Turfgrass Production: Economies of Size, Optimal Product Mix, and Price Sensitivity

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Abstract

Notable economies of size were found both in establishment and continued operation of a turfgrass-sod facility in Alabama. Over a seven-year time horizon, bermudagrass was the most profitable grass to produce on every farm size. Both zoysia and centipede also had positive economic returns over the time horizon.

keywords: turfgrass, economies of size, linear programming

Introduction

The turfgrass-sod industry has experienced tremendous growth in the last 40 years, from its nascent state in the 1960's to a substantial economic force in several areas of the country today. In Alabama, in 2001, farm level receipts approximated $200 million, surpassing cotton as the top crop by several million dollars. Through the last several decades, firms have merged and expanded to take advantage of substantial economies of size and scale. They have increased efficiency with the introduction of improved technology, much of it developed or augmented by the growers.

While several studies have analyzed economic relationships for this dynamic industry (Adrian, Duffy, and Loyd, 1996; Adrian, Duffy, and Loyd, 1995; Adrian, White, and Dickens; Martin and Wells; White, Adrian, and Dickens; and Hall et al.), there is need for additional timely economic information. The objective of this study is to analyze the costs associated with beginning and operating a turfgrass operation in Alabama. Particular attention is focused on

economies of size. Also, the study will analyze the profitability of the commonly grown species, and the sensitivity of the profits and product mix to changes in price.

Background

Turfgrasses, as defined by Turgeon, are "plants that form a more or less contiguous ground cover that persists under regular mowing and traffic." Duble describes four different uses for turfgrasses: 1) on roadsides, to reduce erosion, 2) for lawns at private homes, 3) in general landscaping, and 4) as playing surfaces for sports and recreational activities.

Producer surveys have been the main tool used to collect information on turfgrass production and marketing. In 1980, Yates conducted the first comprehensive turfgrass study for Alabama, identifying 30 growers producing 3,316 acres of turf. He found evidence of economies of size, with total costs per acre over 40 percent higher for the smallest farms compared to the largest. In 1990, White, Adrian, and Dickens undertook a follow up survey to determine the extent of industry growth. This study also showed the existence of strong economies of size. Small farms required over $6,000 per acre in initial investment costs, while larger farms required about half that, at $3,000 per acre. In 1995, Adrian, Duffy, and Loyd used linear programming to study the economic feasibility of adding turfgrass to an existing row-crop operation. For those producers with sufficient capital, turfgrass was found to be a profitable alternative enterprise.

Methods

At the outset of this study, a brief survey was mailed to all known existing producers in Alabama, 150 total. The survey contained short questions about acreage and species of grasses grown. It also asked the producers if they would be willing to fill out a more detailed survey. This second, detailed, survey was sent to the 36 respondents from the first round who indicated

their willingness to provide more information. The detailed survey was mailed in January, 2002, with a follow-up mailed in February, 20002. A total of 22 usable surveys were returned. To gain the detailed information needed to construct budgets, five farm visits were conducted in the fall of 2002.

The information gathered from the surveys and the farm visits was used to synthesize alternatively sized operations. A 100-acre farm was chosen to represent a beginning commercial farm size. A farm having 250-acres was included to evaluate a small operation that should be a more profitable and sustainable size than the 100-acre farm. A 550-acre farm was analyzed because several growers indicated that operations beyond this size exceed the management capacity of a single manager or owner-operator, often requiring organizational restructuring or increased delegation. Two larger sizes, 850 and 1,200 acres, were evaluated to analyze large farm sizes, and also to investigate the possible leveling-out of the average costs as farms grew beyond a certain point.

For the analysis, capital investment levels were based on all new machinery and equipment complements for the alternatively sized operations. Growers participating in the farm visits were asked to identify items in their machinery inventory that were considered "needed" from those that were "excessive," and machinery complements for the synthesized farm were adjusted accordingly. Costs and prices for machinery and equipment were derived from various equipment dealers. If good quality used equipment is available to a producer, costs would be lower than those provided here.

Information provided by growers was used to develop input into Linear Programming (LP) models, which were set up and solved using Microsoft Excel Solver. For the alternative sized farms, models were constructed to determine the most profitable mix of grass species and

comparable profit and breakeven square yard prices for three warm-season species: bermudagrass, zoysiagrass, and centipedegrass. Models were developed for a seven-year planning horizon, because that time period approximates the useful life of many turfgrass specific capital items and it is a period of sufficient length to evaluate viability of the operation.

