

BULLETIN 529

AUGUST 1981

Commercial Turfgrass-Sod Production in Alabama



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FIRST PRINTING 3M, AUGUST 1981
SECOND PRINTING 3M, FEBRUARY 1982

*Information contained herein is available to all persons
without regard to race, color, sex, or national origin.*

PREFACE

This study is divided into four sections. The first section presents a description of the commercial turfgrass-sod industry as it existed in Alabama in 1978-79. General characteristics explaining the nature of the industry are presented along with production, harvesting, and marketing practices which were common in the industry. As with any young and developing industry, these practices vary widely among firms. Therefore, the discussion presents characteristics and practices frequently reported with important deviations noted. These practices may not represent the best options for farmers, but they do seem to be feasible alternatives.

The second section concentrates on developing and analyzing investment requirements, costs, and returns from operating data provided by producers. Estimates were provided for all producers and by size of firm categories. These estimates provide growers who are currently in production an opportunity to evaluate the performance of their operation by comparing their figures with industry averages.

The third section includes development and presentation of investment requirements, costs, and returns using current (1980) input and output prices. Characteristics and practices identified in the prior two sections were used as the basis for budget entries. Use of this information provides individuals the opportunity to evaluate the feasibility of entering turfgrass-sod production. Cost and return estimates presented in this section should be used as guides by those contemplating production. Factors which deviate greatly from the assumptions of the analysis should be accounted for in the feasibility study to lessen the chances for making unsatisfactory decisions. This section includes two subsections: analyses by firm size using 1980 prices and costs and analyses for a firm which will generate approximately \$15,000 annual net income after establishment.

The last section provides a summary of the study with major results presented. Also, conclusions which could be drawn from the study are presented.

COMMERCIAL TURFGRASS-SOD PRODUCTION IN ALABAMA*

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INTRODUCTION

ALABAMA'S COMMERCIAL turfgrass industry is relatively young. Development of the industry in the State began in the early 1940's with the introduction of several improved turfgrass cultivars, especially *Matrella zoysiagrass*. The turfgrass industry grew slowly during the 1940's and 1950's as three to five producers operated on a small scale. Markets for turfgrass were relatively limited in Alabama at this time. Thus, the majority of the sod produced was marketed out-of-state and, in some cases, in foreign countries. Rapid growth of the industry started in the late 1960's when acreage expanded from 500 acres in 1968 to 3,300 acres in 1979.

With this expansion came the infusion of technological advancements by firms in the industry. Also, interest in the use of sod by homeowners, institutions, contractors, golf course managers, etc. created increased need for information associated with sod establishment, production, and marketing. This study aims to provide a sound base on which potential producers can evaluate the feasibility of commercial sod production and existing producers can evaluate the performance of their operation.

OBJECTIVES AND PROCEDURES

Specific objectives of this analysis were to: (1) determine the nature and scope of the commercial sod industry in Alabama; (2) examine production and marketing practices of firms in the commercial sod industry; and (3) evaluate investment requirements and operating costs and returns data for alternative-sized commercial sod production systems.

*This study was conducted under Hatch Project Alabama 499, supported by State and Federal funds.

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To achieve these objectives, a list of commercial sod producers in Alabama was developed with aid from county extension personnel, the Division of Plant Industry of the Alabama Department of Agriculture and Industries, and individual sod producers. An initial list of 40 growers was developed from the information provided by these sources. Growers were contacted by telephone seeking confirmation of their turfgrass activities and preliminary information on their turfgrass operation. From the initial telephone contacts, the list of growers was shortened to include 26 bona fide turfgrass producers (in production) in 1978.¹

During the summer and fall of 1979, these producers were contacted and asked to supply information about their sod operation for 1978 and sales estimates for 1979. Of the 26 producers, 15 participated fully in the study by supplying detailed information about production, harvesting, and marketing. This information was used to determine cultural practices, market outlets, investment requirements, and costs and returns of production. General marketing information concerning output, prices, primary market outlets, and transportation and delivery practices was used to identify the flow of sod from the time of harvest until it reached the final consumer.

Turfgrass operations were segregated into small (less than 100 acres), medium (100 to 250 acres), and large (more than 250 acres) size categories and average costs, returns, and investment estimates were developed utilizing actual data provided by the firm operators. Also, current (1980) input and product prices were used to develop budgets for the various-sized turfgrass firms so as to provide more realistic estimates for an individual contemplating turfgrass production. Finally, costs, returns, and investment estimates were developed for a sod farm large enough to generate approximately \$15,000 net income annually.

CHARACTERISTICS OF THE INDUSTRY

General

Farm and Operator

Organizational characteristics of sod farms varied widely. Sod operations in Alabama, for the most part, were operated as part-

¹For the purpose of this study, nurseries with less than 10 acres of turfgrass or which resold sod strictly on a retail basis, stripper operators who sold pasture grass, and new turfgrass growers who were not in production during 1978 were not considered bona fide turfgrass producers.

time businesses. Only four growers reported that their incomes for 1978 came solely from sod production. Five growers reported having off-farm employment. Seven growers reported growing other agricultural products in addition to turfgrass with row crops (soybeans, corn, and cotton) being the most frequently noted agricultural enterprises. Three growers reported having a nursery operation which complemented the sod operation.

Fifty-three percent of the growers were more than 50 years of age. Eleven growers reported having previous farm experience before entering the sod business. Average farm experience was 21.6 years. Experience growing turfgrass averaged 11.6 years with only four growers reporting less than 6 years experience. The range of experience in turfgrass production was from 2 to 25 years.

The most frequently reported form of business organization was the sole proprietorship with seven producers using this type of organization. Five of the seven growers utilizing this form were in the less than 100-acre farm size category. Six producers utilized the corporate form of business organization while only two partnerships were reported. All three of the farms in the greater than 250-acre size category used the corporate form. Medium-sized farms had each of the three types of business organization; two corporations, two sole proprietorships, and one partnership. One sod operation with less than 100 acres utilized the corporate form of organization, but this was primarily because of the extent of non-sod agricultural operations. Both of the partnerships reported father-son partnerships.

The 15 turfgrass producers participating in this study reported managing 7,067 acres in 1979 which included 2,632 acres of sod. Approximately half of the sod was grown on rented land. Most of the rented land was leased for a period of 10 years at an average annual rate of \$38 per acre in 1979. Two growers reported paying land rent on a per yard of turfgrass sold basis with an average price of \$0.12 per square yard.

Size and Scope of the Industry

Three measures are commonly used to evaluate the size and scope of the sod industry. These are: (1) total acreage maintained for sod production; (2) total square yards of sod sold per year²; and (3) total value of sod sales per year. While each of these measures was used in

²For the purpose of this study, 4,000 square yards of marketable sod are assumed to be produced per acre per cutting unless specified otherwise.

the study, square yards of sod marketed per year were considered to provide a more accurate indicator of firm size since a direct indication of a particular firm's market power is given.

During the late 1970's, sod production in Alabama experienced a period of rapid growth in both the number of acres of sod maintained and the number of sod producers. In 1978, turfgrass was produced by 26 growers in 16 counties. By 1979, turfgrass was produced by approximately 30 growers in 19 counties, figure 1. The largest concentration of acreage and the majority of producers were located near the major population centers of the State. Jefferson, Shelby, and St. Clair counties had 36 percent of the acreage maintained in sod in 1979.

There was an estimated 2,871 acres of sod grown and 4,388,000 square yards marketed in 1978, table 1.³ This compared with 3,316 acres of sod grown and 4,324,000 square yards marketed in 1979.⁴ Total gross income at the farm level in 1978 for all producers⁵ of sod in Alabama was estimated to be approximately \$4,008,484 wholesale, excluding delivery and installation charges, table 2. Gross revenue at the farm level for 1979 was estimated to be approximately \$4,177,596 wholesale, excluding delivery and installation charges. This amounted to an average gross return per acre harvested at the farm level of \$3,654 in 1978 and \$3,865 in 1979, table 2.

In terms of acres grown and gross sales, the most important sod species grown was bermudagrass, tables 1 and 2. Eleven of the 15 producers grew 1,435.5 acres of bermudagrass from which they harvested 680 acres and sold 2,720,000 square yards for \$2,216,800, an average of \$3,260 gross revenue per harvested acre in 1978. Bermudagrass was followed by centipedegrass in importance with eight growers producing 541 acres with sales of 492,000 square yards for \$551,488, an average of \$4,480 gross revenue per harvested acre. Seven growers reported growing 492.5 acres of zoysiagrass and sold 591,600 square yards for \$715,836, an average of \$4,840

³Estimates include approximately 382 acres grown and 584,000 square yards marketed by 11 growers who chose not to participate in the study.

⁴Estimates include approximately 684 acres grown (220 acres of this amount were planted during 1979 and not considered to be in production during the year) and 162 acres marketed by 11 growers who chose not to participate in the study.

⁵When estimating the gross revenue contributed by those growers who did not participate in the study, a weighted average price was computed from the prices provided by the growers who participated in the study. The wholesale price used for 1978 was \$0.915 per square yard. A wholesale price of \$0.967 was computed for 1979. The number of square yards for the non-participant growers was estimated using the mean cut-out percentage of the participating growers. For 1978, a cut-out percentage of 38.22 percent was used while 34.9 percent was used for 1979 estimates.

