Competitive Relationship of Three Warm-Season Turfgrass Species

John Adrian, Patricia Duffy and Michael Loyd

Abstract: *The competitive position of three warm-season turf species commonly grown in the South (bermudagrass, centipedegrass, and zoysiagrass) is evaluated for a farm with 100 acres available to allocate to turfgrass-sod production. A multiperiod linear programming model is used to determine optimal mixes of grasses and resulting net returns for a seven-year planning horizon. Within current observable price ranges, variation in the prices of the different grasses has little impact on the profit-maximizing combination of grasses. Bermudagrass, with the shorter production cycle and positive influence on cash flow, dominates the higher-valued, longer-production-cycle alternative grasses. Availability of initial money capital from internal sources does not alter the feasibility of bermudagrass.*

Key Words and Phrases: *Competitive position, Turfgrass, Multiperiod modeling, Profitability, Net returns.*

Turfgrass-sod production has been a growth enterprise in the southeastern United States. Haydu and Cisar (p. 1) indicate that Florida's turfgrass-sod industry grew from 6,700 acres in 1960, to 14,300 in 1974, and to more than 35,000 acres in 1987 with a value of $115 million. Similarly, White, Adrian, and Dickens note that Alabama's turfgrass-sod industry grew from 500 acres in the late 1960s to more than 20,000 acres in the early 1990s with a farm level value of approximately $55 million. Brooker et al. (p. 13) state that Tennessee had 6,115 acres devoted to turfgrass in 1991 while Johnson and Johnson (p. 60) indicate that Georgia and Texas had 6,026 and 16,911 acres, respectively, in production in 1987.

As the industry grows, there is an increasing demand for viable production, marketing and management information. Previous studies have provided such information as costs, return, investment and cash flow estimates for various sizes and types of turfgrass operations at alternative locations in the United States (Adrian, White and Dickens; Cockerham; Gilbert and Lessley; Hall et al.; Smith and Brewster; and White, Adrian and Dickens). However, research on optimal crop mixes for turfgrass farmers is limited. Accordingly, the purpose of this paper is to address this topic, providing producers with information concerning their "best" production options.

As production has expanded and markets have matured, producers have become interested in the competitive advantage of alternative turfgrass species. Bermudagrass has traditionally been the primary warm-season turfgrass grown; however, producers have increasingly shown interest in the higher-valued grasses such as centipedegrass and zoysiagrass. While wholesale prices for bermudagrass typically range from \$0.65 to \$1.20 per square yard, zoysia and centipede prices may range between \$1.60 and \$2.50 and \$0.80 and \$2.10, respectively. Given the disparity in relative prices, initial producer inclinations might be to allocate resources to production of the higher-valued grasses such as centipede and zoysia to maximize net returns. However, a direct comparison of these prices alone to determine economic feasibility could lead to poor management decisions because these grasses have production cycles that may be two or more times longer than that for bermudagrass. Thus, the optimal choice of warm-season grass or combination of grasses that maximizes net returns is not clear from budgeting alone.

Objectives

The primary purpose of this study is to analyze the competitive advantage of three important warm-season turfgrass species grown in the southeastern United States: bermudagrass, centipedegrass, and zoysiagrass. Production sensitivity to various price regimes for the alternative grass species are evaluated in order to identify optimal combinations of these grasses that maximize net returns. Also, the impacts of capital availability and selected market factors on acreage produced and net returns are analyzed.

Procedures and Data

A multiperiod linear programming model is developed and utilized to determine profit-maximizing combinations of turfgrass crops.[1] Turfgrass species evaluated are those most popular among Alabama producers and important to producers in the Southeast. Base data for the model are derived from updated versions of budgets developed by White, Adrian, and Dickens which reflect characteristics and practices common to on-going turfgrass farms. Budgets for each grass are developed to include early and late season establishment and re-establishment. The basic difference between establishment and re-establishment is that establishment reflects costs for fumigation and extensive soil preparation while re-establishment involves regeneration from strips of grass left during harvest plus minor land preparation.

Late season budgets differ from early season estimates in that the grass is established or re-established after the middle of the production season and fewer productive months during the fall and winter are accounted for in the production cycle. Production relationships used in the analysis were taken from south Alabama, an area that reflects climatic and production conditions similar to those found in portions of other southern states included in U.S. Department of Agriculture Plant Hardiness Zone 8. Thus, results from this analysis provide relevant information for current and prospective turfgrass-sod producers in this and contiguous hardiness zones.

