.

Unlike the standard logit model, the mixed logit model allows for correlation in factors (Train, 2003). We used the mixed logit model to capture all possible correlations for responses from the same participant. The statistical model was

$$(1) \qquad U_{nis} = \beta x_{nis} + \eta_i + \gamma_s + \varepsilon_{nis}$$

where U_{nis} was the use of individual n from choosing alternative i in scenario s; x_{nis} were vectors of observed variables relating to alternative i and individual n, which included the attributes of an alternative turfgrass; β was a vector of fixed coefficients; η_i was a vector of normally distributed random terms with mean zero and standard deviation σ_η, which was used to capture the possible correlations; γ_s was a vector of fixed scenario effects; and ε_{nis} was an identical and independent extreme value error term. The standard logit model is a special case of the mixed logit model where η has zero variance.

The density of η was denoted by $f(\eta|\Omega)$, where Ω was the fixed parameter vector of the distribution. For a given η, the conditional choice probability of alternative i was a standard logit:

$$(2) \qquad L_i(\eta) = \frac{e^{\beta x_i + \gamma + \eta}}{\sum_{j\in J} e^{\beta x_j + \gamma + \eta}}$$

J is the total number of alternatives and j refers to jth alternative, where $j = 1, 2, \ldots J$. Consequently, the unconditional choice probability P in the mixed logit model was the logit formula integrated over all values of η with density of η as weights:

$$(3) \qquad P_i = \int L_i(\eta) f(\eta|\Omega) d\eta$$

This integral was approximated through simulation (Alfnes et al., 2006; Brownstone and Train, 1999). The maximum likelihood estimation method was used to estimate coefficients with Stata 10.0 software (StataCorp, College Station, TX).

Results

Summary statistics of the participants' sociodemographic background are shown in Table 3. On average, participants were approximately 45 years old, and 51% of the participants were female. Sixteen percent of participants had

Table 3. Summary Statistics of Choice Experiment Participants' Background Information (n = 128)

Variable	Description of Variables	Mean	Standard Deviation
Age	Participants' age	44.778	14.005
Education			
Edulow	1 if high school diploma or less; 0 otherwise	0.156	0.363
Edumedium	1 if some college or college diploma; 0 otherwise	0.625	0.484
Eduhigh	1 if some graduate school or graduate degree	0.211	0.408
Gender	1 if female; 0 if male	0.512	0.500
Child	1 if having children younger than 12 years old at home; 0 otherwise	0.197	0.398
Income			
Incomelow	1 if household income is $50,000 or less; 0 otherwise	0.305	0.460
Incomemedium	1 if household income is greater than $50,000 and $100,000 or less; 0 otherwise	0.469	0.499
Incomehigh	1 if household income is greater than $100,000; 0 otherwise	0.227	0.419
Lawnsize	The size of home lawn; 1 if lawn size is more than 8000 ft^2; 0 otherwise	0.180	0.384

a high school diploma or less; approximately 63% of them had some college or a college diploma, and 21% had some graduate school or had a graduate degree. Twenty percent of participants had children younger than 12 years old. Thirty-one percent of the participants' household income was less than or equal to $50,000; 47% of participants' household income was greater than $50,000 and less than $100,000; and approximately 23% of participants' household income was over $100,000.

Eighteen percent of participants' home lawns were larger than 8000 ft^2, and when asked "What type of grass do you currently have on your lawn?," 61.8% indicated they did not know. Twelve percent of participants stated that they had Kentucky bluegrass on their lawn, and only 6.9% stated that they had perennial ryegrass. The lawn care practices of the participants varied widely. When participants were asked how often they watered their lawn during June, July, and August, 20.7% watered their lawn every other week or less; 35.1% watered their lawn once or twice a week; and 19.1% watered their lawn more than three times per week. Twenty-four percent of participants stated they watered their lawn "only when stressed." Sixty-six percent of participants mowed their lawn once or twice per week; 29.0% mowed their lawn every other week; and only 2.3% mowed their lawn once a month. When participants were asked the amount of fertilizer applied to their lawn per year, over half indicated that they did not know. Participants were more familiar with the frequency at which fertilizer was applied to their lawn per year. Twenty-four percent of participants fertilized their lawn three or more times per year; 51.9% fertilized one or two times per year; and 20.6% of participants never fertilized their lawn.