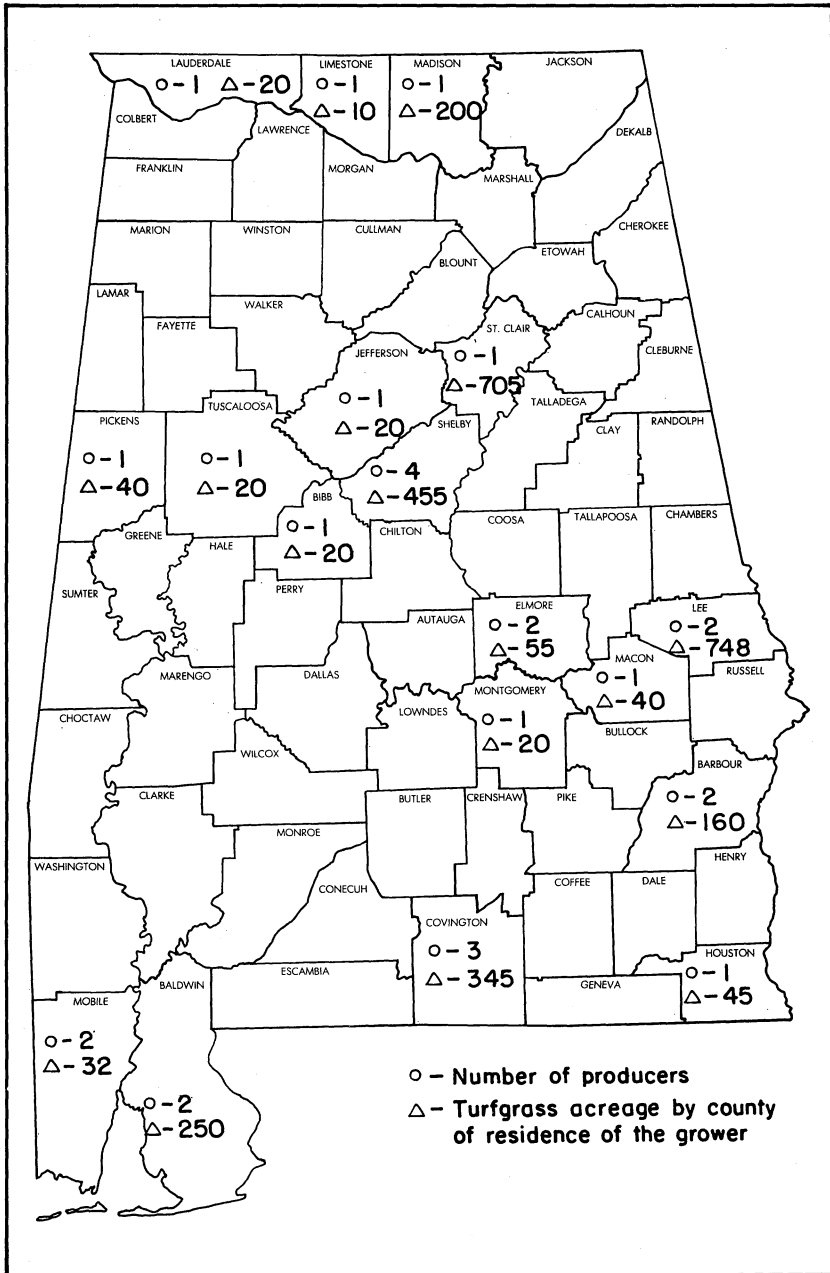


FIG. 1. Number of producers and turfgrass acreage by county of residence of the grower, 1979.

TABLE 1. VARIETAL COMPOSITION OF VARIOUS TURFGRASS GROWN, ALABAMA, 1978 AND 1979

Variety	Number of growers		Acres in		Percent of acreage of participating growers	
	1978	1979	1978	1979	1978	1979
Bermudagrass						
Tifdwarf	2	2	21	21	.8	.8
Tifgreen (328)	11	11	896.5	901.5	36.0	34.3
Tiflawn	1	1	1	1	—	—
Tifway (419)	9	9	517	562	20.8	21.4
Subtotal			1,435.5	1,485.5	57.6	56.5
Centipedegrass	8	8	541	541	21.8	20.6
St. Augustinegrass ^a	1	2	20	24	.8	.9
Zoysiagrass						
Emerald	7	9	260	310.5	10.5	11.8
Matrella	4	5	83	96.5	3.3	3.6
Meyer	4	5	149.5	174.5	6.0	6.6
Subtotal			492.5	581.5	19.8	22.0
Total participating grower's acreage	15	15	2,489	2,632	100.0	100.0
Nonparticipating grower's acreage	11	15	382	684		
Total	26	30	2,871	3,316		

^aFloratom.

gross revenue per harvested acre in 1978. No St. Augustinegrass was reported marketed during 1978 or 1979.

Growers with sod farms of more than 250 acres produced 64 percent of the acreage of participating growers in 1979, a decrease of 2.4 percent from 1978, table 3.⁶ Growers in the 100-250-acre category produced 29 percent of this acreage in 1979, an increase of 32.2 percent from 1978. Growers in the less than 100-acre category produced 7 percent of the acreage of participating growers in 1979 and experienced a decrease of 43.9 percent from 1978. This decrease was because two farms which were classified in the small category in 1978 were classified as medium-sized farms in 1979.

⁶The three largest growers of sod produced 51.6 percent of all turfgrass (acreage of participating and nonparticipating growers) during 1979. This represented a decrease of 5.5 percent in market share from 1978.

TABLE 2. ACREAGE AND FARM SALES OF TURFGRASS BY SPECIES, ALABAMA, 1978 AND 1979

Species	Acres sold		Gross farm sales		Average sales per acre		Percent of total sales	
	1978	1979	1978	1979	1978	1979	1978	1979
Bermudagrass	680.0	637.4	\$2,216,800	\$2,141,664	\$3,260	\$3,360	55.3	51.3
Centipedegrass	123.1	139.3	551,488	635,208	4,480	4,560	13.8	15.2
St. Augustinegrass								
Zoysiagrass	147.9	142.3	715,836	774,112	4,840	5,440	17.9	18.5
Total participating grower's acreage	951.0	919.0	3,484,124	3,550,984	3,664	3,864	86.9	85.0
Nonparticipating grower's acreage	146.0	162.0	524,360	626,612	3,592	3,868	13.1	15.0
Total	1,097	1,081	\$4,008,484	\$4,177,596	\$3,654	\$3,865	100.0	100.0

TABLE 3. ACREAGE OF CULTIVATED TURFGRASSES FOR PARTICIPATING GROWERS BY SIZE OF SOD FARM, ALABAMA, 1978 AND 1979

Sod farm size	No. of growers cultivated sod		Acres of sod		Average acres of sod per farm		Percent of Total cultivated sod		Percent change in cultivated acreage
	1978	1979	1978	1979	1978	1979	1978	1979	
Less than 100 acres	9	7	310	184	34.4	26.3	12.45	6.99	-43.9
100-200 acres	3	5	540	755	180.0	151.0	21.70	28.69	32.2
More than 250 acres	3	3	1,639	1,693	546.3	564.3	65.85	64.32	- 2.4
Total	15	15	2,489	2,632	165.9	175.5	100.00	100.00	5.8

Production Practices

Production practices can be divided into three areas: establishment, primary cultural practices, and pest management. Turfgrass producers were asked to list the three most serious problems associated with commercial sod production. The most prominently mentioned problems were associated with turfgrass production practices. Through proper turfgrass cultural practices, high quality sod can be produced rapidly and at minimum expense.

Establishment

Establishment of a uniform turfgrass sod is essential for efficient production. Bare spots and other open areas must be re-established or harvesting will be hampered or delayed until the sod covers. Competition from weeds is serious where bare soil exists. Sod establishment can be divided into two basic operations: initial establishment and re-establishment of the turfgrass after harvest.

Initial Establishment

Prior to planting, a new turfgrass site should be prepared to correct any present problems and avoid any potential production or harvesting difficulties. Site preparation may involve many operations along with the usual tillage practices, such as land clearing, stone and debris removal, land leveling, installation of drainage and irrigation systems, selection of roadway and building sites, soil fumigation, and fertilization and liming procedures (9).

The vast majority of new turfgrass established for sod production during 1978 and 1979 was established on land which was previously planted in row crops or pasture. Producers avoided establishing turfgrass on land which required clearing because of the high costs of site preparation. Growers preferred to establish turfgrass during late spring and early summer. When row crop and pasture-land were to be planted to sod, the land was usually subsoiled and

plowed with either a moldboard or chisel plow to a depth of 10 inches. This was followed by heavy disking and packing to further smooth the soil and incorporate insecticides, fertilizer, and lime into the soil. These procedures were utilized by the majority of sod growers. However, larger growers utilized a slightly different procedure for initial site preparation. This involved subsoiling to a depth of 18 to 24 inches, chisel plowing to a depth of 10 inches, heavy disking, rototilling, and packing.

Site preparation practices were reported to be the same regardless of the turfgrass species to be planted. Soil type, however, can have a major impact on site preparation costs and on the turfgrass species to be planted. Ideally, growers preferred a sandy loam for turfgrass establishment. Of the growers participating in this survey, 12 reported having sand or sandy loam, two reported clay loam, and one reported clay as the dominant soil type on their farms.

Growers generally agreed that clay soils required more tillage for site preparation and the turfgrass species planted in clay soils required more time to establish a high quality sod than required for sandy soils. A common practice was to plant bermudagrass on the heavier soils and plant zoysiagrass or centipedegrass on the lighter soils.

Initial establishment of St. Augustinegrass, bermudagrass, and zoysiagrass is vegetative while centipedegrass can be established from seed or vegetatively.⁷ Each turfgrass species can be vegetatively established from sprigs or plugs planted in rows. A planting rate of 300 to 400 bushels per acre for bermudagrass and 350 to 450 bushels per acre for zoysiagrass, centipedegrass, and St. Augustinegrass was reported by the majority of sod growers. Several growers reported establishing bermudagrass and centipedegrass sprigs with the use of a manure spreader. A planting rate of 400 to 450 bushels per acre for all turfgrass species was reported with this method. Growers reported a faster rate of soil coverage with this method due to the more uniform distribution of sprigs throughout the soil.

Established turfgrass producers utilized sod grown on their farms for sprigs when increasing the acreage of an existing turfgrass species. Potential turfgrass producers must either purchase all of their sprigs from existing sod farms or they may purchase a sufficient quantity of sprigs to establish a small plot of turfgrass. Usually

⁷The majority of growers reported seeding centipedegrass for initial establishment. Centipedegrass seed currently sell for \$18 to \$24 per pound and a seeding rate of 8 to 12 pounds per acre was reported.

1- to 2-acre plots of sod were established from which sprigs were obtained to increase acreage.

Generally, sufficient quantities of high quality turfgrass are grown by Alabama sod producers to enable one to establish the desired species of turfgrass for a new sod farming operation. However, at times it may be necessary to purchase zoysiagrass and centipede-grass sprigs from Florida or Georgia producers because of the limited availability of these two turfgrass species in various parts of the State. Also, it is not uncommon for established sod producers to be reluctant to sell large quantities of sod to persons known to be in the process of establishing a new sod farm.