Seasonal and establishment alternatives reflect differences in production periods (time) and inputs and thus interest on operating and fixed capital. Fixed costs for early-season establishment comprise approximately 24 percent of total cost for bermudagrass production and approximately 29 percent for centipedegrass and zoysiagrass. Late season fixed-to-total cost ratios increase from early-season levels by less than one percent for each of the species.

For re-establishment, fixed-to-total cost ratios for bermuda increase to 33 and 37 percent for early and late seasons, respectively. Similar relationships for centipede and zoysia are about 3 percent higher for early-season re-establishment and the same as bermuda for late season.

The programming model is comprised of several sections. The model reflects an eight-month-per-year effective growing period (March-October) and allows for early- or late-season establishment and re-establishment of the various turfgrass species as noted above. For example, bermuda established in the early season (March-June) requires ten growing months before harvest; when re-established in the late season (July-October), it requires six months (Table 1). Grasses could not be established or re-established from November-February, though they could be held in inventory. A section of the model deals with cash flow and permits money to be borrowed, repaid and saved. Another section allows sod to be sold or placed in inventory and labor to be hired, when necessary. For example, the model specifies that eight man-hours of labor per acre are required to establish and harvest bermuda while two man-hours per acre are needed for maintenance. Yields are assumed to be 4,000 square yards per acre which

Table 1.
Production Cycles for Alternative Turfgrass-Sod Species with Establishment and Re-Establishment in Early or Late Seasons, South Alabama, 1993-1994

	Production Cycle in Months	
Specie and Season	Establishment	Re-Establishment
Bermudagrass		
Early Season	10	4
Late Season	10	6
Centipedegrass		
Early Season	17	14
Late Season	17	17
Zoysiagrass		
Early Season	17	14
Late Season	17	17

provides about 17 percent of the production area for grass regeneration and also accounts for waste or scrap grass.

The model's objective function is maximization of net returns over a seven-year production horizon subject to constraints relating to available land, capital and markets. A previous analysis by Adrian, White and Dickens indicates that turfgrass operations can be financially stable by seven years and this time period is reflective of the economic life of several capital items. One hundred acres of land is available for turfgrass in each of the seven years. In the base analysis, initial internal capital is limited to one dollar to force borrowing, a requirement common to most new turfgrass farms. This constraint is relaxed in another scenario with internal capital being available and allowed to increase in $50,000 increments up to $300,000.

The effects of price variations for the alternative grasses on optimal crop combinations are also evaluated. Base prices for the three grasses are those typical of the market: $1.00, $1.22, and $1.85 per square yard for bermudagrass, centipedegrass, and zoysiagrass, respectively. To address the question of level of price needed to initiate production of a particular grass, alternative prices are substituted into the model for a "sensitivity" analysis; that is, an analysis that shows the sensitivity of the results to changes in assumptions.

A phenomenon commonly experienced in the bermudagrass market is a seasonal decline in price. Accordingly, an additional sensitivity analysis is modelled to determine the impact on net returns and optimal combinations of turfgrass of lowering the price of bermudagrass by $0.05 per month from its base level of $1.00 per square yard from the early-season price.

Also, we evaluate the impact of producing a minimum level of the higher-valued, longer-production-cycle turfgrass options. Specifically, ten acres each of centipedegrass and zoysiagrass are forced into the optimal product combination. This scenario evaluates the impact of a common producer strategy involving diversification to serve the needs of particular customers (see Loyd for further details about model construction).

Analysis

A base model (Scenario 1) constrained by available initial capital ($1.00) and utilizing typical market prices allocates the available 100 acres to bermudagrass (Table 2). Bermudagrass is first established in March of year one. This grass is harvested and sold in April of year two, taking the ten growing months required by bermudagrass established in the early season (Table 3). Bermuda is then immediately re-established in May of the second year and is available to be sold in February of year three. The 100 acres is then immediately re-established in March and is available to be sold in June. This cycle continues through year seven with cumulative net returns amounting to $1,965,733.

Scenario 2 identifies the optimal combination of species and net returns when bermudagrass is subject to a seasonal decline in price of $0.05 per month, as is generally observed in the market. The resulting optimal combination of grasses is the same as for Scenario 1. However, with the seasonal decline in the price of bermuda, net returns decrease by $349,816 to $1,615,917 for the seven-year period (Table 2).

In Scenario 3, the model forces production of ten acres each of centipede and zoysia. Producers indicate that they like to be able to provide their customers with different varieties of turfgrass upon request, and/or to meet the needs of a market niche that has been identified and developed. Also, this practice may facilitate market development through provision of a more diverse product line. Net returns to this alternative are $1,264,908, or $700,825 below the level attained in the base alternative

Table 2.

