Turfgrass producer preferences for certification and royalty fee structures

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Abstract

Plant scientists have bred turfgrass varieties to create more desirable traits for long-term maintenance, appearance, utility, and resistance to abiotic and biotic stressors. As universities seek to capture revenue to cover research costs, these varieties are increasingly protected by intellectual property rights such as US plant patents and plant variety protection certificates. Producers require license to produce and sell proprietary varieties, and are required to pay royalties, impacting the types of varieties marketed for sale. Therefore, turf breeders must identify producer demand for various grass varieties, and understand 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 variety, certification agency, fee structure, maintenance reduction potential, and price per square foot. Results from the analysis indicate that producers preferred genetically modified breeds and fee structures that allow producers to share the cost with the breed developers.

JEL classification – D18 consumer protection, L15 information and product quality; standardization and compatibility

Introduction and objectives

Sod and turfgrass has become a landscaping essential over the years, and its economic implications on the US economy and its environmental impact is quite significant. The nursery, greenhouse, floriculture, and sod in the US is a $14 billion industry in sales and counts more than 52 thousand commercial operations. Out of this, 1,739 sod farms used 321 thousand acres of land for their operations and accounted for a sales value of more than $1 billion by 2012 (United States Department of Agriculture 2012). Although the demand for turfgrass is essentially due to its necessity in the landscaping sector (Haydu, Hodges and Hall 2006), and its aesthetically pleasing qualities, turfgrass also provides significant environmental benefits (Beard and Green 1994). Turfgrass acts as an air purifier by trapping dust and absorbing carbon dioxide, serves as a cooling agent in the environment, and also helps curb soil erosion.

Turfgrass maintenance requirements have become increasingly demanding over the last few decades with increases in maintenance costs, homeowners' lack of time to invest in lawn care, and unpredictable weather conditions (Hodges, et al. 1994, Cisar 2004). Therefore, plant scientists have sought ways to breed turf varieties with improved qualities, such as drought tolerance, salinity tolerance, and other attributes that reduce maintenance (Funk, White and Breen 1993, Casler 2006). As a result, hybrid varieties of turf were bred, where different genotypes of grasses with individual desired characteristics were cross-pollinated to achieve a variety that encompasses both desired characteristics of the parent grasses. Later using genetic engineering technologies, breeders were able to further intensify desirable characteristics of turf seed and to make maintenance of the grasses more convenient. However, genetically modified technologies do not come without risk. Bio safety concerns, and concerns over cross-pollination with native plant species are often cited as risks associated with introducing genetically modified plant species.

Regardless of the method, turfgrass with enhanced desirable characteristics are often protected by intellectual property rights, and turf producers are required to obtain licenses and incur royalty fees for the production and sale of these varieties. Turfgrass licensing also acts as a marketing tool for the producers, because the license indicates an assured quality to the end consumer. Therefore, understanding the demand for these commodities is important for successful marketability of innovative breeds and maintaining profits for both the sod producers and the seed breeders. Hence, one of the objectives of this study is to understand what methods of licensing and royalty fee structures that producers prefer. Overall producer preferences will be analyzed for turfgrass sod characteristics such as their marketable end price, genetic type, licensing, and maintenance requirements.

Literature review

Improved seed varieties that enhance desirable qualities and/or reduce undesirable qualities have led to increased turf productivity in the US for the last few decades (Cisar 2004). Most of these improved qualities are attained via hybridization or genetic modification of the crop. Demand preference studies related to genetically modified plants are abundant, and mainly in the areas of preference for genetically modified food crops and other commercially valuable plants. The United States has been generally receptive to the technology of genetic modification compared to other parts of the world (Fernandez-Cornejo, et al. 2014, Wu 2004), and has adopted these heavily in food and commercial crops such as corn, soy, and cotton (Fernandez-Cornejo, et al.

2014). However, the acceptability of genetic modification in the turfgrass industry has largely not been examined.

Although, hybrid varieties of grasses have historically achieved the desirable characteristics that are useful for human convenience, genetic modification of turf grasses is expected to further enhance these qualities. Unlike traditional hybridization, the technology of genetic modification allows foreign genes from unrelated species to be introduced to a species of turf (Wang and Brummer 2012). Today, genetically modified plant species are among the most common forms of major cash crops in the United States, predominantly to make them 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).

In general, genetically modified food crops are undesirable to consumers, and this is largely evident in European countries. Studies found that perceived risks of genetically modified food usually overwhelm the consumers when no direct benefit is presented; thus, some consumers are usually willing to pay a premium for genetically modified organism genetically modified organism (GMO) free food (Lusk, House, et al. 2004, Lusk, Daniel, et al. 2001, Chung, Boyer and Han 2009). Other studies suggested that lower prices and education regarding the safety of GMO food can sway some to become more accepting consumers (Lusk, House, et al. 2004, Noussair, Robin and Ruffieux 2004).