Re-establishment

Procedures used for re-establishment of turfgrass after harvest generally varied directly with the size of the sod farming operation. Most small producers reported allowing turfgrass to re-establish itself from ribbons which were left in the field after harvesting. A common practice was to apply a complete fertilizer, roll, and frequently irrigate the ribbons. If the sod field was left in an unusually rough condition after harvest, the field would be disked lightly prior to rolling.

Large sod firms utilize large and heavy equipment in the harvesting process. Since sod is usually irrigated prior to harvest, wheel imprints left by mechanical sod harvesters, fork lifts, and heavy trucks can cause severe problems in sod re-establishment. The soil surface needs to be smooth so the next crop of sod can be harvested efficiently by mechanical sod cutters. Therefore, because of the size of their operations, most large growers usually completely renovated a sod field after each harvest.⁸

The procedures utilized by large growers for re-establishment were similar to those utilized during the initial establishment operation. The field was initially fertilized and limed according to an established program and then chisel plowed, rototilled, rotovated, rolled, and irrigated. Several growers reported they could often omit chiseling and rototilling operations when sandy or sandy loam soils were present.

Primary Cultural Practices

Following establishment, the primary objective is to encourage sod development by enhancing stolon and rhizome growth. These organs provide sod with the tensile strength necessary for harvesting

⁸Several growers reported they were planning on experimenting with clean-cutting bermudagrass to increase yields from 4,000 to 4,600 square yards per acre per cutting.

and handling. Management practices which encourage stolon and rhizome growth of turfgrasses may differ from those practices which encourage the quality of the visible portion of the turf (2,3).

Mowing

Mowing is perhaps the most basic of all turfgrass cultural practices. Mowing operations are generally performed to maintain turfgrass growth within specific limits and control undesired weedy grasses which are intolerant to close mowing.

Principal mower types used by Alabama sod growers were reel, rotary, and flail. Of these, the reel mower was the most popular because the highest possible mowing quality could be achieved and the power requirement was less. The most common size mower reported was the 5-gang, ground-driven unit; however, units from 3-gang to 9-gang were reported. Since reel mowers do not work well on tall turfgrass and can be damaged if operated on sparse turf, it is necessary for sod producers to own other mower types. Generally, flail mowers are used until sufficient grass cover is achieved and to mow "tall" turfgrass. Some growers reported using rotary mowers for "tall" turfgrass.

Two relatively new types of reel mowers are becoming increasingly popular for mowing large sod fields. These are the power-take-off and hydraulically powered reel mowers. Growers reported these mowers cut much faster and more cleanly than ground-driven reel mowers and they did not "bog down" in dense turf. The major impediment to use of these mowers is their higher initial cost and maintenance requirements.

New sod fields were generally mowed once every 3 to 4 weeks depending on grass growth and weed encroachment. Three growers reported a weekly mowing frequency while two growers mowed new sod on a bi-weekly basis. Established bermudagrass and zoysiagrass turf was normally mowed once every 5 to 7 days while centipedegrass and St. Augustinegrass were mowed once every 10 to 14 days. The general rule of thumb was to establish a mowing frequency which would ensure that no more than one-third of the leaf area would be removed during mowing.

Growers generally mowed established bermudagrass turf within a range of 0.75 to 1.5 inches while new turf was mowed 0.5 to 1.0 inch higher. Eighty-three percent of the growers producing bermudagrass sod maintained a mowing height of 1.0 to 1.5 inches while the rest maintained a mowing height of 0.75 inches. Zoysiagrass and centipedegrass were generally maintained at a mowing height of 1.0

to 1.5 inches and St. Augustinegrass was maintained at a height of 2.0 inches during the growing season. Prior to harvest, growers reported mowing all turfgrass at a height of 0.5 to 0.75 inches because closely mowed sod is easier to handle during harvesting. Also, sod that has been mowed lower than normal has a better chance to survive because less leaf surface area is available for transpiration. Mowing heights were normally raised in early spring and fall to compensate for cold stress and reduced growing activity.

Thatch removal is an important aspect of sod production. Nine of the growers reported they de-thatched turfgrass on an annual basis. Two growers de-thatched by burning dormant sod in the field in late winter. The remaining seven growers combined burning and/or close mowing followed by sweeping and removal of excessive clippings. One grower reported switching from spring de-thatching to fall de-thatching. The three most common means of disposing of thatch were: burning, composting, and landfill.

Irrigation

Irrigation is essential for sod production, especially during germination and establishment phases. Failure to maintain adequate soil moisture levels is a major cause of poor turf establishment. Young turfgrass sprigs or seedlings have limited root systems and need readily available water.

The inability to irrigate sod frequently during periods of limited rainfall appeared to be a minor problem in Alabama. Sod producers reported that irrigation frequency varied widely from year to year depending upon the weather. In 1978, some growers reported irrigating up to 100 percent of their sod acreage while one grower reported he did not irrigate at all. Generally, sod producers can plan to irrigate from 33 to 50 percent of their sod acreage at least once a year. This is in addition to the normal practice of irrigating sod prior to harvest and directly related to anticipated sales for the growing season.

Volume of water applied per irrigation reported by sod growers varied from 0.5 inches to 2.0 inches. The most frequently reported irrigation rate was 1.0 inch per irrigation. Growers generally reported they preferred to irrigate during the early morning or late afternoon hours to reduce evaporation losses that occur during midday.

Sod growers reported using a variety of irrigation systems with the traveling cable-tow system connected to underground pipe being the most popular (eight growers). Other types of systems used were: (1) center-pivot (three growers), (2) underground pipe with guns or

sprinklers (three growers), (3) above-ground aluminum pipe with guns or sprinklers (three growers), and (4) automatic sprinkler systems with underground pipe (one grower). Several producers had more than one type of irrigation system in use. All but one grower reported that the present irrigation system was adequate while one grower had no irrigation system but was planning to purchase one in the near future. Growers reported having the capacity to irrigate 40 to 100 percent of their acreage in sod during a 5-day irrigation cycle.

It is important to have a water source which will provide water throughout the growing season. The quantity of water available should be sufficient to enable the irrigation system to be operated at full capacity in accordance with equipment design. Independent water sources not subject to city, state, or federal regulation were preferred by Alabama sod growers. Three common sources of irrigation water used were ground water from wells, lakes and reservoirs, and continuously flowing creeks and rivers.

Fertilization

Fertilization is the process of supplying essential plant nutrients to turf as part of a regular cultural management program. Timing of fertilizer applications is important. A minimum of two applications (spring and fall) of a complete fertilizer per year was preferred by Alabama sod producers. Supplemental nitrogen fertilizer applications were applied during the summer, usually on a monthly basis.

The amount of fertilizer required for optimum turfgrass quality throughout the growing season depends on various factors such as turfgrass species and mowing and irrigation practices. A general rule followed by Alabama sod producers was to apply no more than 50 pounds of available nitrogen per application per acre to mature turf since higher rates might cause turf injuries or excessive shoot growth.⁹ New sod fields were generally fertilized at higher rates to promote rapid growth. Application rates of mixed fertilizer in the spring and fall varied considerably according to soil tests. However, most growers applied a complete fertilizer, such as 13-13-13, at rates which supplied between 60-75 pounds of available nutrients per acre in each application.

Most growers reported soil testing on a regular basis, either annually or semi-annually. Generally, growers followed fertilizer and lime recommendations; however, some growers did report applying

⁹The most common form of nitrogen was ammonium nitrate (34-0-0). One grower reported trying slow release nitrogen in his fertilizer program; however, use was discontinued when it did not show any significant improvement in turf quality for the additional cost.

fertilizer at rates above recommended levels. Lime was usually applied in the spring or incorporated during re-establishment at recommended rates. One grower reported applying fertilizer through the irrigation system with poor results.

Pest Management

One of the most important aspects of sod quality is uniformity. High quality sod must be uniform in coverage and thickness to ensure proper harvesting and installation. Uniformity is also desirable for aesthetic reasons. The presence of turfgrass pests disrupts uniformity and leads to consumer dissatisfaction.

Insect Control

Insect pests may be grouped into three categories: root feeding, shoot feeding, and burrowing. The first two pose a direct threat to turfgrass while the latter category includes insects that are a nuisance because of the disruption caused to the surface of the sod.

Grubs, billbugs, ground pearls, and mole crickets were the most common root-feeding insect pests reported. Grubs included May beetles, Japanese beetles, and French beetles. Adults do not normally feed on turfgrasses, but the larvae thrive on turfgrass roots and shoots. Ground pearls are usually found feeding on the roots of several warm-season turfgrasses, especially centipedegrass. Mole crickets can cause severe damage to young turf stands by uprooting individual plants as they burrow through the soil, causing death by desiccation. Growers reported using diazinon or chlordane to control common grubs.

Common shoot-feeding insect pests reported were sod webworms, armyworms, grasshoppers, and chinch bugs. Sod webworms usually feed at night by chewing leaves at the base of the sheath. If infestations are substantial, these pests can cause severe damage to sod during the summer months. Usually, two generations occur during a normal growing season. Armyworms are the most feared of insect pests. Most growers reported having to control from two to six generations of armyworms during the growing season. Grasshoppers do not normally pose a severe threat to sod fields; however, they did become a problem for several growers during the 1978 crop year. Chinch bugs can become a major problem in sod production, especially if St. Augustinegrass is grown. From one to five generations of chinch bugs were reported during a single growing season. Pesticides normally used to control shoot feeding insects were toxaphene, chlordane, diazinon, carbaryl, heptachlor, and methomyl.

Fire ants were the only major burrowing insect pests reported. When their population becomes large, they excavate soil to the surface causing large mounds. This results in turf which lacks uniformity and is not pleasing to the eye. Fire ants are insects which cannot be tolerated in sod production. They must be eradicated before a marketable sod can be produced. Also, if fire ants are present in a given field, sod cut from that field cannot be certified by the Alabama Department of Plant Industries. Growers reported using dieldrin and chlordane to control fire ants in sod.¹⁰ Dursban has recently been approved for fire ant control in commercial turf production; however, it does not seem to be as effective as dieldrin or chlordane. Most growers expressed concern over how this problem would affect production costs in the future.

Weed Control

Sod producers followed an intensive weed control program combining frequent mowing and herbicide application. Weeds are usually divided into three categories: annual grasses, broadleaf weeds, and perennial grasses. Growers reported that most herbicides used for controlling annual grasses and broadleaf weeds did not seriously affect desired turfgrasses when properly used according to label directions. However, many perennial grasses, such as common bermudagrass, cannot be controlled selectively. Therefore, control of most perennial grasses required spot-spray treatment of problem areas with nonselective herbicides such as glyphosate.