Results of Alternative Scenarios, Linear Programming Model, 100-Acre Turfgrass Farm With Seven-Year Production Horizon, South Alabama, 1993-1994

Scenario with Constraints	Acreage by Grass Specie	Objective Function/ Net Returns
Scenario 1 (Base):[a]	100 Bermuda	$1,965,733
Scenario 2: Same as (1) except constrained by seasonal price decline in bermuda by $0.05/month from $1.00	100 Bermuda	$1,615,917
Scenario 3: Same as (2) except constrained to include ten acres each of centipede and zoysia with bermuda price seasonality	80 Bermuda 10 Centipede 10 Zoysia	$1,264,908
Scenario 4: Same as (2) except bermuda price constrained at:		
$1.40/sq. yd.	100 Bermuda	$2,678,947
$0.70/sq. yd.	100 Bermuda	$809,629
$0.60/sq. yd.	73.6 Bermuda in March and 26.4 Zoysia in April, year 1; 100 Zoysia in March, year 4	$603,538

Scenario 5: Same as (2) except centipede price constrained at $2.72/sq. yd. with bermuda price seasonality	70 Bermuda and 30 Centipede in year 1	$1,653,933
Scenario 6: Same as (2) except zoysia price constrained at $2.65/sq. yd. with bermuda price seasonality	98 Bermuda and 2 Zoysia in year 1	$1,615,987
Scenario 7: Same as (2) except starting capital constrained at: $1	100 Bermuda	$1,615,917
$300,000	100 Bermuda	$1,694,765

[a] Assume the market prices per square yard for each grass specie are: Bermuda $1.00; Centipede $1.22; and Zoysia $1.85.

Table 3.
Optimal Grass Combinations for 100-Acre Turfgrass Farm (Scenario 1—Base Model) with Seven-Year Production Horizon, South Alabama, 1993-1994

Year	Month	Activity	Acres
1	March	Establish Bermuda	100
2	May	Re-establish Bermuda	100
3	March	Re-establish Bermuda	100
	July	Re-establish Bermuda	100
4	May	Re-establish Bermuda	100
5	March	Re-establish Bermuda	100
	July	Re-establish Bermuda	100
6	May	Re-establish Bermuda	100
7	March	Re-establish Bermuda	100

(Table 2). As expected, the model devotes the land not needed to satisfy the constraints to bermudagrass. Eighty acres of bermuda are established in March of year one and, in April, ten acres each of zoysia and centipede are established (Table 4). After growing for the required seventeen months, the centipede and zoysia are harvested and sold in April of year three. Centipede and zoysia are re-established on this acreage in May and are available for harvest again in October of year four. This land is re-established in March of the fifth year and grass is available for sale in October of year five. This pattern continues through year seven. The pattern of bermuda establishment and sale mimics prior scenarios.

Scenarios 4, 5 and 6 evaluate the sensitivity of production of the three grasses to the price of a particular grass; that is, price levels that trigger changes in optimal turfgrass combinations are identified. These analyses utilize Scenario 2 as a base in which bermudagrass is subject to price seasonality. Scenario 4 evaluates sensitivity to the price of bermudagrass with the prices of centipede and zoysia held at base levels of $1.22 and $1.85 per square yard. Obviously, raising the price of bermuda from $1.00 would have no effect on the optimal combination and would only increase

Table 4.
Optimal Grass Combinations for 100-Acre Turfgrass Farm with Seven-Year Production Horizon with Constraints Forcing the Production of Ten Acres Each of Centipedegrass and Zoysiagrass (Scenario 3), South Alabama, 1993-1994

Year	Month	Activity	Acres
1	March	Establish Bermuda	80
	April	Establish Centipede	10
	April	Establish Zoysia	10
2	May	Re-establish Bermuda	80
3	March	Re-establish Bermuda	80
	May	Re-establish Centipede	10
	May	Re-establish Zoysia	10
	July	Re-establish Bermuda	80
4	May	Re-establish Bermuda	80
5	March	Re-establish Bermuda	80
	March	Re-establish Centipede	10
	March	Re-establish Zoysia	10
	July	Re-establish Bermuda	80
6	March	Re-establish Centipede	10
	March	Re-establish Zoysia	10
	May	Re-establish Bermuda	80
7	March	Re-establish Bermuda	80

net returns. Thus, the price of bermuda is decreased by $0.10 increments until a change is noted in optimal grass combination.

