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Water Savings and Return on Investment of a New Drought Resistant Turfgrass

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Abstract:

TifTuf is a new cultivar of Bermudagrass that has increased drought resistance compared to similar cultivars. Furthermore, TifTuf has outperformed other cultivars of Bermudagrass in traffic tolerance, shade tolerance, and time till dormancy. Given increasing pressure to conserve water throughout the U.S. there is a desire by many consumers to incorporate more drought tolerate plants/turfgrasses into their landscape. Since TifTuf has been proven to provide increased drought tolerance it is currently sold at a premium price compared to other Bermudagrass cultivars. As such, there is no information available that examines the payback period and potential water savings for TifTuf. In this study we develop a model evaluate potential cost savings for TifTuf relative to a conventional Bermudagrass. We produce a total cost savings and water savings over a five year period as well as developing a return on investment time for two different scenarios.

Conservation of water has become an increasingly important issue throughout the United States. Drought times and the disappearance of reservoirs around the country have led to a change in water usage for many Americans. Citizens' awareness of water issues has led to the creation of a market for less water intense products. Bermudagrass cultivars are some of the most drought tolerant turfgrasses (Harvivandi et al., 2009) with the TifTuf Bermudagrass cultivar having better drought tolerance than previous cultivars developed (Schwartz, 2017). Along with increased drought tolerance, TifTuf has a shorter dormancy period, higher traffic tolerance, and has shown some shade tolerance (Schwartz, 2017). TifTuf costs a premium of five cents per square foot from the older conventional Bermudagrass cultivars. While the initial cost of TifTuf is higher, the payback period from decreased water usage and the potential water savings is unknown. In this paper, we calculate and compare cost savings, water savings, and the return on investment (ROI) as well as payback period for homeowners installing TifTuf relative to traditional bermudagrass.

The cost savings, water savings, ROI and payback period are dependent on the amount of rainfall and the water rates of the city where the homeowner lives. Areas with lower rainfall or higher water rates have the potential to benefit more from a drought resistant turfgrass as compared to an area with high rainfall or lower water rates. For this study utilize past weather data to assess the potential returns for TifTuf in five major cities in the Southeast: Atlanta (Georgia), Athens (Georgia), Columbus (Georgia), Macon (Georgia), and Birmingham (Alabama). We also examine the potential for market expansion of TifTuf into six cities in the Southwest and West: Dallas/Fort Worth (Texas), Phoenix (Arizona), Reno (Nevada), Las Vegas (Nevada), San Diego (California), and Bakersfield (California). These locations were chosen based on population size, varying rainfall and potential for adoption of warm season grasses, and availability of daily precipitation data. Population is important given a major component of marketing turfgrasses is done through word of mouth. Hurd (2006) found that landscapes of others play an important role in the decisions of consumers. Hurd's findings reveal the importance of marketing to areas with high populations, especially in areas like subdivisions.

The most prevalent substitute in the Southeast United States is a conventional Bermudagrass, like Tifway 419. The term conventional Bermudagrass is used to describe previous cultivars that do not have the same drought tolerance as TifTuf. Artificial turfgrass is considered to be another substitute for TifTuf, especially on the West Coast and on athletic fields. TifTuf, along with its other positive attributes, has the highest traffic tolerance of existing turfgrasses, making it a very capable grass for athletic fields (Schwartz, 2017). The initial cost of artificial turfgrass has been shown to be higher than turfgrass, but the maintenance cost is lower for artificial turf and it also has a much longer life than TifTuf, 20 years compared to a suggested 6 year cycle of resodding (Massachusetts Toxics use Reduction Institute, 2016). The return on investment is higher with artificial turf, but according to Massachusetts Toxics use Reduction Institute (2016) "in nearly all scenarios, the full life-cycle cost of natural turf is lower than the life-cycle cost of a synthetic turf field for an equivalent area" (Table 1).