Simplifying assumptions, each of which could have a substantial impact for an actual farm situation, include:

(1) Financing is available for fixed and operating outlays at 10 percent and 9 percent per year, respectively,

and excess cash could generate a 4 percent return.

(2) Operating labor is available at $8.00 per hour plus overhead and benefit costs.

(3) Wholesale prices of the product were held constant in the initial analysis at averages determined in a marketing survey of growers. These prices were $1.05, $2.37, and $1.41 per square yard for bermudagrass, zoysiagrass, and centipedegrass, respectively.

In the evaluations of price sensitivity, prices for two grasses were held at the average levels while the other grass price varied until it entered the optimal solution, that is, when it became economically attractive to produce it.

Nature of Turfgrass Operations

Constraints were placed on production levels to represent grower responses to market preferences and production realities. Most growers desire to maintain a somewhat diverse product mix. Thus, in the initial analysis, available acreage was allocated to include 70 percent bermudagrass and 15 percent each of zoysiagrass and centipedegrass. Additionally, given requirements for start-up, only 25 percent of the bermudagrass acreage and none of the other

grasses could be harvested in the first year. In the second and succeeding years, 80 percent of the bermudagrass acreage could be harvested twice per year and two-thirds of the zoysia and centipede could be harvested per year.

Bermudagrass improves cash flow through more frequent turnover, while zoysia and centipede provide a premium price per unit,. Production cycles vary substantially among the grasses. Turnover rate for these grasses can vary depending on weather conditions, production practices, location, and time of year. For example, a marketable bermudagrass could be produced in as little as 3- to 4-months from regeneration under ideal conditions in the southern parts of the southern tier of states, while marketable centipede and zoysia grasses would generally require 14- to16-months.

Soil preparation, which includes liming, grading, fertilization, and removal of debris, is usually accomplished by the producer. When done, fields are usually custom fumigated using methyl bromide at a rate of roughly $1,600 per acre. Initial establishment is usually by sprigging for bermudagrass, while zoysiagrass is plug planted and centipedegrass is seeded. Reestablishment is most frequently from ribbons left at harvest for all three grasses. However, bermudagrass reestablishment is sometimes supplemented with application of sprigs and centipedegrass growers sometimes overseed the ribbons.

Results

Turfgrass-sod production is a capital intensive enterprise. Total capital outlays ranged from $0.5 to $3.6 million for 100-acre to 1,200-acre farms, respectively (Table 1). Maintenance and establishment was the largest cost category for all alternative sized operations, claiming roughly two-fifths of the total. Harvesting equipment was next in prominence (23 percent) for 100-acre operations while irrigation (22 percent) and delivery (25 percent) equipment were next

largest for the 1,200-acre operations. Some growers have opted for contract trucking to reduce capital outlays. However, this alternative increases operating expenses for rentals and leases. On a per acre basis, capital outlays ranged from approximately $5,100 for 100-acre operations to $3,000 for 1,200-acre farms, showing strong economies of size for establishment. The economies of size were most notably in moving from the smallest operation (100 acres) to the mid-sized operation (550 acres), with about 84 percent of the per acre establishment cost reduction being achieved by this size.

Annual fixed and variable costs for the different sized operations are presented in table 2. Total costs ranged from $3,535 per acre for the 100-acre farm to $2,718 per acre for the 1,200-acre farm, a 23 percent reduction in per-acre costs. Variable costs range from 56 percent of total costs for the smallest operation to 64 percent of total costs for the largest one. While both variable and fixed costs per acre decreased as the operation grew in size, the decrease was greater for the fixed costs. The largest farms had 38 percent lower fixed costs per acre than the smallest farms. By contrast, the per acre variable costs decreased by 11 percent. Major cost components included depreciation, labor, interest on borrowed capital, and pallets. Figure 1 provides a graphical view of the average annual total costs for the different size operations.