At $0.60 per square yard, 73.6 acres are established in bermuda in March of year one and 26.4 acres are established in zoysia in April of year one (Table 5). The bermuda is harvested and sold in April of year two, with re-establishment in May. Of the 73.6 acres re-established in May,

Table 5.
Optimal Turfgrass-Sod Combinations for 100-Acre Turfgrass Farm With Seven-Year Production Horizon with Price of Bermudagrass at $.60 (Scenario 4), South Alabama, 1993-1994

Year	Month	Activity	Acres
1	March	Establish Bermuda	73.6
	April	Establish Zoysia	26.4
2	May	Re-establish Bermuda	73.6
	October	Re-establish Bermuda	65.7
3	March	Re-establish Bermuda	7.9
	May	Re-establish Zoysia	26.4
4	March	Establish Zoysia	73.6
5	March	Re-establish Zoysia	26.4
6	April	Re-establish Zoysia	73.6
7	--	--	--

65.7 acres are harvested and sold in September of year two, allowing this land to be re-established with bermuda in October of year two. The remaining 7.9 acres are harvested and sold in October of year two and are re-established in March of year three.

The 26.4 acres of zoysia which are established in year one are harvested and sold in April of year three and are re-established in zoysia in May. In March of year four, the 73.6 acres which were previously allocated to bermuda are established in zoysia. Thus, the 100 acres are now in zoysia; this allocation will continue through year seven. At $0.60 per square yard for bermuda, net returns for the seven-year period are $603,538 (Table 2).

Scenario 5 evaluates the impact of varying the price of centipede upward in $0.10 increments from its base level of $1.22 per square yard. Centipede is initially produced when its price reaches $2.72. At this level, 70.1 acres of bermuda and 29.9 acres of centipede are established in year one and are then continually re-established through year seven (Table 6). Net returns for the seven years for this alternative are $1,635,933 (Table 2). Scenario 6 analyzes how variations in the price of zoysia affect optimal combinations of grass. As with centipede, the price of zoysia is increased

Table 6.
Optimal Turfgrass-Sod Combinations for 100-Acre Turfgrass Farm with Seven-Year Production Horizon with Price of Centipedegrass at $2.72 (Scenario 5), South Alabama, 1993-1994

Year	Month	Activity	Acres
1	March	Establish Bermuda	70.1
	April	Establish Centipede	29.9
2	May	Re-establish Bermuda	70.1
3	March	Re-establish Bermuda	70.1
	May	Re-establish Centipede	29.9
	July	Re-establish Bermuda	70.1
4	May	Re-establish Bermuda	70.1
5	March	Re-establish Bermuda	70.1
	March	Re-establish Centipede	29.9
	July	Re-establish Bermuda	70.1
6	May	Re-establish Bermuda	70.1
	September	Re-establish Centipede	29.9
7	March	Re-establish Bermuda	70.1

from its base level of $1.85 per square yard in $0.10 increments until a change in the optimal mix of grasses is noted. At $2.65, zoysiagrass becomes competitive with bermudagrass and production is initiated at 1.8 acres in March of year one (Table 7). This acreage is continually re-established with zoysia until September of year six at which time it is established in bermudagrass. Zoysia disappears from the solution because there is insufficient time to produce another crop before year seven ends. Net returns for this alternative for the seven-year period are $1,615,987 (Table 2).

The impact of available initial internal capital is evaluated in Scenario 7 by allowing starting capital to vary in $50,000 increments from its original value of $1.00 up to $300,000. There is no change in the optimal combination of turfgrass from Scenario 2 (Table 3). However, net returns

Table 7.
Optimal Turfgrass-Sod Combinations for 100-Acre Turfgrass Farm with Seven-Year Production Horizon with Price of Zoysiagrass at $2.65 (Scenario 6), South Alabama, 1993-1994

Years	Months	Activity	Acres
1	March	Establish Bermuda	98.2
	March	Establish Zoysia	1.8
2	May	Re-establish Bermuda	98.2
3	March	Re-establish Bermuda	98.2
	April	Re-establish Zoysia	1.8
	July	Re-establish Bermuda	98.2
4	May	Re-establish Bermuda	98.2
5	March	Re-establish Bermuda	98.2
	March	Re-establish Zoysia	1.8
	July	Re-establish Bermuda	98.2
6	May	Re-establish Bermuda	98.2
	September	Establish Bermuda	1.8
7	March	Re-establish Bermuda	98.2

increase because less borrowing is required to operate the farm. At $300,000 available initial capital from internal sources, net returns for the seven years are $1,694,765 (Table 2).