The marketing of a drought resistant turfgrass, such as TifTuf, will be enhanced by showing customers potential money savings through reduced water use via their water bills. Hugie et al. (2012) found that the most important characteristic of turfgrass to consumers is shade tolerance, and the consumers who put a high value on shade tolerance also put a high emphasis on water conscious crops. Further, Hugie et al. (2012) found that consumers were willing to pay $9.70 more per 1,000 square feet for water conscious crops. Curtis and Cowee (2010) showed that more than half of its sample (52.6%) valued drought resistance out of all turfgrass attributes tested. Drought tolerance is an attractive attribute for two main reasons. Homeowners like to save money on their monthly water bills, but also like to feel as if they are being environmentally conscious by saving water. According to Yue et al. (2012), consumers are becoming increasingly environmentally conscious and are making more ecologically minded purchases. In a study done by Curtis and Cowee (2010), they found that 37.1% of people feel they are very responsible for conserving water, and 49% believe they are fairly responsible. TifTuf's drought resistant qualities will appeal to the environmentally conscious consumer as well as the financially conscious one.

Ghimire et al. (2016) showed that consumers' highest priority, across the study's five state sample, including Georgia, is low maintenance cost, followed by shade tolerance and drought tolerance. The lowest priority for the five states was a low purchase price (Ghimire et al. 2016). Ghimire et al. (2016) states that "price is a small factor for overall replacement of lawn or sod installation". TifTuf's qualities align well with consumer preferences for turfgrass, and shows that the five cent premium per square foot should not be an obstacle for TifTuf, assuming consumers feel they get a return on the investment.

Materials and Methods:

To determine an accurate return on investment timeframe we used residential irrigation rates to determine that costs of required irrigation. We retrieved data from the University of North Carolina Environmental Finance Center (2017) to find accurate water rates for cities in Alabama, Arizona, Georgia, and Texas. Water rates for cities in Nevada (Reno and Las Vegas) and California (Bakersfield and San Diego) were retrieved from their respective city websites. To determine water rates for our model, we calculated the price per gallon water rate for 5,000 gallons. We multiplied the per gallon water rate by 27,154 to calculate the per acre water rate. The final calculation for cost of irrigation is:

$$Cost\ of\ irrigation = City_j water\ rate * 27{,}154 * yard\ size\ (acres) * irrigated\ amount$$

We retrieved daily rainfall data from the National Weather Service Forecast NOWData (2017). The NOWData provides us with daily precipitation amounts for different areas throughout the country. We collected 5 years of daily rainfall data from January 1, 2011 to December 31, 2016. NOWData reports rainfall in amounts that are less than a hundredth of an inch as “T” (“NOWData,” 2017). We replaced all “T” values with 0, because we assume that less than a hundredth of an inch of rain will not make a significant difference in irrigation amounts and irrigation costs. We used Atlanta Area, Athens Area, Columbus Metropolitan, Macon Middle GA, Birmingham, Dallas/Fort Worth Area, Las Vegas, Reno, Bakersfield, San Diego, and Phoenix for the locations of the NOWData.

To calculate cost savings from monthly water bills and water savings due to the installation of TifTuf we compare it to a conventional Bermudagrass, which requires an inch of water a week. TifTuf research has shown that it requires 38% less water than conventional Bermudagrass, which is 0.62 inches (Schwartz, 2016). Based on these assumptions, we allow the amount of water needed for TifTuf to be simulated using a triangular distribution with a minimum of 0.5 an acre, a mean of 0.62 inches, and a maximum of 1 inch. Half an inch was chosen under the assumption that some consumers will experience above average drought tolerance with some consumers potentially seeing no difference between TifTuf and conventional Bermudagrass, hence the one inch maximum.

We calculate the sum of weekly rainfall for all five years of our data. The difference between the amount of water needed per acre and the amount of rainfall in the seven day period represents the amount the resident will need to irrigate to maintain their lawn. We calculate the cost of irrigation for a conventional Bermudagrass lawn and a TifTuf lawn. The difference is the savings for TifTuf relative to conventional turfgrass.