Cash flow over a seven-year planning horizon provides a useful means for evaluating the economic feasibility of a turf farm. Tables 3 and 4 show cash flow for the 100-acre and the 1,200-acre operations, respectively. Prices used for the cash flow estimation were average prices reported by the growers who responded to the survey: $1.05 per square yard of bermudagrass, $2.37 per square yard of zoysia, and $1.41 per square yard of centipede. For the 100-acre operation, positive net cash returns are not generated until year 6. The large farm, by contrast, experiences positive cash flow in year 3. The 100-acre farm had about $200,000 of accumulated

net cash after year 7 while the 1,200-acre farm accumulated over $11 million. Per acre per year, this amounted to $286 and $1,345 for the 100 and 1,200 acre farms, respectively.

Optimal crop mix was found using an LP model, with a seven-year planning horizon, for the costs and prices discussed above. When no marketing constraints were included in the LP model, all operations, regardless of size, allocated all acreage to bermudagrass, the most profitable grass to grow at the current average prices because of its rapid turn-over.

The LP models were also used to evaluate the sensitivity of the optimal solution to grass prices. That is, other factors held constant, what would the price of centipede (or zoysia) have to be for it to be equally profitable to grow as bermudagrass. Results are presented in table 5. Over the alternative operation sizes for the seven-year planning horizon, zoysia must be in the $2.54 to $2.56 range to compete economically with burmudagrass. Centipede would need a price of $2.33 to $2.37 to offset the production cycle advantage of bermudagrass. Given the average market prices ($2.37 for zoysia and $1.41 for centipede) the economic advantage of bermudagrass is fairly stable.

The LP models were also used to find the price of each graph that would give a zero economic profit for the seven-year period. Results of the break-even analysis are presented in table 6. Break-even prices for bermudagrass range from $0.95/square yard for the 100-acre operation to $0.77/square yard for the 1,200-acre operation, consistently higher than the current average price received by producers. Similarly, the average wholesale price for zoysia of $2.37 is higher than break-even levels for each farm size, ranging from $2.28 for the 100-acre to $1.80 for the 1,200-acre farm. Breakeven prices for centipede (from $2.07 for 100-acre to $1.62 for 1,200 acre) are higher than the average market price ($1.41) for each farm size, indicating that

market prices need to increase substantially to make centipedegrass profitable for a representative farm in this region.

Discussion

Bermudagrass continues to be the profit maximizing enterprise when compared to typical warm season zoysiagrass and centipedegrass competitors. The production cycle advantage of 4-6 months to grow it to marketable form versus 14-16 months for zoysia and centipede is difficult to overcome. Results of the analysis and average wholesale prices shows that the zoysiagrass price must increase about 8 percent and the centipedegrass price must increase by about two-thirds to generate profits comparable to bermudagrass.

History indicates that farm level turfgrass prices are somewhat slow to increase. Between 1978 and 1987, average farm level prices for bermudagrass rose from $0.85 to $0.90, zoysia from $1.21 to $1.80, and centipede from $1.12 to $1.13, respectively (Adrian et.al, 1981; White et.al., 1991).

Some growers have attempted to improve profitability of zoysia and centipede by shortening production cycles of these grasses by using mesh netting to improve the physical integrity of grass squares and rolls. Costs and operational issues have limited the effectiveness of this option.

On average over the 1978-2001 period, costs have increased more rapidly than have prices. Comparing cost estimates from Adrian et. al. (1981) and those from this current study indicates that total costs for the smaller operations have increased about 13 percent, that 250-acre farms had cost increases of about 17 percent, while farms in the 550-acre range have had cost increases of about 9 percent. Given these changes in costs and prices, growers' profit margins

have been reduced. Economies of size have also become more pronounced because costs are not rising as rapidly for the larger farms.

Much of the scale efficiency relates to the capital intensity of the industry. Capital outlays ranged from about a half million dollars for the 100-acre operation to $3.6 million for the 1,200-acre farm, slightly more than twice levels required for each size in 1978. Some mix of debt and equity capital must be secured to meet this amount. Purchasing land could add substantially to money capital needs, being $2,000 to $3,000 per acre in the area of analysis. In this study, we assumed rental of land at $100 per acre annually, a common practice and rate in the area of analysis. Growers may be attempting to reduce capital requirements by renting land. Some growers are also using contract hauling to reduce outlays for transportation and handling equipment and the need to maintain licensed truck drivers on the payroll.