To investigate consumer WTP for turfgrass attributes, a mixed logit model[2] was used to estimate the probability of participant choice. Specifically, we used the "xtlogit" command in Stata to run the analysis. Log-likelihood ratio tests were conducted to compare the full model, which had both low-input attributes and the aesthetic attributes (log-likelihood of –2464.66), the model which had only the low-input attributes (log-likelihood of –2494.95), and the model that only had the aesthetic attributes (log-likelihood of –2575.29). The *p* values of the log-likelihood ratio test statistics were <0.05, and the test results showed that the full model had the best goodness-of-fit. The low-input attributes did significantly affect participants' preference and WTP for turfgrasses. We also tested for relationships between participants' lawn care practices and their stated preferences, but we did not detect any significant relationships.

The estimation results of the mixed logit model are shown in Table 4. The coefficient of price (*Price*) was negative and significant, meaning that the higher the price, the less likely that a choice alternative was chosen. The coefficients of the low irrigation requirement (*Waterlow*) and the moderate irrigation

Table 4. The Estimation Results of the Mixed Logit Model (n = 6144)[a]

Independent Variables	Coefficient	Standard Error
Price	−0.155***	0.059
Waterlow	1.505***	0.173
Watermedium	0.906***	0.156
Fertilizerlow	0.31	0.214
Fertilizermedium	0.17	0.169
Mowinglow	0.607***	0.216
Mowingmedium	0.460*	0.287
Native	0.825	0.58
Sun	0.805**	0.387
Fine	1.360**	0.547
Dark	0.413*	0.26
Weeds	−1.161***	0.337
*Native*Price*	0.055***	0.022
*Sun*Fine*	−0.509	0.625
Intercept	0.179	0.512
Random individual effect		
σ_η	0.203***	0.031

[a] There were 128 participants and each of them evaluated 16 alternatives, which gives 6144 (128*16) observations in total. A single asterisk (*), double asterisks (**), and triple asterisks (***) denote significance at the α = 0.05, 0.01, and 0.001 levels, respectively.

[2] Both a probit model and logit model were used for the statistical analysis, and the resulting willingness-to-pay estimates were nearly identical.

requirement (*Watermedium*) were positive and significant indicating that, compared with the high irrigation requirement, low and moderate irrigation requirements increased the likelihood that a turfgrass choice alternative was chosen. The coefficients of the low mowing requirement (*Mowinglow*) and the moderate mowing requirement (*Mowingmedium*) were also positive and significant, meaning that compared with the high mowing frequency, low and moderate mowing requirements increased the likelihood that a choice alternative was chosen.[3] Turfgrasses with fine leaf texture, dark green color, and no weed encroachment were more likely to be chosen. The presence of weeds in a plot strongly discouraged participants from choosing the turfgrass. Being native to the United States did not increase the likelihood of a turfgrass choice alternative being chosen because the main effect of origin (*Native*) was not significant. However, it did decrease participant sensitivity to price because the interaction between price and origin (*Native*Price*) was positive and significant. The scenario fixed effects were controlled in the model. The random individual effect was significant, which indicated there was a significant correlation between the choices made by the same participants. The random individual effect effectively controlled the differences in sociodemographic backgrounds among participants.

The price premium participants were willing to pay for an attribute was estimated by dividing the corresponding attribute's coefficients by the absolute value of the coefficient of price, and these premiums represent the extra cost participants were willing to pay to seed an area of 1000 ft^2. The price premiums for low-input attributes are shown in Table 5. Compared with the high irrigation requirement, participants were willing to pay \$9.70 per 1000 ft^2 more for a turfgrass with a low irrigation requirement and \$5.85 per 1000 ft^2 more for a turfgrass with a moderate irrigation requirement. Compared with the most frequent mowing requirement, participants were willing to pay \$3.92 per 1000 ft^2 more for a turfgrass requiring infrequent mowing and \$2.97 per 1000 ft^2 more for a turfgrass requiring moderately frequent mowing. Compared with the high fertility requirement, the premiums for turfgrasses with low and moderate fertility requirements, \$2.00 and \$1.10 per 1000 ft^2, respectively, were not significant. We conducted tests to investigate if there were any significant differences between the WTP for low and moderate levels of irrigation, mowing, and fertilizer requirements. The WTP for the low irrigation requirement was significantly higher than that for the moderate irrigation requirement ($p = 0.027$); the WTP for the low mowing requirement was not significantly different from that for the moderate mowing requirement ($p = 0.482$); and the WTP for the low fertilizer requirement was not significantly different from that for the moderate fertilizer requirement ($p = 0.140$).