Frequently mentioned problem weeds of the annual grass category were annual bluegrass, crabgrass, and goosegrass. The most frequently mentioned perennial weeds were common bermudagrass and dallisgrass, while purslane, wild onion, and wild garlic were frequently mentioned problem broadleaf weeds.

Growers reported controlling summer annual grasses with post-emergence herbicides such as atrazine, simazine, MSMA, and DSMA. One to four applications of these compounds were necessary to control crabgrass and goosegrass. Annual bluegrass was reportedly controlled successfully in bermudagrass sod with applications of pronamide or paraquat applied when the bermudagrass was dormant.

Some perennial weeds can be controlled selectively in warm-season turfgrasses. Dallisgrass and bahiagrass were controlled in bermudagrass sod with several applications of MSMA or DSMA. However, most perennial grass weeds must be controlled using

¹⁰Dieldrin, heptachlor, and chlordane have been removed from the list of chemicals approved by the EPA. However, farmers may use those quantities on hand.

glyphosate as a spot-spray.

Broadleaf weeds were controlled selectively using 2,4-D, mecoprop, dicamba, atrazine, and simazine applied post-emergent. Many growers reported applying these compounds in combinations such as: 2,4-D plus MSMA or 2,4-D plus atrazine. This method was found to be very successful for controlling broadleaf weeds and several of the annual grasses such as crabgrass and goosegrass. Growers reported that care must be exercised when mixing herbicides because a thick paste may form which will block nozzles of spray equipment.

In some cases, especially on new sod sites, presence of serious weed or nematode problems can only be corrected through the use of soil fumigants or nonselective herbicides. The principal herbicide used for this purpose was glyphosate. Glyphosate was applied when weeds were young and growing vigorously. While glyphosate is usually effective, growers reported that additional applications may be necessary if weed problems persist.

Fumigation is the process of injecting a highly volatile chemical, usually methyl bromide, into the soil to control weed seeds, vegetative growth, nematodes, and disease-causing organisms. Four growers reported using methyl bromide fumigation prior to turfgrass establishment. One grower noted good results from this process while three growers were disappointed. Because of the cost of fumigation (from \$800 to \$1,000 per acre), growers stated they preferred the nonselective herbicide approach to weed control on new land and that soil fumigation with methyl bromide would be used only as a last resort.

Disease Control

For turfgrass disease to occur, there must be a virulent pathogen, susceptible turfgrass, and proper environmental conditions. Sod producers reported few incidents of turf diseases during 1978 and 1979. During the summer of 1980, an outbreak of gray leafspot was reported in St. Augustinegrass sod in south Alabama. Diseases did not appear to be a serious problem on most commercial turfgrass farms in the State.

Harvesting and Marketing Practices

The purpose of this section is to identify various harvesting and marketing practices utilized by commercial sod firms. General information concerning output, prices, market outlets, and transportation and harvesting practices is included.

Harvesting Operations

Sod can be harvested as soon as the stem system has developed sufficiently to permit cutting and handling without tearing. Growers reported the time required to produce a marketable sod from initial establishment varied from 2 to 24 months depending on the turfgrass species. For bermudagrass, a period of 6 to 12 months was generally adequate to produce a marketable sod from initial establishment, while a period of 3 to 6 months was required to produce a marketable sod from regrowth.

The production time required to produce a marketable zoysiagrass sod varied from 12 to 24 months with 24 months being generally required from initial establishment or from regrowth. Similarly, a marketable centipedegrass sod could generally be produced in 12 to 24 months. However, the majority of producers growing centipedegrass reported that 18 months were required to produce a high quality sod. The production period for St. Augustinegrass was expected to be similar to that of centipedegrass.

Irrigating sod fields prior to harvest was a normal practice utilized by sod growers to facilitate harvesting operations. Mechanical sod cutters which cut sod into strips of various widths and thicknesses were used. Two basic types of mechanical sod cutters were reported. Small growers often utilized sod cutters which were hand-guided and required hand-rolling and/or stacking. All growers with more than 100 acres used one or more tractor-mounted sod cutters. These machines cut, rolled, and palletized the sod in one operation.

Thickness of cut can be important in the productive life of a sod field. Thickness of cut varied with the turfgrass species. Growers generally removed 0.5 inch of rootzone when cutting bermudagrass sod, 0.6 inch for centipedegrass sod, and 0.75 inch for zoysiagrass sod. Thin-cut sod is easier to handle, establishes faster, and is less expensive to transport than thick-cut sod. However, thin-cut sod is more prone to injury from atmospheric drought.

The fear that fields planted to sod will become unproductive because of soil loss from sod harvesting operations has been expressed by turfgrass researchers and by some turfgrass growers. However, growers did not report any noticeable decline in productivity of sod fields caused by soil loss from harvesting operations. In fact, several growers reported that sod fields which were established more than 15 years ago were still productive. Growers did not expect to add topsoil to existing sod fields in the future. In the event a sod field did become unproductive, most growers reported they would establish sod in a new field and plant the unproductive field

to cover crops for several years to improve soil structure.

A yield of 4,000 square yards of marketable sod per acre per cutting was reported by most growers. However, growers with excellent management reported that yields in excess of 4,300 square yards of sod per acre per cutting could be harvested. The normal harvesting practices allowed a 2-inch ribbon of turfgrass per harvested strip to be left in the field for re-establishment. This practice can be beneficial when harvesting zoysiagrass and centipedegrass sods because they are slow to re-establish. However, bermudagrass, under normal conditions, will re-establish quickly when clean-cut if fertilized and irrigated adequately. More growers are expected to utilize clean-cutting of bermudagrass sod in the near future to increase sod yields.

Growers generally planned to harvest one-third of the total acreage maintained in sod per year. Under normal conditions, this practice allowed the producer to have adequate supplies of marketable turfgrass on hand during times of an unexpected increase in demand.

Marketing

Buyers and users of sod were grouped into four major categories: golf course operators, garden centers, private homeowners, and landscape contractors. Landscape contractors were by far the major buyers of sod, accounting for 66 percent of total turfgrass sales in 1978, table 4. Garden center operators who sell sod to the final consumer purchased 18 percent of the turfgrass sold by sod farms.

TABLE 4. VOLUME, DISTRIBUTION, AND VALUE OF SALES BY MAJOR MARKET OUTLINES FOR TURFGRASS, ALABAMA, 1978

Type of buyer	Volume sales	Distribution of sales	Value of sales
	<i>Sq. yd.</i>	<i>Pct.</i>	<i>Dol.</i>
Golf courses	145,000	4.0	125,116
Garden centers	650,000	17.8	557,037
Home owners	435,000	12.0	375,535
Landscape contractors	2,405,000	66.2	2,071,742
Total	3,635,000	100.0	\$3,129,430

Distribution Area

Seventy-eight percent of all sod produced in Alabama in 1978 was sold within the State. The Birmingham and Tuscaloosa areas were major sales regions with Huntsville, Mobile, and Montgomery being other important markets. Out-of-state sales went to neighboring states plus Arkansas, with Georgia receiving more than three-fourths of the out-of-state volume, primarily in the Atlanta area,

TABLE 5. OUT-OF-STATE MARKETS FOR TURFGRASS, ALABAMA, 1978

State	Out-of-state sales	Value of sales	Percent of total sales	Percent of out-of-state sales
	<i>Sq. yd.</i>	<i>Dol.</i>	<i>Pct.</i>	<i>Pct.</i>
Georgia	599,775	516,356	16.5	75.5
Tennessee	72,700	62,589	2.0	9.2
Mississippi	13,958	12,518	0.4	1.8
Florida	105,932	90,753	2.9	13.3
Arkansas	1,750	1,925	—	0.2
Total	794,115	\$684,141	21.8	100.0

table 5. Sales in the northwest Florida area accounted for 13.3 percent of the out-of-state sales.

Shipping Practices

Eighty percent of the sod growers reported having the ability to deliver sod. However, three small growers required customers to transport sod from the field. All growers, regardless of size, reported selling some sod directly from the field. In general, large growers would deliver sod to any location in the Southeastern United States as long as the buyer was willing to pay transportation charges. Most medium- and small-sized growers, however, preferred to restrict deliveries of sod to a radius of less than 100 miles.

Growers who offered delivery services reported delivering up to 90 percent of the sod harvested. Normally, sod was delivered in quantities of 500 to 1,000 square yards per truckload. Delivery (transportation) charges were determined by three basic methods: per load, per loaded mile, and per square yard. Delivery charges per tractor-trailer load ranged from \$150 to \$180 while charges per loaded mile ranged from \$0.45 to \$1.80. Generally, a load of sod containing 500 to 1,000 square yards would entail transportation costs of \$1.25 to \$1.80 per loaded mile. Smaller growers generally charged from \$0.10 to \$0.20 per square yard for delivery.

Pricing Practices

Ninety-three percent of sod sales during 1978 were at the wholesale level. A central market in which wholesale and retail prices are determined did not exist in the sod industry. The general tendency in price establishment was for the larger growers to establish base prices for all species of turfgrass and for smaller growers to use these prices as a guide to establish their prices. Wholesale and retail prices during 1978 and 1979 for farms larger than 100 acres were fairly stable with a range of \$0.20 per square yard, table 6. Prices set by small growers, however, varied by as much as \$0.75 per square yard.