We simulate the potential cost and water savings of TifTuf and the payback periods in two different scenarios. In the first scenario, a homeowner is replacing their current lawn with TifTuf. In the second scenario the homeowner is installing a new lawn and choosing TifTuf over a conventional Bermudagrass. When replacing the lawn the owner will pay the full 36 cents per square foot, but with a new lawn the homeowner will only account for the five cent premium that is placed on TifTuf. For the first scenario we will multiply \$0.36 by the number of acres the owner is installing and then multiply again by 43,560, the number of square feet in an acre. This will allow us to get the cost of installation for the replacement of a lawn with TifTuf. The equation for a new lawn will be the same, but we assume that the homeowner will be installing a new lawn, so the premium of \$0.05 will be the only charge that needs to be considered. To calculate the payback period for each scenario, we divide the total installation cost by the yearly savings, calculated as total five year savings divided by five.

$$Payback\ period(replaced\ lawn) = \frac{.36 * acres * 43{,}560}{Total\ Savings/5}$$

$$Payback\ period\ (new\ lawn) = \frac{.05 * acres * 43{,}560}{Total\ Savings/5}$$

Results

As expected cost savings by location were indicative of the water rates for the city and the rainfall amount. The average cost savings were highest for San Diego, Bakersfield, and Reno.

The water rates and rainfall amounts used for each city can be seen in the tables below (Table 2 & 3). The water rates for Bakersfield and San Diego are $0.0104 and $0.0144 per gallon, and the water rate for Reno, $0.0034, was much lower, but the reduced amount of rainfall resulted in the higher savings for the citizens of Reno. In the Southeast region of the United States, the mean costs savings were highest for Athens, Birmingham, and Atlanta. The rain fall amounts were similar for these three cities, so the water rates were the main indicator in savings.

We run our simulations of cost savings over ten thousand iterations using @Risk software. We report the minimum, maximum, lower and upper bound of the 90 percent interval, mean, and the standard deviation of the cost savings for TifTuf over conventional Bermudagrass (Table 3). We report the same statistics for water savings with TifTuf over conventional (Table 4). From the tables we can see that the cities outside of the Southeast see much higher water savings as well as costs savings. The average water savings for all cities west of Dallas, TX are shown to save over 85 inches of irrigated water over the five year period on a one acre lawn. Within the Southeast the most water savings occurs in Macon, GA, which will see an average savings of 60 inches over the five year period on a one acre lawn.

The average cost savings were much higher for Athens and Atlanta, which have a water rate of 0.006802 and 0.006908 dollars per gallon. The average savings for Athens is $10,571.53 over a five year period on an acre of lawn and $9,830.91 in Atlanta over the five year period on an acre of lawn. The savings for Columbus and Macon are $5,016.25 and $7,631.66 over the five year period on an acre of lawn. When broken down to a per square foot savings, Athens' and Atlanta's per square foot savings are $0.049 and $0.045, which are lower than the square foot premium for TifTuf. Macon and Columbus have lower per square foot savings. The results for cost savings in Atlanta and Athens confirms our predictions that the selling of TifTuf in Athens and Atlanta, areas with higher water rates, will be more attractive to consumers. All locations in the Southeast had similar rainfall amounts over the five year period, implying water rates is a key variable associated with a cost savings.

Outside of the state of Georgia, the results differ greatly due to less rainfall and higher costs of water. The locations in the West, Reno, Las Vegas, Bakersfield, and San Diego, have significant less rainfall amounts, which results in more irrigating. The water rates, especially in California, are higher than the water rates in the Georgia cities. The cost per gallon in Bakersfield and San Diego is $0.010 and $0.012. The higher water rates, as well as the reduced rainfall amounts results in a higher cost savings from using a more drought resistant turfgrass. The mean cost savings for San Diego and Bakersfield over the five year period are $27,051.16 and $25,259.90 per one acre lawn, which is $0.12 and $0.11 savings per square foot of irrigated turfgrass.

The payback period is similar to the cost savings results. For a replaced lawn the average payback return on investment for all cities can be seen below for a one acre lawn (Table 5). The return on investment is shown to be realized much faster on the West coast, San Diego, Bakersfield and Reno, than in the Southeast. The ROI for replacing a one acre lawn with TifTuf in San Diego is 3.084 years compared to Birmingham, the lowest ROI in the Southeast, of 9.81 years. The return on investment of a new lawn is under a year for Bakersfield and San Diego. A table for ROI of a new one acre lawn can be seen below (Table 6). As we expected the ROI is much sooner for cities that experience less rainfall and have higher water rates. The results show that the purchase of TifTuf is only financially feasible for a new lawn. The return on investment for a replacement lawn will not be realized soon enough to make the investment worthwhile, but other reasons could allow for the installation of TifTuf as a replacement lawn such as, environmental responsibility.