Discussion and Conclusions

Turfgrass is an important and beneficial component of urban landscapes, and approximately 75% of the total U.S. turfgrass coverage is home lawn acreage (Hull, Alm, and Jackson, 1994). As public concerns about the environment continue

Table 5. Willingness-to-Pay Premium Estimates for Low-Input Attributes from the Mixed Logit Model (n = 6144)

Attribute	Mean (\$ per 1000 ft^2)	Standard Error
Waterlow	9.70	3.52
Watermedium	5.85	1.95
Fertilizerlow	2.00	0.78
Fertilizermedium	1.10	0.83
Mowinglow	3.92	2.18
Mowingmedium	2.97	1.90

[3] The fertilizer attribute levels were both insignificant. It is possible that there was a correlation between fertilizer attribute levels and mowing requirement (i.e. greater fertilizer application could lead to more frequent growth and therefore mowing). We tried to avoid this correlation in the experimental design to obtain the separate effects of the fertilizer attributes and mowing frequency attributes on participants' preference. When tested, the correlation between the two attributes was very low. Specifically, the correlation between *Mowinglow* and *Fertilizerlow* was 0.07; the correlation between *Mowingmedium* and *Fertilizermedium* was 0.08; and the correlation between *Mowinglow* and *Fertilizermedium* was –0.02.

to grow and costs of natural resources rise, the demand for low maintenance landscapes will also increase. Additional regulation of lawn care practices may also increase this demand. The use of low-input turfgrasses could be a viable strategy to meet these demands, but the success of this strategy will be largely determined by the market potential of low-input turfgrasses.

The primary goal of this research was to explore how low-input attributes of turfgrasses might affect consumer demand. Choice experiments with turfgrass plots were used to elicit the WTP for turfgrasses with various attributes to accomplish this objective. Our results suggest that the maintenance attributes of turfgrasses greatly affect consumer demand. Although aesthetic characteristics played a significant role in consumer choice, our results indicate that low-input characteristics are equally important marketing points for turfgrasses. These results also provide direction for future efforts of plant breeders in developing more low-input, sustainable turfgrass varieties.

Irrigation requirement was the most influential maintenance attribute affecting consumer choice behavior, followed by mowing requirement, and lastly fertility requirement. Likewise, participants were willing to pay the highest premium for a turfgrass with a low irrigation requirement. It is likely that the strong preference for water conservation is not only the result of cost savings, but also the result of environmental concerns. Over 75% of participants slightly to strongly agreed with the statement "water use on home lawns is an environmental concern."

Mowing requirement was the second most influential input attribute on choice behavior. Although participants did not indicate a significant preference between having to mow every other week vs. once or twice a week, they did indicate a strong preference for mowing on a monthly basis. The results indicate there is great market potential for some turfgrass species (e.g. fine fescues) that can provide acceptable quality when mowed on a monthly basis or only twice per year (Meyer and Pedersen, 2000; Watkins et al., 2011).

Fertilizer requirement did not affect consumer WTP. Participants' responses to the questionnaire show that approximately half of participants did not know the total amount of fertilizer applied to their home lawn per year. Previous research has also found that most homeowners are unfamiliar with the recommended fertility practices (Carpenter and Meyer, 1999). This lack of knowledge could be a potential reason for the lack of significance of fertility requirement. Another possible explanation for why fertility requirement did not affect choice behavior is that participants already perceived their fertility practices to be low input, considering over 70% of participants fertilized their lawn two times per year or less.

Although native origin decreased consumer sensitivity to price, species origin was not an important driver of WTP. Although origin may affect the choice behavior of consumers concerning other landscape plants (Helfand, Sik Park, and Nassauer, 2006; Zadegan, Behe, and Gough, 2008), our results suggest that currently there may not be significant demand for native turfgrasses in residential landscapes. Rather, participants placed higher importance on aesthetic and maintenance attributes.