TABLE 6. AVERAGE WHOLESALE AND RETAIL PRICES REPORTED BY TURFGRASS SPECIES AND SOD FARM SIZE, ALABAMA, 1978-1979

Farm size and Turfgrass species	Price								Percent increase 1978 to 1979	
	1978				1979					
	Wholesale		Retail		Wholesale		Retail		Wh.sale	Retail
	Average	Range	Average	Range	Average	Range	Average	Range		
<i>Dol. per/Sq. yd.</i>		<i>Dol. per/Sq. yd.</i>		<i>Dol. per/Sq. yd.</i>		<i>Dol. per/Sq. yd.</i>				
<u>Greater than 250 acres</u>										
Bermudagrass	0.73	0.65-0.85	1.03	1.00-1.05	0.77	0.70-0.85	1.03	1.00-1.05	5.5	0.0
Zoysiagrass	1.10	—	—	—	1.15	—	—	—	4.6	—
Centipedegrass	1.10	—	—	—	1.15	—	—	—	4.6	—
<u>100-250 acres</u>										
Bermudagrass	0.75	—	—	—	0.80	—	—	—	6.7	—
Zoysiagrass	1.13	1.05-1.20	—	—	1.20	1.10-1.25	—	—	6.2	—
Centipedegrass	1.05	1.00-1.10	—	—	1.08	1.05-1.10	—	—	2.9	—
<u>Less than 100 acres</u>										
Bermudagrass	0.87	0.60-1.00	0.95	0.75-1.25	0.88	0.70-1.00	1.01	0.90-1.25	1.2	6.3
Zoysiagrass	1.27	1.00-1.40	1.50	1.00-2.00	1.47	1.25-2.00	1.71	1.25-2.00	15.8	14.0
Centipedegrass	1.20	1.00-1.35	—	—	1.20	1.00-1.35	—	—	0.0	—
<u>All growers</u>										
Bermudagrass	0.82	0.60-1.00	0.98	0.75-1.25	0.84	0.70-1.00	1.02	0.90-1.25	2.4	4.1
Zoysiagrass	1.21	1.00-1.40	1.50	1.00-2.00	1.36	1.10-2.00	1.71	1.25-2.00	12.4	14.0
Centipedegrass	1.12	1.00-1.35	—	—	1.14	1.00-1.35	—	—	1.8	—

Without exception, prices for all species of turfgrass increased as farm size decreased.

Generally, the amount of sod purchased determined whether the wholesale or retail price was charged. Usually, if buyers purchased more than 250 square yards of sod, they were charged at the wholesale rate. However, in some cases wholesale prices were available only to middlemen, such as landscape contractors, and not to the final consumer. Prices for scrap-grass ranged from 50 percent of the wholesale price to as little as \$20 per pickup truck load.

Sales

Growers reported that sales in 1978 were the highest ever. Eighty-seven percent of the growers reported they could not meet the demand for sod. Bermudagrass sales accounted for 70 percent while zoysiagrass and centipedegrass each accounted for 15 percent of the total volume of sales during 1978 and 1979.

Average sales volume per month, as a percent of total sales, is presented in figure 2. May and June were the months of peak sod

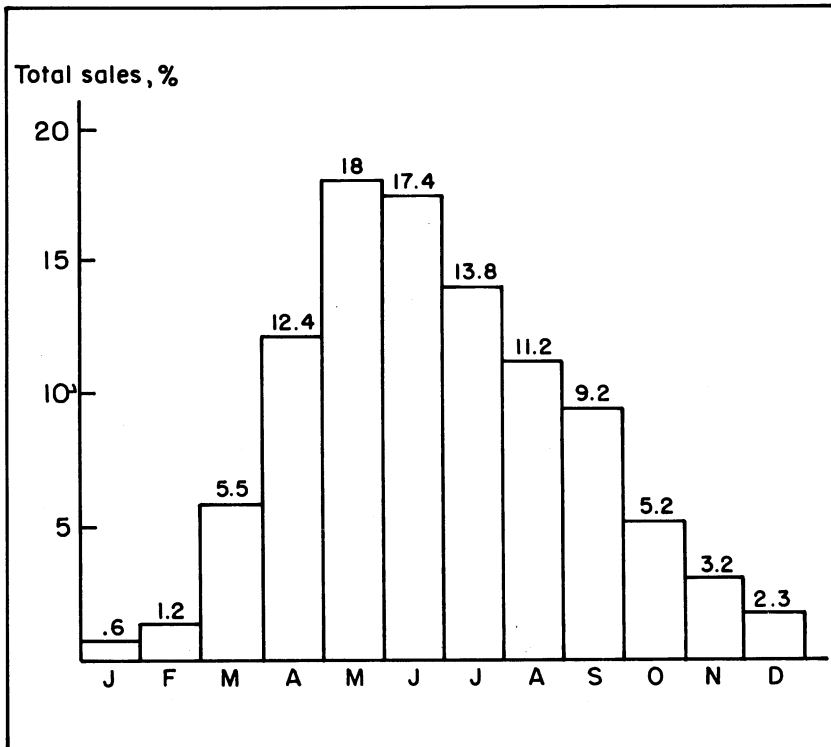


FIG. 2. Sales volume of commercial turfgrass by month, Alabama, 1978.

sales followed by July, April, and August, respectively. Growers reported harvesting sod during every month of the year; however, 73 percent of the sod was harvested from April to August.

Market Share

Large growers dominated commercial sod production and marketing in Alabama. In 1978, farms with more than 250 acres of sod accounted for 74 percent of total sod sales while medium and small sized farms accounted for 17 and 9 percent, respectively. Market share of large farms declined slightly during 1979 because of the increase in size of several of the smaller farms.

Miscellaneous Marketing Practices

Fifty percent of the growers reported using some type of advertising to promote sales. Growers generally advertised in trade magazines, local newspapers, or in the yellow pages. One grower reported employing a salesman mainly to increase out-of-state sales.

Four growers provided sod installation services. However, most growers preferred not to install sod since this would force them to compete directly with their major buyers, landscape contractors.

In an effort to protect the consumer, a sod certification program exists in Alabama. Certification is against the presence of fire ants. Ten of the 15 growers participating in this survey were certified. Most of the growers interviewed agreed that the certification program was beneficial in reducing the spread of fire ants.

ANALYSIS OF INVESTMENT REQUIREMENTS, COSTS AND RETURNS USING FARM DATA

This section includes an analysis of investment requirements and costs and returns synthesized from detailed data provided by the 15 producers who cooperated in this study. Estimates are provided on an aggregate basis for all producers and by size categories. These results provide an excellent means by which existing producers can evaluate the performance of their operation.

Capital Investment

Capital investment for individual sod farms include land, buildings, and equipment used in the production and maintenance of sod. To estimate capital investment, turfgrass producers were asked to supply an inventory of their equipment, machinery, land, and buildings plus information concerning purchase price, date of purchase, estimated useful life, salvage value, and estimated current value of each item. Lack of a standard accounting system throughout the industry presented some problems in estimating deprecia-

tion. Investment values supplied by growers were used to calculate depreciation costs on a straight line basis for individual operations.

Sod producers surveyed reported \$4.4 million in capital investment in 1978 with land, buildings, and equipment accounting for 37 percent, 3 percent, and 60 percent of the total, respectively. The relatively large outlay for equipment resulted primarily because of the extensive machinery investment required in sod production and because growers rented almost 50 percent of the land maintained in sod during 1978.

Average capital investment per acre for small, medium, and large farms was \$2,349, \$1,606, and \$1,689, respectively, table 7. Small growers generally reported greater capital investment per acre in all investment categories. However, large growers reported the greatest investment per acre in trucking and harvesting equipment. The higher land value of small growers reflected their utilization of 90 percent owned land.

Average investment per farm was \$81,000, \$298,000, and \$932,000 for small, medium, and large farms, respectively. The range of per acre equipment investment for each size category varied widely, especially for smaller farms. This was due, in part, to growers having excess equipment capacity so they could expand the operation using the existing complement of equipment.

TABLE 7. AVERAGE CAPITAL INVESTMENT FOR LAND, BUILDINGS, AND EQUIPMENT PER ACRE BY FARM SIZE, ALABAMA, 1978

Item	Sod farm size		
	<100 acres	100-250 acres	>250 acres
	<i>Dol./acre</i>	<i>Dol./acre</i>	<i>Dol./acre</i>
Land ^a	1,038.85	648.15	570.47
Buildings	103.25	43.52	51.86
Equipment			
Harvesting	164.55	166.67	176.94
Maintenance and establishment	429.09	296.29	361.20
Irrigation	361.29	246.30	204.39
Trucking	251.66	205.56	323.98
Total	1,206.59	914.82	1,066.51
Total investment per acre	2,348.69	1,606.49	1,688.84

^aActual average value of owned land was: \$1,143 for small farms; \$1,458 for medium farms; and \$1,352 for large farms.

Costs of Production

Fixed Costs

Fixed cost considerations include both explicit and implicit costs of production. Depreciation, interest of fixed capital, taxes, insurance, cash rent, a land charge, and a charge for the owner's labor

were included in total fixed costs. Implicit costs of production (depreciation, operator labor, interest on fixed capital, etc.) are frequently overlooked by sod growers in computing expenses for their firms since these costs involve no direct cash outlay. However, a complete economic accounting of profit or loss would be improperly represented without this consideration.

Implicit costs considered in this study included the costs of productive resources owned and utilized in sod production. The implicit cost of fixed capital was calculated using the Federal Land Bank interest rate for new loans during 1978, which was 8.3 percent. Implicit costs for variable capital were calculated at 8.8 percent, the average for new loans made by Production Credit Associations during 1978. The implicit cost used for land, \$35.84, was obtained by taking a weighted average of the charges paid by Alabama sod growers for rented sod land during 1978. The charge for operator labor was computed from information provided by individual growers. Each grower was asked to estimate the number of hours spent with the sod operation per year. A charge of \$3.50 per hour for a maximum of 2,000 hours was used to determine the imputed value for operator's labor.

Fixed costs per acre averaged \$237 for all growers, table 8. This amount varied from a low of \$209 for medium-sized producers to a high of \$254 for small operations. Depreciation on equipment and buildings was a major fixed-cost item comprising approximately 40 percent of the total for all size categories.

Variable Costs

Average variable cost per acre was \$664 for all turfgrass producers, table 8. Hired labor, fuel and lubrication, and fertilizer and lime were major variable cost outlays at 53, 17, and 10 percent of the total, respectively. When evaluated on the basis of size, average variable costs per acre declined between small (\$659) and medium-sized (\$445) categories but increased between medium and large (\$740) categories.