Not unlike food crops, genetically modified turf is also faced with considerable opposition despite its potential to make landscaping convenient (Warren and Cummins 2014), due to its biosafety hazards (Wang and Brummer 2012). There are several biohazard concerns when it comes to commercializing genetically modified grasses. Firstly, there is a possibility of genetically modified crops intermixing with their wild relatives. Secondly, because such gene flow tendencies can occur rapidly and over a considerably higher distances. Finally, because wild species after mating with genetically engineered relatives could cause invasiveness (Ellstrand 2003, Marvier and Acker 2005, McHughen and Smyth 2012). However, expectations of higher and quality-wise resilient harvests, and the overall reduction in costs associated with pesticides and maintenance has increasingly induced producers to adopt genetically modified crops.

With the introduction of improved turfgrass varieties and the renewal of intellectual property rights, breeders of improved varieties of seed increasingly opted for seed certification to maintain profits and market share (Fernandez-Cornejo, The seed industry in U.S. agriculture 2004). Certification is a tool that is used to ensure unobservable quality attributes of a given product under asymmetric information conditions and part of the certification process involves establishing royalty payments for the breeder and/or the patent holder. Both licensing and royalty payment for an innovation lends validity and marketability to the product. Therefore, certification and licensing is a very important aspect in the sod industry and is relatively less researched.

In the US, certification of genetic purity is conducted by state agencies of the Association of Official Seed Certifying Agencies (AOSCA) where the certification is provided after inspecting all aspects of the production process from ground preparation to harvest (Martin 2014). According to Jahn, Schramm and Spiller (2005) state run certification systems' objectives are to attain market transparency, and consumer protection by signaling information to the consumer, while the privately structured certification systems aim at quality controling 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 increases costs. This process includes testing the seed for its certification, and testing the fields for contaminants such as other plant species, weeds, and pests. Once the seeds are planted, a field inspection will be carried out by the state agency or licensing breeder, depending on who serves as the certifier. Once After the producer passes the field test, official tags or labels for the final produced seed or 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 n.d.).

As certified seed are developed with considerable time and effort on the part of the breeder, patenting such varieties 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 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).

Hypotheses and methodology

Determining producer preferences for different types of certification methods and royalty fee structures given other attributes such as price and breed etc. 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 conjoint method to determine consumer preferences (Behe 2006, Campbell, et al. 2004, Yue, et al. 2010, Hugie, Yue and Watkins 2012, Lusk 2011, Roe, Sporleder and Belleville 2004). Conjoint choice 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 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).

Based on the material already published, we hypothesize that producers maximize profit. Therefore, the profit maximizing producer is assumed to opt for some form of certification compared to not having a certification requirement. We assume breeders would prefer a lump-sum minimum and a percentage on sales to maximize their profits. We also assume that the rational producer will opt for a percentage on sales to avoid having to pay a lump-sum amount as royalty for a breed that might not be poplar in the market. Therefore the second hypothesis is that producers would prefer a royalty payment structure that is proportional to sales, and share the risk of market acceptance with the breeder at all times.

The survey consisted of a choice experiment with 6 choice sets, basic demographics on the producers, and questions concerning the producers' operation such as size, revenue, and location. Producers made choices between different turfgrass options based on price, breed variety, maintenance reduction, certification requirements, and fee structures. Each of these attributes was allowed to change at different levels. The differences in these levels are slight but important in terms of arriving at a middle ground both the producer and the breeder. A complete list of attributes is presented in Table 1.

Table 1: Attributes and attribute levels used for the choice experiment

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

The choice experiment in each survey included 6 randomly selected conjoint choice questions out of a pool of 30 questions. Each choice question was presented with three scenarios, of which one was always the status quo or the “opt out”. See Figure 1 for a sample of choice set.

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: Example from a discrete choice set used to assess the producer willingness to pay for a new variety of turfgrass

Because the attribute levels were unbalanced as presented in Table 1 and because a full factorial design cannot be accommodated in the 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 attempt to understand the producers' stated preference for one bundle of turfgrass attributes among two alternatives, and an opt-out option. As a result, the dependent variable is a three by one binary vector where zeros represent the non-chosen alternatives and 1 represents the chosen

[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

alternative. Because the dependent variable is discrete and options are conditional among the alternatives, the analysis calls for a conditional logit model.

If *V* represents a discrete choice among *j* number of alternatives, U_{ij} is the utility derive from the j^{th} alternative for the i^{th} individual. But, as utility is a latent variable, the model attempts to explain *V* in terms of *X* where, X_{ij} is the matrix of attributes of option *j* for the i^{th} individual –

$$U_{ji} = f(V_{ji}) \quad (1)$$

$$V_{ij} = f(X_{ij}) \quad (2)$$

We assume that the option chosen by the producer (indicated by 1 in the response vector *V*) maximizes his/her utility compared to the other alternatives. Therefore the utility maximizing model for the i^{th} individual can be denoted by:

$$V_{ij} = X_{ij}\beta + \varepsilon_{ij} \quad (3)$$

Where ε_{ij} is the stochastic error term, and $X_{ij}\beta$ explains the producer choice.

Data were analyzed using STATA13 (June 2013) software package with the goal of estimating producers' willingness to produce. Since the producer's utility function is linear in parameters the functional form of a producer's utility may be written as:

$$V_{ij} = \beta_{Price} + \beta_{Breed} + \beta_{Certification} + \beta_{Fee\ structure} + \beta_{Maintenance\ reduction} \quad (4)$$

The variables used for the conditional logit model are presented in Table 2.