Participants preferred turfgrasses with dark green color and fine leaf texture, and the most important aesthetic characteristic was the absence of weeds. Efforts should be focused on developing cultivars that are competitive against weed encroachment. We also found more than 80% of participants agreed with statement "pesticide use is harmful to human health and the environment." Results suggest that future plant breeding efforts could be directed to increasing the aggressiveness or allelopathy (i.e. natural weed suppression) of turfgrass varieties as a means of providing non-chemical weed control for low-input or organic lawns.

The development of low-input turfgrasses deserves further consideration as a strategy to reduce the environmental and economic costs of home lawn maintenance. These results suggest that changes in residential turfgrass management could potentially benefit the turfgrass seed industry because of the large price premiums associated with low-input attributes. Low-input turfgrasses could also provide a means for the industry to take advantage of increased regulatory action. As environmental concerns continue to manifest, the turfgrass industry may develop a greater interest in producing and marketing low-input turfgrasses.

There are some limitations to the methods and analysis used in this study. Participants were recruited from in and around the Minneapolis–St. Paul, MN, metropolitan area, so the results may not be representative of other regions of the United States. Compared with other hypothetical surveys, the sample size was relatively small. These limitations suggest the results should be interpreted carefully, but the results also identify directions for future research for the improvement of low-input turfgrasses and their introduction to the lawn care industry and consumers.

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References

Alfnes, F., A. Gutormsen, G. Steine, and K. Kolstad. "Consumers' Willingness to Pay for the Color of Salmon: A Choice Experiment with Real Economic Incentives." *American Journal of Agricultural Economics* 88(2006): 1050–61.

Alig, R., J. Kline, and M. Lichtenstein. "Urbanization on the U.S. Landscape: Looking Ahead in the 21st Century." *Landscape and Urban Planning* 69(2004):219–34.

Beard, J., and R. Green. "The Role of Turfgrasses in Environmental Protection and Their Benefits to Humans." *Journal of Environmental Quality* 23(1994):452–60.

Boer, K., and J. Ripp. 2008. "Wisconsin Municipal Water Use Regulation: A Summary of Water Use Ordinances in Wisconsin." Madison, WI: Public Service Commission of Wisconsin. Internet site: http://psc.wi.gov/utilityinfo/water/document/WIWaterUseRegulation.pdf (Accessed March 26, 2012).

Brilman, L., and E. Watkins. "Hairgrasses (*Deschampsia* spp.)." *Turfgrass Biology, Genetics, and Breeding*. M. Casler and R. Duncan, eds. Hoboken, NJ: John Wiley and Sons, 2003.

Brooks, K., and J. Lusk. "Stated and Revealed Preferences for Organic and Cloned Milk: Combining Choice Experiment and Scanner Data." *American Journal of Agricultural Economics* 92(2010):1229–41.

Brownstone, D., and K. Train. "Forecasting New Product Penetration with Flexible Substitution Patterns." *Journal of Econometrics* 89(1999): 109–29.

Burton, M., and D. Pearse. "Consumer Attitudes towards Genetic Modification, Functional Foods, and Microorganisms: A Choice Modeling Experiment for Beer." *AgBioForum* 5(2002):51–58.

Carlsson, F., P. Frykblom, and C. Lagerkvist. "Consumer Benefits of Labels and Bans on GM Foods—Choice Experiments with Swedish Consumers." *American Journal of Agricultural Economics* 89(2007):152–61.

Carpenter, P., and M. Meyer. "Edina Goes Green Part III: A Survey of Consumer Lawn Care Knowledge and Practices." *HortTechnology* 9(1999):491–94.

Christians, N. *Fundamentals of Turfgrass Management*. 2nd ed. Hoboken, NJ: John Wiley and Sons, 2004.

Diesburg, K., N. Moore, R. Branham, B. Danneberger, T. Reicher, Z. Voigt, T. Minner, and D. Newman. "Species for Low-Input Sustainable Turf in the U.S. Upper Midwest." *Agronomy Journal* 89(1997):690–94.

Duncan, R. "Seashore Paspalum (*Paspalum vaginatum* Swartz)." *Turfgrass Biology, Genetics, and Breeding*. M. Casler and R. Duncan, eds. Hoboken, NJ: John Wiley and Sons, 2003.