Large growers reported spending 66 percent more per acre on variable expenses than medium-size growers and 12 percent more than small growers. The large expenditure of \$149 per acre for fuel and oil by large producers was attributed to three major factors: (1) operation of large trucks used to deliver sod, (2) the capacity to store large quantities of fuel in on-farm storage tanks, and (3) more intense cultural practices. Small growers did not operate automatic sod harvesting equipment and, as a result, their labor costs per acre

TABLE 8. ESTIMATED COSTS OF PRODUCTION PER ACRE OF MAINTAINED TURFGRASS BY FARM SIZE AND FOR ALL GROWERS, ALABAMA, 1978

Item	Sod farm size			All growers
	<100 acres	100-250 acres	>250 acres	
	Dol./acre	Dol./acre	Dol./acre	
Variable Costs				
Herbicides ^a	17.55	19.18	21.05	20.35
Insecticides ^a	6.35	16.30	25.50	18.91
Fertilizer and lime ^b	67.10	69.33	68.77	68.68
Fuel and lubrication ^b	36.57	48.15	149.36	113.35
Repairs	29.61	11.11	49.42	38.64
Hired labor	448.37	249.07	371.08	354.24
Other	25.83	13.00	24.06	21.88
Int. on var. capital				
@ 8.8%	27.78	18.75	31.21	27.99
Total	659.16	444.89	740.45	664.04
Fixed costs				
Insurance	9.03	24.07	35.69	29.85
Taxes	30.84	20.37	29.93	27.97
Miscellaneous ^c	2.19	5.56	12.14	9.47
Depreciation	104.19	82.04	100.06	96.66
Int. on fixed capital				
@ 8.3%	20.51	16.77	16.95	17.35
Land charge ^d	35.84	35.84	35.84	35.84
Management charge ^e	51.37	24.22	11.53	19.90
Total	253.97	208.87	242.14	237.04
Total cost	913.13	653.76	982.59	901.08

^aIncludes custom applied services.

^bAll fuel (gasoline, diesel fuel, butane, etc.).

^cIncludes pallets, etc.

^dThe opportunity cost of land based on a weighted average of land rents paid during 1978.

^eSee table 19, page 46 for details.

were the highest reported. Basically, they substituted labor for capital to a greater extent.

Total Costs

Total costs per acre averaged \$901 for all producers, table 8. Small operations had an average total cost of \$913 per acre while medium and large-sized firms had costs of \$654 and \$983 per acre, respectively. In general, average total costs were highest on large farms because more resources were devoted to production. Since the demand for sod is highly variable from year to year (even from day to day), large sod operators had more invested in machinery, especially harvesting and trucking, than would be necessary if the demand for sod were more stable. It was important for these growers to be able to supply sod to their customers during peak periods of demand because they could lose business otherwise. Large investments in harvesting and trucking equipment were viewed as a necessary precaution to ensure against losing sales during periods of peak demand.

Labor Requirements and Expenses

Commercial sod producers were not able, in many cases, to supply specific information about labor requirements associated with individual cultural practices. They did, however, provide detailed information on total yearly labor requirements on a per farm basis, table 9.

The average labor requirement on a yearly basis for farms with less than 100 acres was approximately 2,800 hours. This included both part-time and full-time labor. Medium-sized farms required an average of 11,000 hours of hired labor per year while large farms required an average of 45,000 hours. On a per acre basis, small farms required 81, medium farms required 61, and large farms required 82 hours of hired labor per year.

Growers reported employing a total of 92 part-time employees, 64 full-time employees, and 9 foremen during 1978. In addition, large farms employed a full-time secretary or bookkeeper. Generally, small operations employed family labor for bookkeeping; however, a few small operators did hire a bookkeeper on a part-time basis.

Average part-time wage rates ranged from \$3.27 per hour on small farms to \$3.13 per hour on large farms. Average full-time wage rates ranged from \$4.15 on small farms to \$4.28 on medium-sized farms. During 1978, large sod farms spent an average of \$202,733, medium-sized farms spent \$44,833, and small farms spent \$15,444 for hired labor. Farms having more than 100 acres were of sufficient size to require several laborers throughout the production process. Therefore, once these growers found a reliable employee, they generally offered full-time employment at a reasonable wage to ensure employment.

Because of the size of their operations, large sod farms generally employed several foremen to ensure the smooth operation of the business. Small and medium-sized farms did not employ foremen (with one exception) other than the owner. Large sod operations employed from one to four foremen. These employees were normally placed in charge of one or more facets of sod production, such as: (1) establishment and irrigation, (2) cultural practices, or (3) harvesting operations. The majority of these employees had several years experience in sod production and a few had college degrees in turfgrass management. In addition to the employees mentioned above, managers of large sod operations sometimes found it advantageous to have a qualified mechanic on hand during peak production months.

TABLE 9. AVERAGE ANNUAL LABOR REQUIREMENTS AND LABOR EXPENSES BY FARM SIZE, ALABAMA, 1978

Average Labor Requirements or expense	Sod farm size		
	<100 acres	100-250 acres	>250 acres
Part-time employees	4.1	2.0	16.3
Hr./year per employee	394	660	767
Wage per hour	\$3.27	\$3.25	\$3.13
Full-time employees	1.2	4.7	13.0
Hr./year per employee	960	2,000	2,000
Wage per hour	\$4.15	\$4.28	\$4.17
Supervisory employees ^a			3.0
Average labor expense per firm	\$15,444	\$44,833	\$202,733
Average labor expense per acre	\$448.37	\$249.07	\$371.09

^aThe owner/operator is not included.

Various other labor expenses such as secretarial and bookkeeping expenses were included in total labor expenses. Several farms in each size category utilized custom services such as custom applied fertilizer, herbicides, and especially custom insecticides applied by air. If growers were unable to obtain these services, their labor requirements and labor expenses would increase.

Returns

Utilizing the data provided in the previous sections, returns to land, risk, and management on a per acre basis were estimated for the three farm-size categories and all producers for 1978, table 10.

TABLE 10. ESTIMATED RETURNS TO LAND, MANAGEMENT, AND RISK PER ACRE OF MAINTAINED TURFGRASS BY FARM SIZE AND FOR ALL GROWERS, ALABAMA, 1978

Item	Sod farm size ^a			
	<100 acres	100-250 acres	>250 acres	All growers
	<i>Dol./acre</i>	<i>Dol./acre</i>	<i>Dol./acre</i>	<i>Dol./acre</i>
Gross Receipts ^b	1,174.60	1,124.26	1,407.27	1,316.89
Variable costs ^c	659.16	444.89	740.45	664.04
Return above variable costs	515.44	679.37	666.82	652.85
Fixed costs ^c				
Ownership costs (depreciation, interest, taxes, etc.)	166.76	148.81	194.77	181.30
Return to land, risk, and management	348.68	530.56	472.05	471.55
Land charge ^d	35.84	35.84	35.84	35.84
Return to risk and management	312.84	494.72	436.21	435.71
Management charge ^e	51.37	24.22	11.53	19.90
Return to risk	261.47	470.50	424.68	415.81

^aAverage farm sizes were: 34 acres, 180 acres, and 546 acres.

^bAt the farm level, does not include delivery charges.

^cFrom table 8.

^dRepresents the opportunity cost of land based on a weighted average of land rents paid during 1978.

^eSee table 19, page 46 for details.

Large farms reported the highest gross returns per acre of \$1,407. This was due primarily to the higher harvested cut-out percentage. Small operations reported higher gross returns per acre (\$1,175) than medium-sized farms (\$1,124) because of higher prices received. However, net returns to risk were highest for medium-sized farms (\$471) principally because of lower variable costs. Net returns to risk were estimated to be \$425 per acre for large firms and \$261 for small firms. While most growers were estimated to have operated at a profit, two growers in the small farm category and one grower in the medium-sized category were estimated to have had negative net returns in 1978.

ANALYSIS OF INVESTMENT REQUIREMENTS, COSTS AND RETURNS USING CURRENT (1980) CONDITIONS: HYPOTHETICAL EXAMPLES

This section describes, develops, and presents estimated minimum machinery complements, investment requirements, and estimated costs and returns using current (1980) prices for various sized hypothetical sod farming operations. Also, requirements for a minimum-sized, hypothetical sod-farming operation are estimated. Data presented in this section could be utilized to evaluate approximate investment requirements and estimated costs and returns given qualifying assumptions inherent to the example farm. Data presented in this section are hypothetical in nature and should serve only as a guide in evaluating the feasibility of commercial sod production.

Minimum machinery and investment requirements were developed by utilizing averages from data supplied by individual sod growers and from experience with the sod industry. In general, each hypothetical sod farm was developed to closely simulate the nature of the average farm sizes developed in the previous chapter. However, three major factors affecting gross returns were changed. First, all farms were assumed to be in production and to be able to sell one-third of their maintained sod acreage annually. Second, each farm was assumed to utilize the same cultural practices and, therefore, to have basically the same cost per acre for such items as fertilizer, lime, herbicides, and insecticides. Third, yields of various turfgrasses were increased over those reported by sod growers in 1978. That is, it was assumed that each grower had a high level of expertise in sod production and yields should be changed accordingly. Also, it was assumed that growers of bermudagrass would

clean-cut their bermudagrass fields on a periodic basis.¹¹ Likewise, the ribbon size for zoysiagrass and centipedegrass was assumed to be 2 inches or less.

A complete listing of the machinery complements utilized by each farm size, along with a detailed explanation of how costs and returns were derived, is contained in Appendices A and B.

Estimated Minimum Machinery Investment Requirements

Minimum machinery investment requirements for the three hypothetical farms were estimated using current (1980) manufacturers suggested retail prices. Average farm sizes used in this section were: 35 acres for small farms with a range from 30 to 100 acres; 180 acres for medium-sized farms with a range from 100 to 250 acres; and 550 acres for large farms with a range from 250 to 700 acres. Minimum investment requirements for machinery were estimated to be \$130,600 for small farms, \$321,100 for medium-sized farms, and \$673,800 for large farms.¹² Equipment complements presented in Appendix A were developed to provide an adequate machinery complement for the specific size operation mentioned and, in most cases, to provide an adequate machinery complement for the specific size "range" included.

Costs

Average variable costs increased as farm size increased, table 11. This was because of the higher labor and fuel costs incurred on larger turfgrass operations. Fuel costs were high for large farms because of large fuel consumption by irrigation and trucking equipment. Large growers were assumed to deliver 75 percent of the sod harvested and sod delivery required large fuel expenditures. Medium-sized farms were estimated to have variable costs of \$640 per acre, while small farms were estimated to have the lowest variable cost per acre of \$535.

Average fixed costs per acre were estimated to be greatest for the small farms, \$716 per acre, table 11. Two factors responsible for the high fixed cost were depreciation and interest charges resulting from the large machinery investment required. Medium-sized farms were estimated to have fixed costs of \$415 per acre while large farms

¹¹Indications were that bermudagrass producers would adopt the practice of clean-cutting the sod field on a 2 out of 3-year basis.