Discussion:

TifTuf appears to provide a significant return on investment for homeowners in our selected cities. As shown by our simulation, homeowners see a return on their investment in TifTuf relatively soon, which would allow them to begin savings money every month once the premium is paid off. The average cost savings in the Southeast cities over the five year period is $8,702.88, which is a savings of $1,740.57 a year on a one acre lawn. In cities west of Birmingham the average five year savings for the one acre lawn is $14,174.53, which is a savings of $2,834.91 a year on the one acre lawn size. The high amount of savings for the West is due mainly to the high costs savings for Bakersfield and San Diego.

While the numbers suggest that TifTuf would be a good investment for homeowners, the catch will be to convince homeowners that TifTuf will in fact have positive effects for them. Homeowners are becoming more environmentally conscious, and the reduction in prices of water bills obviously shows less water usage (Curtis and Cowee, 2010). TifTuf's ability to maintain greener longer also provides more opportunities for word of mouth interactions between neighbors. These interactions will ultimately lead to more homeowners realizing the potential savings of TifTuf, and eventually installing it themselves. Homeowners' preference of shade tolerance also allows TifTuf to stand above the competition. Due to TifTuf's potential savings ability along with the other positive attributes that it contains, the installation of TifTuf by a contractor, homeowner, or a school on an athletic field will be a good financial investment. It also can provide environmental benefits by reducing homeowner water usage.

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Table 1. Artificial vs Natural Turf Costs at a Community Level[1]

	Natural Grass	Synthetic Turf
Construction Costs	$ 153,000.00	$ 508,000.00
Annual Operating Costs	$ 20,000.00	$ 18,000.00
25 Year Life Cycle Cost	$ 724,000.00	$ 1,813,000.00
50 Year Life Cycle Cost	$ 1,295,000.00	$ 3,118,000.00
Sample Costs (65,625 square foot field)		
	Natural Grass	Synthetic Turf
Installation	$ 39,000.00	$ 295,000.00
Annual Maintenance	$ 4,000.00	$ 4,000.00
Annual Labor Cost	$ 5,000.00	$ 6,000.00
Resodding (yrs 6,11,16)	$ 25,000.00	$ -
Disposal and Resurfaceing	$ -	$ 557,000.00
Net Present Value	$ 197,000.00	$ 1,189,000.00

[1] Data taken from Massachusetts Toxics use Reduction Institute, 2016.

Table 2. Rainfall Amounts over a 5 Year Period and Water Rates for Cities in the Model. [1]

City	Rainfall (in)	Water Rates ($/gallon)
Athens	282.43	$ 0.006802
Atlanta	296.82	$ 0.006908
Columbus	287.8	$ 0.003230
Macon	270.28	$ 0.004700
Birmingham	326.32	$ 0.007806
Dallas/Fort Worth	205.95	$ 0.004988
Pheonix	39.06	$ 0.001900
Las Vegas	37.26	$ 0.005590
Reno	21.68	$ 0.003400
Bakersfield	26.9	$ 0.010400
San Diego	48.5	$ 0.014400

[1] Data taken from the University of North Carolina Environmental Finance Center (2017), city webpages, and the National Weather Service.

Table 3. Cost Savings in Dollars for TifTuf Over 5 Years for One Acre of Land with Optimal Watering.