This analysis provides an update of costs, revenue, and investment levels and operation practices for turfgrass-sod farms. Indications are that the industry is entering the maturing phase of development with substantial competition among growers and firms positioning themselves to better meet market requirements and to provide themselves an identity.

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Table 1. Capital Investment and Percent of Total Outlay for Alternative Sized Turfgrass-Sod Farms, Alabama, 2001

	Size (Acres)									
	100		250		550		850		1,200	
Item	$000	%	$000	%	$000	%	$000	%	$000	%
Buildings and Office Equipment	21.0	4	39.0	3	58.0	3	79.0	3	97.0	3
Equipment										
Harvesting	116.9	23	191.8	16	206.8	11	272.6	10	371.6	10
Maintenance and Establishment	201.8	39	378.5	31	701.6	38	1139.4	41	1437.9	40
Irrigation	85.0	17	205.0	17	415.0	23	670.0	24	790.0	22
Delivery	87.5	17	392.5	33	457.5	25	610.0	22	915.0	25
Total ($1000)	512.2	100	1206.8	100	1838.9	100	2771.0	100	3611.5	100
Per Acre ($)	5,122	--	4,827	--	3,343	--	3,260	--	3,010	--

Table 2. Costs Per Acre for Alternative Sized Turfgrass Farms, Alabama, 2001

	Size (Acres)				
Item	100	250	550	850	1,200
Variable Costs					
Herbicides	50	50	50	45	45
Insecticides and Fungicides	25	25	25	20	20
Fertilizer and Lime	135	135	135	121	121
Fuel and Lubrication	140	140	140	140	140
Pallets	360	360	360	324	324
Irrigation	39	39	39	39	39
Repairs	342	242	168	161	148
Hired Labor	480	640	640	602	533
Interest on Variable Capital (@9%)	147	148	146	133	130
Other Variable Costs	250	250	250	250	250
Subtotal	1968	2029	1953	1836	1751
Fixed Costs					
Land Rent	100	100	100	100	100
Insurance	41	39	27	26	24
Depreciation	670	602	418	408	380
Interest on Fixed Capital (@10%)	256	241	167	163	150
Operator Labor Management	400	160	145	235	233
Miscellaneous	100	100	100	80	80
Subtotal	1567	1242	957	1012	967
Total	3535	3271	2910	2848	2718

Table 3. Cash Flow Estimates for a Seven-Year Planning Horizon for a 100-Acre Turfgrass Farm, Alabama, 2001

	Year						
Item	1	2	3	4	5	6	7
Receipts[1]							
Bermuda	73,500	470,400	470,400	470,400	470,400	470,400	470,400
Zoysia	0	35,550	95,274	95,274	95,274	95,274	95,274
Centipede	0	21,150	56,682	56,682	56,682	56,682	56,682
Total	73,500	527,100	622,356	622,356	622,356	622,356	622,356
Expenses							
Variable	196,800	356,700	356,700	356,700	356,700	356,700	356,700
Fixed	156,700	156,700	156,700	156,700	156,700	156,700	156,700
Borrowing from previous year paid back	0	305,200	317,735	227,569	129,288	22,162	0
Interest Earned	0	0	0	0	0	0	0
Cumulative Inflow/Outflow	-280,000	-291,500	-208,779	-118,613	-20,332	86,794	108,956
Borrowing Needs	-280,000	-291,500	-208,779	-118,613	-20,332	0	0
Compiled Yearly Cash	0	0	0	0	0	86,794	195,750

[1] Prices per square yard are $1.05 for Bermuda, $1.41 for Centipede and $2.37 for Zoysia. Production includes 70 acres for Bermuda, 15 acres of Centipede and 15 acres of Zoysia.

Table 4. Cash Flow Estimates for a Seven-Year Planning Horizon for a 1,200-Acre Turfgrass Farm, Alabama, 2001