¹²These figures do not account for various shop tools and other miscellaneous equipment which may be required in special situations. In many cases, the investment in shop tools and other miscellaneous equipment can easily run into thousands of dollars.

were estimated to have the lowest fixed costs per acre, \$360. Fixed costs decreased as size increased indicating that larger growers were able to reduce fixed costs by spreading them over more acres of turfgrass.

Average total costs per acre were estimated to be \$1,251, \$1,054, and \$1,187 for small-, medium-, and large-sized farms, respectively, table 11. This represented an increase of 37 percent, 61 percent, and 21 percent in average costs per acre for small-, medium-, and large-sized operations, respectively, when compared with 1978 cost data. In general, the estimated average total costs developed in this example approximated the same cost pattern as reported using 1978 data. However, when 1980 cost data were used, small-sized farms were estimated to have the highest average total cost.

TABLE 11. ESTIMATED COSTS OF PRODUCTION PER ACRE OF MAINTAINED TURFGRASS BY FARM SIZE, UTILIZING CURRENT DATA AND THE ASSUMPTIONS CONTAINED IN APPENDIX B, ALABAMA, 1980

Item	Sod farm size		
	<100 acres	100-250 acres	>250 acres
	<i>Dol./acre</i>	<i>Dol./acre</i>	<i>Dol./acre</i>
Variable costs			
Herbicides	23.13	23.42	23.20
Insecticides	14.81	14.72	14.75
Fertilizer and lime	86.69	86.50	86.56
Fuel and lubrication	62.86	122.22	160.00
Repairs	31.40	51.86	61.46
Hired labor	251.66	276.33	399.20
Other	29.70	22.89	27.67
Int. on var. capital			
@ 14.0%	35.02	41.86	54.10
Total	535.27	639.80	826.94
Fixed costs			
Insurance	18.66	8.92	6.13
Depreciation	304.98	175.36	158.53
Taxes	19.79	27.07	39.16
Miscellaneous	2.41	6.12	13.35
Int. on fixed capital			
@ 12.5%	279.00	133.46	91.54
Land Charge	39.42	39.42	39.42
Management charge	51.37	24.22	11.53
Total	715.63	414.57	359.66
Total cost	1,250.90	1,054.37	1,186.60

Returns

Gross receipts per acre were estimated to be \$1,451 for the small farm, \$1,296 for the medium-sized farm, and \$1,270 for the large farm, table 12. Estimated gross receipts were higher for small-sized farms because of the relatively higher prices charged for their turfgrass. Net returns to risk were estimated to be \$83 per acre for the large-sized farms, \$242 per acre for the medium-sized farms, and

TABLE 12. ESTIMATED RETURNS TO LAND, MANAGEMENT, AND RISK PER ACRE OF MAINTAINED TURFGRASS BY FARM SIZE, UTILIZING CURRENT DATA AND THE ASSUMPTIONS CONTAINED IN APPENDIX B, ALABAMA, 1980

Item	Sod farm size ^a		
	<100 acres	100-250 acres	>250 acres
	<i>Value or cost per acre</i>		
Gross receipts ^b	\$1,451.40	\$1,296.34	\$1,269.70
Variable costs ^c	535.27	639.80	826.94
Return above variable costs	916.13	656.54	442.76
Fixed costs ^c			
Ownership costs (depreciation, interest, taxes, etc.)	624.84	350.93	308.71
Return to land, management, and risk	291.29	305.61	134.05
Land charge ^d	39.42	39.42	39.42
Return to management and risk	251.87	266.19	94.63
Management charge ^e	51.37	24.22	11.53
Return to risk	200.50	241.97	83.10

^aAverage farm sizes were: 35 acres, 180 acres, and 550 acres.

^bGross receipts using average 1979 wholesale prices and excluding delivery charges which could contribute \$.10 to \$.20 per square yard delivered.

^cFrom table 11.

^dRepresents the opportunity cost of land based on a weighted average of land rents paid during 1978 plus 10 percent for appreciation in value.

^eSee table 19, page 46 for details.

\$201 for the small-sized farms. However, since income from sod delivery services was not included in gross receipts, the estimated net return figures represent a negative bias on the profitability of larger-sized farms (see footnote b on table 12).

It must be reemphasized that the data presented in this section concerning gross receipts are purely hypothetical. Sod farms, especially small-sized farms, can experience great variability in income from year to year. This is because costs remain relatively constant regardless of the amount of sales volume. Once a sod field has been established, the majority of the costs involved in sod production can be considered fixed; that is, all the cultural practices necessary for the growth and development of a high quality sod must be continued even if sales fall drastically. For example, if the small-sized farm used in this section could only market 28 percent of the acreage maintained in sod during the year rather than one-third, return to risk would be a negative \$19 per acre (a decrease of 109%), resulting in a net loss of \$665. Sod production is a high risk venture which requires a large capital outlay. As with any investment opportunity which provides potential large returns, there is the definite possibility of large losses.

There are several questions which need to be considered before starting a sod business: (1) Is a market readily available? (2) Is there a grower within the area large enough to supply the present and future needs for sod in this area? (3) Are suitable land and water available

for expansion? (4) Is adequate capital available? (The time between initial planting and first harvest is normally 18 to 24 months.) (5) Do you have the technical knowledge to produce and market quality sod or must you learn from others through field trips, tours, meetings, or seminars which require time and money? If the answers to the above questions were: (1) no, (2) yes, (3) no, (4) no, and (5) no, the feasibility of initiating the business venture is extremely questionable. If inappropriate answers were provided for more than one of the above questions, it is extremely doubtful whether a profitable sod operation can be established.

A Minimum-Sized Operation

Interest has been expressed in knowing what size sod operation would be required to generate a net income of approximately \$15,000 to the owner. It was estimated the minimum machinery investment for such an operation would be \$42,425, Appendix A, table 15. Estimated returns to land, management, and risk for this operation were \$676 per acre, table 13. This return was based on the following assumptions relative to the sod farm: (1) The farm is in production with 20 acres of bermudagrass and 5 acres each of zoysiagrass and centipedegrass. (2) Thirty percent of the acreage of each sod species is marketed per year in the general vicinity of the sod farm. (3) Customers pick up sod in the field. (4) Yields and prices of sod are as follows: Bermudagrass — 4,300 square yards per acre at \$0.88 per yard; Zoysiagrass — 4,200 square yards per acre at \$1.47 per yard; Centipedegrass — 4,200 square yards per acre at \$1.20 per yard. (5) Labor requirements: 1,500 hours at \$3.50 per hour plus 500 hours operator labor. (6) Operator owns 100 percent of the land. (7) The machinery complement in table 15 is used.

Another hypothetical situation was analyzed to serve as an example for estimating the profitability of a sod farm, assuming the minimum machinery complement presented in this section and the assumptions previously mentioned with the exception that the sod farm was not considered to be in production. Additional assumptions were: (1) Expenses reported during the first 2 years include \$500 per acre to cover establishment costs. (2) Twenty acres of bermudagrass were established in the first year and 5 acres each of zoysiagrass and centipedegrass were established in year two. (3) Machinery was purchased by paying 20 percent down and financing the balance at 12.5 percent simple interest for 5 years. (4) Prices paid and prices received were considered fixed for the time period under consideration. (5) Weather conditions were assumed to be suitable

TABLE 13. ESTIMATED COSTS AND RETURNS PER ACRE FOR AN ESTABLISHED HYPOTHETICAL 30-ACRE TURFGRASS FARM, ALABAMA, 1980

Item	Amount
Gross receipts	\$1,317.50
Variable costs	
Herbicides	23.13
Insecticides	14.81
Fertilizer	86.69
Fuel and lubrication	36.67
Repairs	23.00
Hired labor	175.00
Other	23.00
Int. on var. capital @ 14.0%	26.76
Total	409.06
Return above variable costs	908.44
Fixed costs	
Insurance	7.07
Depreciation	107.03
Taxes	13.33
Int. on fixed capital @ 12.5%	105.02
Total	232.45
Return to land, risk, and management	675.99

for sod production and severe insect infestations were assumed not to occur.

The farm in this example was considered to be the beginning operation in year one, requiring intermediate-term financing, which was assumed to be available through a local lending institution. A down payment of \$8,500 (20 percent) was assumed to be made on machinery purchases before farming operations began. Annual payments of \$7,637 were to be made for 5 years.

An annual cash flow summary for this enterprise, with the required debt payment, is shown in table 14. All short-term operating expenses were assumed to be made from cash inflow to the farming operation during the production period or from other sources such as personal funds or short-term financing. Net cash income is cash available for intermediate or long-term debt repayment, expansion, or use by the owner.

The first 3 years of operations did not generate adequate income to meet the minimum debt requirements for the \$7,637 machinery loan payment. Therefore, the operator was required to supply \$20,918 from other sources during the first year, \$22,952 from other sources during the second year, and \$14,379 from other sources during the third year. This was because of the time required to fully establish a dense, marketable sod. It was assumed that 10,000 square yards of bermudagrass sod could be sold during the first year of operation. The remainder of bermudagrass sod was assumed to be in full

TABLE 14. ESTIMATED ANNUAL SUMMARY OF NET CASH INCOME AND CASH BALANCE AFTER LOAN PAYMENTS FOR A HYPOTHETICAL 30-ACRE TURFGRASS OPERATION, ALABAMA, 1980

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>
Receipts						
Bermudagrass	8,800	22,684	22,684	22,684	22,684	22,684
Zoysiagrass	0	0	3,087	9,261	9,261	9,261
Centipedegrass	0	0	2,520	7,560	7,560	7,560
Total	8,800	22,684	28,291	39,525	39,525	39,525
Outflow						
Variable expenses	21,469 ^a	16,469 ^b	11,469	11,469	11,469	11,469
Insurance	212	212	212	212	212	212
Taxes	400	400	400	400	400	400
Total	22,081	17,081	12,081	12,081	12,081	12,081
Net cash income	-13,281	5,603	16,210	27,444	27,444	27,444
Machinery payment ^c	7,637	7,637	7,637	7,637	7,637	0
Cumulative cash						
Excess or shortage ...	-20,918	-22,952	-14,379	5,428	25,235	52,679
Annual borrowings	20,918	22,952	14,379	0	0	0

^aIncludes expenses for establishment of 20 acres of bermudagrass.