Conclusions

Bermudagrass is apparently the most profitable of the three warm-season turfgrass-sod species analyzed. This grass benefits from a relatively short production cycle. Two or more crops can be produced in the time frame required for one crop of centipede or zoysia. Therefore, total net returns per unit of land for a fixed time period from the production of bermudagrass are greater than the net returns from producing other crop species. Price sensitivity analyses suggest that variations in the prices of the different turfgrass species have little effect on the profit-maximizing combination of grasses. The price of centipedegrass was increased $1.50 per square yard above its base price ($1.22) and zoysiagrass was increased by $0.80 above its base ($1.85) before they were brought into production, even with the price of bermuda decreasing seasonally by $0.05 per month. Similarly, the price of bermuda had to be lowered to $0.60 per square yard before either of the other turfgrass species was brought into production.

Demand conditions in particular markets may affect the decision to grow a particular specie; for example, preference for the premium-valued grasses on the part of consumers and/or landscape firms and longstanding relationships with customers could be important factors affecting allocation of acreage to the grasses. However, the analysis indicates that a decision to grow other grasses results in lower net returns. Production of ten acres each of centipede and zoysia rather than bermuda reduced net returns by almost $100,000 from the base analysis for the seven-year period.

Varying the amount of available starting capital from mostly external (borrowing) to primarily internal (equity) sources has no impact on the optimal combination of turfgrass species. Production of bermudagrass was sufficiently profitable to address debt service.

Production cycles for the three grasses have an important influence in determining their economic feasibility. More intensive production practices such as introduction of new technologies to shorten production cycles could affect feasibility. For example, use of netting to permit earlier harvest of the grasses, especially for centipede and somewhat for zoysia, could cut several months from the production cycle and limit problems related to slower root development and integrity of the squares or rolls in harvest and installation. Feasibility of these alternative technologies and practices would require additional economic analyses.

A shortcoming of the analysis is that markets are assumed to be present for the available turfgrass at maturity and harvest. As noted, bermudagrass prices have shown a tendency to be seasonally sensitive to market supplies. Thus, producers may have to hold mature grass in inventory longer than that defined in the analysis. This issue is addressed in the analysis through use of conservatively long production cycles. To the extent that the assumed cycles do not represent producers' experience, net returns will be reduced. Adrian, White, and Dickens indicate that turfgrass operations exhibit substantial scale economies. Thus, larger turfgrass farms will have greater ability to cope with downward price pressures and still maintain profitability.

Notes

John Adrian, Patricia Duffy and Michael Loyd are Professor, Associate Professor and former Graduate Research Assistant, respectively, Department of Agricultural Economics, Auburn University. *Journal Paper 1-954954 of the Alabama Agricultural Experiment Station.*

1. The authors wish to acknowledge the contribution made by John Hamrick, who programmed an early version of the model.

References

Adrian, John L., Robert White, and Ray Dickens. "Turfgrass-Sod Production as an Alternative Use for Farm Resources," *J. Amer. Society of Farm Mgrs. and Rural Appraisers* 56(1992):41-46.

Brooker, John R., Morgan D. Gray, J. Eric Carson, and Thomas J. Samples. "Tennessee's Turfgrass Industry: Structure and Economic Value." University of Tennessee Agr. Exp. Sta. Res. Rep. 93-16, 1993.

Cockerham, Stephen T. "Turfgrass Sod Production." University of California Coop. Ext. Serv. Pub. 21451, 1988.

Gilbert, J. Thomas, Jr., and Billy V. Lessley. "Structure, Costs and Returns for Maryland Turfgrass Industry, 1976." University of Maryland Agr. Exp. Sta., Bull. 492, 1979.

Hall, Charles R., Lennie G. Kizer, Jeffrey V. Krans, Travis D. Phillips, and G. Euel Coats. "Economic and Agronomic Analysis of Mississippi Turfgrass Sod Farms." Mississippi State University Agr. & For. Exp. Sta., Agr. Econ. Res. Rep. 182, 1988.

Haydu, J.J., and J.L. Cisar. "Sales, Quality, and Market Channel Characteristics of Florida Sod." *Turf Dollars and Sense*, vol. 5, no. 3, pp. 1-4. University of Florida Food & Res. Econ. Dept., Florida Coop. Ext. Serv., IFAS, 1993.

Johnson, Doyle C., and Tarra M. Johnson. "Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-91." Washington, DC: USDA ERS Bull. 862, 1993.

Loyd, William Michael. "Turfgrass-Sod Production: Economic Feasibility." M.S. Thesis, Auburn University Dept. of Agr. Econ., 1994.

Smith, Cecil N., and Robert H. Brewster. "An Economic Study of the Florida Cut Sod Industry." University of Florida Agr. Exp. Sta. Rep. 69-3, 1968.

White, Robert W., John L. Adrian, and Ray Dickens. "Alabama's Turf-grass-Sod Industry." Auburn University Agr. Exp. Sta. Bull. 610, 1991.