	Year						
Item	1	2	3	4	5	6	7
Receipts[1]							
Bermuda	882,000	5,644,800	5,644,800	5,644,800	5,644,800	5,644,800	5,644,800
Zoysia	0	426,600	1,143,288	1,143,288	1,143,288	1,143,288	1,143,288
Centipede	0	253,800	680,184	680,184	680,184	680,184	680,184
Total	882,000	6,325,200	7,468,272	7,468,272	7,468,272	7,468,272	7,468,272
Expenses							
Variable	2,101,200	3,808,425	3,808,425	3,808,425	3,808,425	3,808,425	3,808,425
Fixed	1,160,400	1,160,400	1,160,400	1,160,400	1,160,400	1,160,400	1,160,400
Borrowing from previous year paid back	0	2,593,764	1,348,754	0	0	0	0
Interest Earned	0	0	0	0	0	47,230	149,098
Cumulative Inflow/Outflow	2,379,600	1,237,389	1,150,693	2,499,447	2,499,447	2,546,677	2,648,545
Borrowing Needs	2,379,600	1,237,389	0	0	0	0	0
Compiled Yearly Cash	0	0	1,150,693	3,650,140	6,149,587	8,696,264	11,344,809

[1] Prices per square yard are $1.05 for Bermuda, $1.41 for Centipede and $2.37 for Zoysia. Production acres includes 840 acres of Bermuda, 180 acres of Centipede and 180 acres of Zoysia.

Table 5. Minimum Zoysia and Centipede Grass Prices to Generate Profit Comparable to Bermudagrass for Seven-Year Planning Horizon and Five Alternative Farm Sizes, Alabama, 2001

	Size (Acres)				
Grass	100	250	550	850	1,200
Zoysia	$ 2.54	$ 2.52	$ 2.52	$ 2.54	$ 2.56
Centipede	$ 2.33	$ 2.31	$ 2.31	$ 2.35	$ 2.37

Table 6. Breakeven Prices for Bermuda, Zoysia, and Centipede Grasses for Seven-Year Planning Horizon and Five Alternative Farm Sizes, Alabama, 2001

	Size (Acres)				
Grass	100	250	550	850	1,200
Bermuda	$ 0.95	$ 0.92	$ 0.84	$ 0.81	$ 0.77
Zoysia	$ 2.28	$ 2.15	$ 1.95	$ 1.89	$ 1.80
Centipede	$ 2.07	$ 1.93	$ 1.74	$ 1.69	$ 1.62

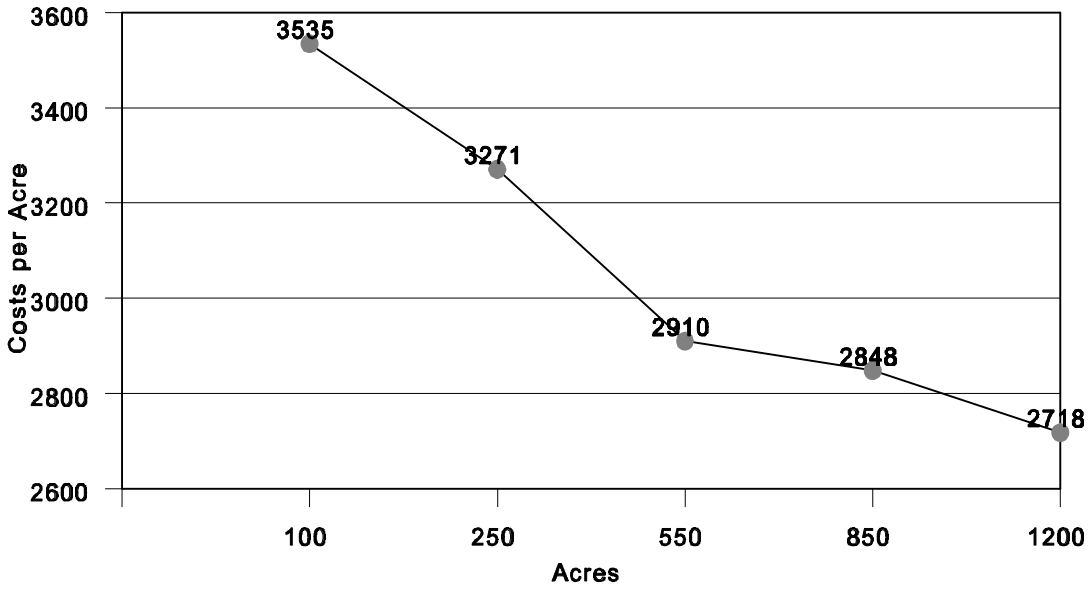

Figure 1. Costs Per Acre for Alternative Sized Turfgrass-Sod Farms, Alabama, 2001