Engel, U., and M. Poetschke. "Willingness to Pay for the Environment: Social Structure, Value Orientations and Environmental Behavior in a Multilevel Perspective." *Innovation (Abingdon)* 11(1998):315–32.

Engelke, M., and S. Anderson. "Zoysiagrasses (*Zoysia* spp.)." *Turfgrass Biology, Genetics, and Breeding*. M. Casler and R. Duncan, eds. Hoboken, NJ: John Wiley and Sons, 2003.

Gladwin, T., J. Kennely, and T. Krause. "Shifting Paradigms for Sustainable Development—Implications for Management Theory and Research." *Academy of Management Review* 20(1995):874–907.

Government of Quebec. 2006. The Pesticides Management Code. Ministere du Developpement Durable, de l'Environnement et des Parcs, Quebec, Canada. Internet site: http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=3&file=/P_9_3/P9_3R1_A.HTM (Accessed March 26, 2012).

Guagnano, G., T. Dietz, and P. Stern. "Willingness to Pay for Public Goods: A Test of the Contribution Model." *Psychological Science* 5(1994):411–15.

Hanna, W., and J. Liu. "Centipedegrass (*Eremochloa ophiuroides*)." *Turfgrass Biology, Genetics, and*

Breeding. M. Casler and R. Duncan, eds. Hoboken, NJ: John Wiley and Sons, 2003.

Helfand, G., J. Sik Park, and J. Nassauer. "The Economics of Native Plants in Residential Landscape Designs." *Landscape and Urban Planning* 78(2006):229–40.

Hu, W., A. Hünnemeyer, M. Veeman, W. Adamowicz, and L. Srivastava. "Trading Off Health, Environmental and Genetic Modification Attributes in Food." *European Review of Agriculture Economics* 31(2004):389–408.

Hu, W., T.A. Woods, and S. Bastin. "Consumer Acceptance and Willingness to Pay for Blueberry Products with Nonconventional Attributes." *Journal of Agricultural and Applied Economics* 41(2009):47–60.

Hull, R.J., S.R. Alm, and N. Jackson. "Toward Sustainable Lawn Turf." *Handbook of Integrated Pest Management for Turf and Ornamentals*. A.R. Leslie, ed. Boca Raton, FL: CRC Press, 1994.

Johnson, P. "Native Grasses as Drought-Tolerant Turfgrasses of the Future." *Handbook of Turfgrass Management and Physiology*. M. Pessarakli, ed. Boca Raton, FL: CRC Press, 2008.

Krenitsky, E., M. Carroll, R. Hill, and J. Krouse. "Runoff and Sediment Losses from Natural and Man-Made Erosion Control Materials." *Crop Science* 38(1998):1042–46.

Laroche, M., J. Bergeron, and G. Barbaro-Forleo. "Targeting Consumers Who Are Willing to Pay More for Environmentally Friendly Products." *Journal of Consumer Marketing* 18(2001): 503–20.

Louviere, J., D. Hensher, and J. Swait. *Stated Choice Methods: Analysis and Applications*. 5th ed. New York, NY: Cambridge University Press, 2000.

Lusk, J., and T. Schroeder. "Are Choice Experiments Incentive Compatible? A Test with Quality Differentiated Beef Steaks." *American Journal of Agricultural Economics* 86(2004): 467–82.

Massachusetts Department of Environmental Protection (MassDEP). 2010. *Municipal Water Use Restrictions*. Massachusetts Office of Energy and Environmental Affairs: Boston, MA. Internet site: http://www.mass.gov/dep/water/resources/wateruse.htm (Accessed March 26, 2012).

McCluskey, J.J., R.C. Mittelhammer, A.B. Marin, and K.S. Wright. "Effect of Quality Characteristics on Consumers' Willingness to Pay for Gala Apples." *Canadian Journal of Agricultural Economics* 55(2007):217–31.

McPherson, E., J. Simpson, and M. Livingston. "Effects of Three Landscape Treatments on Residential Energy and Water Use in Tucson, Arizona." *Energy and Building* 13(1989):127–38.

Meyer, M., and B. Pedersen. "Low Maintenance Alternative Turf Trials." *Journal of Turfgrass Management* 3(2000):49–57.

Milesi, C., S. Running, C. Elvidge, J. Dietz, B. Tuttle, and R. Nemani. "Mapping and Modeling the Biogeochemical Cycling of Turf Grasses in the United States." *Environmental Management* 36(2005):426–38.