			Cost Savings (Over 5 Years)			
	Minimum	Maximum	90% Minimum	90% Maximum	Mean	Std. Dev
Athens, GA	$ 527.69	$ 16,991.10	$ 3,765.00	$ 15,471.00	$ 10,571.46	$ 3,600.23
Atlanta, GA	$ 480.98	$ 15,731.35	$ 3,460.00	$ 14,354.00	$ 9,830.91	$ 3,346.27
Columbus, GA	$ 80.56	$ 8,134.90	$ 1,758.00	$ 7,386.00	$ 5,016.42	$ 1,730.23
Macon, GA	$ 135.64	$ 12,204.78	$ 2,648.00	$ 11,154.00	$ 7,631.47	$ 2,611.43
Birmingham, AL	$ 242.74	$ 16,786.61	$ 3,682.00	$ 15,359.00	$ 10,464.13	$ 3,580.85
Dallas, TX	$ 289.40	$ 14,745.80	$ 3,098.00	$ 13,427.00	$ 9,036.63	$ 3,165.41
Pheonix, AZ	$ 82.90	$ 7,624.10	$ 1,528.00	$ 6,904.00	$ 4,573.53	$ 1,648.19
Las Vegas, NV	$ 164.87	$ 14,177.94	$ 2,809.00	$ 12,736.00	$ 8,419.89	$ 3,044.61
Reno, NV	$ 533.73	$ 22,411.61	$ 4,442.00	$ 20,143.00	$ 13,357.48	$ 4,816.16
Bakersfield, CA	$ 671.71	$ 42,487.31	$ 8,385.00	$ 38,155.00	$ 25,259.31	$ 9,120.26
San Diego, CA	$ 1,218.77	$ 55,909.89	$ 11,177.00	$ 50,487.00	$ 33,436.98	$ 12,051.37

Table 4. Water Savings in Inches for TifTuf Over 5 Years for One Acre of Land with Optimal Watering.

			Water Savings (Over 5 Years)			
	Minimum	Maximum	90% Minimum	90% Maximum	Mean	Std. Dev
Athens, GA	2.46	91.26	20.3	83.8	57.24	19.49
Atlanta, GA	2.33	84.05	18.6	76.6	52.41	17.84
Columbus, GA	2.06	91.96	19.9	84.3	57.20	19.72
Macon, GA	1.05	95.67	20.8	87.7	60.03	20.54
Birmingham, AL	1.70	79.10	17.4	72.4	49.37	16.89
Dallas, TX	1.82	109.39	22.9	99.1	66.72	23.37
Pheonix, AZ	3.71	148.70	29.6	133.8	88.65	31.95
Las Vegas, NV	3.84	152.24	30.0	136.1	90.04	32.55
Reno, NV	2.60	148.42	29.3	132.8	88.00	31.73
Bakersfield, CA	1.23	150.90	29.9	135.7	89.81	32.43
San Diego, CA	1.21	144.80	28.5	129.4	85.70	30.90

Table 5. Return on Investment in Years for a Replacement Lawn of TifTuf.

			Return on Investment Replacement (Years)			
	Minimum	Maximum	90% Minimum	90% Maximum	Mean	Std. Dev
Athens, GA	4.65	810.27	5	21	10.11	26.47
Atlanta, GA	5	158.62	5.5	22.3	10.21	9.84
Columbus, GA	9.63	456.87	10.6	44.2	20.27	22.13
Macon, GA	6.42	398.21	7	29.2	13.47	17.13
Birmingham, AL	4.64	319.1	5.1	20.9	9.81	12.99
Dallas, TX	5.32	312.34	5.8	25	11.4	13.77
Pheonix, AZ	10.26	509.61	11	51	22.66	25.12
Las Vegas, NV	5.56	924.49	6	28	12.96	30.81
Reno, NV	3.49	152.55	3.9	17.4	7.73	8.17
Bakersfield, CA	1.86	643.77	2	9	4.65	20.54
San Diego, CA	1.398	57.416	1.6	6.9	3.084	3.211

Table 6. Return on Investment in Years for a New Lawn of TifTuf.

			Return on Investment New (Years)			
	Minimum	Maximum	90% Minimum	90% Maximum	Mean	Std. Dev
Athens, GA	0.645	36.544	0.7	2.68	1.336	1.59
Atlanta, GA	0.697	26.513	0.76	3.11	1.42	1.414
Columbus, GA	1.345	52.067	1.5	6.1	2.806	2.897
Macon, GA	0.894	186.6	1	4.1	1.99	6.04
Birmingham, AL	0.645	26.07	0.71	2.92	1.342	1.394
Dallas, TX	0.732	29.301	0.81	3.47	1.565	1.596
Pheonix, AZ	1.42	116.96	1.6	7.1	3.19	4.53
Las Vegas, NV	0.768	41.096	0.85	3.86	1.718	1.991
Reno, NV	0.489	148.17	0.5	2.4	1.2	4.75
Bakersfield, CA	0.258	24.802	0.29	1.29	0.582	0.917
San Diego, CA	0.195	12.007	0.22	0.97	0.434	0.539