Table 2: Variable description

Parameter	Type	Description
Genetically modified	Breed/Variety	1 if genetically modified, 0 otherwise
Certification_state	Certification/Inspection	1 if certification is done by state, 0 otherwise
Certification_breeder	Certification/Inspection	1 if certification is by breed developer, 0 otherwise
Fee1	Fee Structure	1 if annual flat rate payment with unlimited unit sales, 0 otherwise
Fee2	Fee Structure	1 if annual fee plus percentage on unit sale, 0 otherwise
Fee3	Fee Structure	1 if fee based on percentage of sales, 0 otherwise
Fee4	Fee Structure	1 if fee based on annual fee plus percentage on sales with minimum sales payment, 0 otherwise
Maintenance	10% Maintenance Reduction	1 if a variety has a 10% maintenance reduction 0 otherwise
Price	Price	price is varied in 10 cent increments form 15 cents per square foot to 55 cents per square foot

Data and results

Because data for producer preferences of grasses given genetics, certification method, and fee structures were not available, a survey instrument was used to collect the necessary data. The survey was inspected and approved by the 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 turf producer 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.

At the end of the survey collection period, the total number of surveys received was 48, out of which only 16 surveys were completed, accounting for a response rate of about 2.54 percent. 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. Close to 56 percent of the responding producers already produced proprietary varieties and pedigree varieties, and the businesses' revenue from turf sales in 2014 ranged from less than $100 thousand to $6 million.

To understand the data better and to avoid losing too many degrees of freedom due to the limited number of observations, we only estimate a main effects model. Along with the conditional logit for the parameter estimate, we also calculate the producer's marginal willingness to produce as a post estimation procedure. The producer's willingness to produce is similar to that of an individual's willingness to accept. Both willingness to pay and willingness to accept are welfare measures that try to 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). Both willingness to pay and accept use the same equation (only the interpretation of it differs), and can be written as –

$$WTA = \frac{\Delta\beta_j}{\beta_y} \quad \text{(Haab and McConnell 2003)} \tag{5}$$

Where, β_j is the parameter estimate of a selected attribute, and β_y is the marginal utility of income/price. Results of the conditional logit model and marginal willingness to produce calculations obtained from the coefficients are reported in Table 3 and Table 4 respectively.

Table 3: Results of the conditional logit estimation

Parameter	Coefficient	Standard deviation
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
Pseudo R^2	0.111	
AIC	289.291	
SCI	318.921	
Log Likelihood	-136.645	

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

Table 4: Marginal willingness to produce estimates in US dollars per square foot of sod on sale

Parameter	WTP [$]	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

Results recorded in Table 3 indicate that most of the hypotheses we formed held. The main effects model indicated that respondents preferred genetically modified seed compared to hybrid varieties, and the results are significant at 99% level of significance. Producers also preferred paying a percentage on sales (fee structure 3) compared to fee structures 1, 2, and 4. These coefficients are significant at least 90% level of significance. The price coefficient is positive and significant indicating that higher the price per square foot of turf, greater the chances of producers opting to produce, and is significant at 99% level of significant.

Marginal willingness to produce estimates reported in Table 4 allow us to understand how valuable each attribute or each level of a certain attribute is to the producer and also records the 95% confidence intervals for the estimates using a non-parametric bootstrap method. From the main effects model, 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 $0.34, $0.44 and $0.42 in price per square foot respectively to accept fee structures 1, 2 and 4 (USD, 2014). These makes intuitive sense as fee structures other than 3 are more regimented compared. Because producers preferred genetically modified turf compared to traditional hybrid varieties, on average producers are willing to produce genetically modified varieties for $0.33 less than the farm gate price. However, none of these estimates are statistically significant.

Conclusion

The results obtained from the analysis give a basic intuition of sod producers' preference for different attributes and potential pricing schemes for new turfgrass varieties. The key findings of this study shed light into two important questions for breed developers: the turfgrass producer preference for certification and licensing fee structures.

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 as they wish to share risk with breeders. This is also evident in the greater coefficients for these fee structures in the conditional logit. However, because the marginal willingness to pay estimates are not statistically significant we refrain from making any broader conclusions about its welfare implications. Producers opting to share the risks of marketability and profit might indicate that there is uncertainty in the market. This lack of certainty in the market for efficient seed varieties suggests that there is room for research on consumer preferences, i.e. the end market, to reduce the risk that producers perceive when adopting seed varieties production. As producers can only adopt a handful of varieties to grow in quantity, breeders may need to close that information gap prior to development. Breed 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.

Due to the low response rate for the survey, results of this study should be used with some caution. Results obtained for this survey should only serve as ballpark estimates, or to suggest directionality of the variables used. Especially, considering that the number of observations were as low as 300, 250 iterations in the bootstrapped willingness to pay estimates may be too intensive for the data set to handle. Because of the limited number of observations, sampling out from the already low sample may cause the standard errors to be artificially large resulting in the lack of statistical significance in the willingness to pay estimates.

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 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 variety of turfgrass.

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