Mintenko, A., S. Smith, and D. Cattani. "Turfgrass Evaluation of Native Grasses for the Northern Great Plains Region." *Crop Science* 42(2002):2018–24.

Mtimet, N., and L. Albisu. "Spanish Wine Consumer Behavior: A Choice Experiment Approach." *Agribusiness* 22(2006):343–62.

Onken, K.A., J.C. Bernard, and J.D. Pesek. "Comparing Willingness to Pay for Organic, Natural, Locally Grown, and State Marketing Program Promoted Foods in the Mid-Atlantic Region." *Agricultural and Resource Economics Review* 40(2011):33–47.

Purser, R., C. Park, and A. Montuori. "Limits to Anthropocentrism: Toward an Ecocentric Organization Paradigm?" *Academy of Management Review* 20(1995):1053–89.

Quian, Y., R. Follett, and J. Kimble. "Soil Organic Carbon Input from Urban Turfgrasses." *Soil Science Society of America Journal* 74(2010): 366–71.

Riordan, T., and S. Browning. "Buffalograss, *Buchloe dactyloides* (Nutt). Engelm." *Turfgrass Biology, Genetics, and Breeding*. M. Casler and R. Duncan, eds. Hoboken, NJ: John Wiley and Sons, 2003.

Robbins, P., and T. Brikenholtz. "Turfgrass Revolution: Measuring the Expansion of the American Lawn." *Land Use Policy* 20(2003): 181–94.

Robbins, P., and J. Sharp. "The Lawn–Chemical Economy and Its Discontents." *Antipode* 35(2003):955–79.

Ruemmele, B., J. Wipff, L. Brilman, and K. Hignight. "Fine-Leaved *Festuca* Species." *Turfgrass Biology, Genetics, and Breeding*. M. Casler and R. Duncan, eds. Hoboken, NJ: John Wiley and Sons, 2003.

Ryan, M., and D. Skatun. "Modeling Non-Demanders in Choice Experiments." *Health Economics* 13(2004):397–402.

Schlegelmilch, B., G. Bohlen, and A. Diamantopoulos. "The Link between Green Purchasing Decisions and Measures of Environmental Consciousness." *European Journal of Marketing* 30(1996):35–55.

State of Minnesota. 2010. *Minnesota Statute 18C.60: Phosphorus Turf Fertilizer Use Restrictions*. Office of the Revisor of Statues, State of Minnesota, St. Paul, MN. Internet site: https://www.revisor.mn.gov/statutes/?id=18C.60&year=2011 (Accessed March 26, 2012).

State of Wisconsin. 2011. *Wisconsin Statute 94C.643: Restrictions on the Use and Sale of Fertilizer Containing Phosphorus*. Legislative Reference Bureau, State of Wisconsin, Madison, WI. Internet site: http://docs.legis.wi.gov/statutes/statutes/94/643 (Accessed March 26, 2012).

Straughan, R., and J. Roberts. "Environmental Segmentation Alternatives: A Look at Green Consumer Behavior in the New Millennium." *Journal of Consumer Marketing* 16(1999):558–75.

Train, K. *Discrete Choice Methods with Simulation*. 1st ed. New York, NY: Cambridge University Press, 2003.

Watkins, E., S. Fei, D. Gardner, J. Stier, S. Bughrara, D. Li, C. Bigelow, L. Schleicher, B. Horgan, and K. Diesburg. "Low-Input Sustainable Turfgrass Species for the North-Central United States." *Applied Turfgrass Science* (2011):1–11. Internet site: http://www.plantmanagementnetwork.org/ats/element/sum2.aspx?id=9393 (Accessed March 26, 2012).

Yue, C., C. Hall, B. Behe, B. Campbell, J. Dennis, and R. Lopez. "Are Consumers Willing to Pay More for Biodegradable Containers Than for Plastic Ones? Evidence from Hypothetical Conjoint Analysis and Non-hypothetical Experimental Auctions." *Journal of Agricultural and Applied Economics* 42(2010):757–72.

Zadegan, Y., B. Behe, and R. Gough. "Consumer Preferences for Native Plants in Montana Residential Landscapes and Perceptions for Naturalistic Designs." *Journal of Environmental Horticulture* 26(2008):109–14.