^bIncludes expenses for establishment of 5 acres each of zoysiagrass and centipedegrass.

^cYearly requirement for retirement of equipment loan of \$34,000 at 12.5 percent simple interest for 5 years.

production by year 2. One-half acre each of zoysiagrass and centipedegrass was marketed beginning in year 3. All turfgrass species were assumed to be in full production by year 4.

The fourth year of operation generated \$27,444 of net income which was available for debt repayment and/or reinvestment. After the machinery debt payment of \$7,637 was made, \$5,428 remained before taxes for reinvestment to expand the operation or for personal uses. All subsequent years generated adequate cash balances to provide for the operator's income and reinvestment funds for the sod operation after meeting debt requirements.

It must be reemphasized that the income projections presented in this example depend entirely on the assumptions stated earlier. For example, lack of rainfall, severe insect infestations, or a decrease in sod marketings would severely affect profitability of a sod farming operation. However, given the assumptions, this example presents a realistic representation of the yearly costs and returns for a sod operation exhibiting these characteristics.

Alternatives open to individuals interested in beginning a sod operation could be to (1) consider starting on a much smaller scale to reduce financing costs and generate cash which would allow for slow growth, (2) finance assets over longer periods of time to reduce annual payments, or (3) purchase used equipment. These alternatives would greatly reduce the financing requirements for a begin-

ning sod operation. However, in alternative (1), growth potential would not be as rapid because of the lack of available funds for expansion.

Additional Comments

This section has attempted to examine the costs and returns for four alternative sized turfgrass operations utilizing new equipment, current prices, and acceptable cultural practices. In all cases, a reasonable return was indicated given various assumptions on prices and expected sales volume. Because of the exclusion of income received from sod deliveries, returns earned by large- and medium-sized sod operations were understated by as much as \$180 per acre. These charges were omitted because of the great variability in delivery charges throughout the State. Also, the volume of sod deliveries varied greatly from year to year. However, to present a more accurate picture of the profitability of the sod industry, a net return of \$0.10 to \$0.20 per square yard is considered normal for most sod operations. And, in a good year, most larger sod growers deliver from 50 to 85 percent of the sod they market.

The most important factor affecting the success or failure of a sod farming operation is market availability. A guaranteed market does not exist for sod in Alabama, and the demand for sod fluctuates greatly from year to year. Producing a quality turfgrass at minimum cost does not ensure the profitability of a sod farm. If demand for sod decreases or if markets for sod do not exist near the area where the firm is located, the chances for success are greatly reduced.

Most of the existing sod firms have been established for several years and have the ability to supply most of the State's turfgrass needs for years to come. They, therefore, have the market strength to effectively compete with new entrants so as to protect their market share. The decision to produce sod is a long-term decision and should be made only after careful consideration of all the factors involved.

SUMMARY AND CONCLUSIONS

The production of turfgrass for commercial sod is a viable industry in Alabama. Alabama's sod industry experienced a period of rapid growth throughout the 1970's. As a result, many individuals developed an interest in obtaining information concerning the economics of sod production. A lack of economic data on turfgrass production has characterized the industry. Results of this study should improve this situation.

Three major objectives of this study were to: (1) determine the nature and scope of the commercial turfgrass industry, (2) examine marketing and production practices of the commercial turfgrass industry, and (3) evaluate investment requirements and operating costs and returns data for various sized commercial turfgrass firms. Individual turfgrass owners were contacted during the summer and fall of 1979. Of the 26 growers in production during 1978, 15 participated fully in the study.

During 1978, 26 turfgrass producers located in 16 counties grew approximately 2,900 acres of turfgrass, while in 1979, 30 producers had approximately 3,300 acres of turfgrass in production. Approximately 1,097 acres of sod valued at \$4 million (farm level) were sold during 1978. Sod sales declined by 16 acres in 1979, but because of price increases for sod, gross farm income at the farm level increased to \$4.2 million. Turfgrass growers utilized two basic methods of harvesting sod. The method used by growers with more than 100 acres was the tractor-mounted sod harvester which cut sod and palletized it in one operation. Small growers used hand-guided sod cutters which required the sod to be rolled or stacked on pallets by hand.

Six to 12 months were normally required to produce a marketable bermudagrass sod, while 18 to 24 months were usually required to produce a marketable zoysiagrass or centipedegrass sod. Growers in the northern counties reported more time was required to grow a marketable sod than growers in the southern counties. Also, growers in the northern counties reported having difficulty in establishing zoysiagrass.

Landscape contractors (66 percent) were the major purchasers of sod, followed by garden centers (18 percent), individual homeowners (12 percent), and golf courses (4 percent). A total of 3.6 million square yards of sod was sold by 15 participating growers in 1978. Of this amount, 22 percent was sold in out-of-state markets, with Georgia being the major out-of-state marketing area. Other out-of-state markets were Arkansas, Florida, Mississippi, and Tennessee. Major in-state markets were in the Birmingham, Tuscaloosa, Mobile, Montgomery, and Huntsville areas.

Pricing policies were established on a firm-by-firm basis. Wholesale-retail price differentials were generally based on the volume of sod purchased. Prices reported decreased for all species of turfgrass as firm size increased.

Total capital investment for land, equipment, and buildings of \$4.4 million was reported in 1978. Equipment investment accounted

for 60 percent, land 37 percent, and buildings 3 percent of capital investment. Small firms reported the highest per acre investment of \$2,349, with medium- and large-sized firms reporting \$1,606 and \$1,689 per acre, respectively. Average capital investment per farm was \$81,000, \$298,000, and \$923,000 for small, medium, and large firms, respectively.

Average production costs were separated into fixed and variable costs and developed for each firm size. The average cost for producing turfgrass was \$901 per acre for all firms. Average costs were highest on farms with more than 250 acres (\$983 per acre) and lowest on farms with 100 to 250 acres (\$654 per acre). Firms with less than 100 acres reported average costs of \$929 per acre.

Average fixed costs per acre were relatively constant for the three firm sizes with a range from \$208 for medium-sized firms to \$253 per acre for small firms. Fixed costs varied widely among firms in the same size category depending on how long the firm had been established. Established firms generally reported lower fixed costs reflecting lower equipment prices present when the business was established.

Costs relating to the variable input requirements of production were greatest for large growers (\$743 per acre). Large firms generally followed a more intensive cultural program than smaller firms and, as a result, expenditures for insecticides, herbicides, equipment repairs, and fuel were substantial. Fuel costs for large firms accounted for 20 percent of variable costs, while fuel costs for small- and medium-sized firms accounted for 11 percent of the respective variable costs. Small firms reported variable costs of \$660 per acre with 68 percent of this amount going to labor. Medium-sized firms reported the lowest variable costs of \$446 per acre with labor accounting for 56 percent. Labor expense for large firms accounted for 53 percent of variable costs.

Firms with 100 to 250 acres of sod reported the highest net returns to risk, \$471 per acre. Large firms with more than 250 acres reported returns of \$425 per acre while small firms reported the lowest returns, \$261 per acre.

Using current (1980) prices and various other assumptions concerning production and marketing, costs and returns were analyzed. Average fixed costs per acre decreased as firm size increased, while average variable costs per acre increased. Average costs per acre were lowest for firms of medium size (\$1,054 per acre) and highest for small firms (\$1,251 per acre). Average costs for large firms were estimated to be \$1,187 per acre. These estimates indicated that

economies of size existed in sod production. The most efficient firm size seemed to be one of approximately 250 to 300 acres. However, there was insufficient data to support this contention statistically.

Returns to risk, utilizing current data (without delivery income), were estimated to be \$201, \$242, and \$83 per acre for small, medium and large firms, respectively. With the addition of income generated from sod deliveries, returns to risk per acre were \$253, \$341, and \$236 for small, medium, and large firms, respectively.

It was estimated, given qualifying assumptions, that a sod farm of 30 acres and \$42,500 in machinery investment could provide a return to land, risk, and management of \$676 per acre. Minimum machinery investment requirements were also estimated for three additional firm sizes. Firms of 30 to 100 acres were estimated to require a minimum machinery investment of \$131,000; firms of 100 to 250 acres were estimated to require \$321,000 investment in machinery; and firms with more than 250 acres were estimated to require a minimum of \$674,000 investment in machinery.

The following conclusions can be drawn from this study with respect to the industry's present and future state:

(1) Sod acreage in Alabama and the number of sod growers will continue to increase in the mid-1980's. Acreage planted to turfgrass is expected to reach 4,000 acres by 1985.

(2) Acreage of zoysiagrass, centipedegrass, and St. Augustinegrass is expected to increase throughout the 1980's. Also, experimentation with "cool season" turfgrass blends is expected to develop in the northern counties. Bermudagrass acreage is expected to remain near present levels.

(3) Growers will continually adjust cultural practices and equipment purchases to reduce costs.

(4) Producer conversion to vertically integrated operations (i.e., sod laying, landscaping, etc.) is not expected to have a significant influence on the structure of the sod industry since this move would place sod growers in direct competition with their major buyers.

(5) Growers will monitor all costs of production in the future with special emphasis given to fuel and labor costs.

(6) If large firms continue to lose their market share, the industry may face severe price competition as large firms decide to protect their existing market shares. Smaller firms may be forced out of business under these circumstances.

(7) It is estimated that the most efficient size for turfgrass firms is approximately 250 to 300 acres. However, data were insufficient to support this contention statistically.

(8) Returns from sod production may vary over wide ranges from year to year, subject to weather, insects, weeds, and demand factors. As a result of these risks, one should carefully consider all the factors (pro and con) involved before going into turfgrass production.

(9) There appear to be two general types of sod producers in the State: (a) those who are willing to accept risks and are therefore more capital intensive (these growers are set up to handle large orders on relatively short notice), and (b) those who do not wish to accept risk and opt for a less capital intensive approach to sod production (these growers are set up to handle small orders only).

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APPENDICES

Appendix A Machinery Complements

TABLE 15. ESTIMATED MINIMUM MACHINERY COMPLEMENT FOR TURFGRASS FARMS
OF LESS THAN 40 ACRES, ALABAMA, 1980

Item	Description	Price
Field cultivator	9 shank	\$ 675
Disk	8 ft. tandem	1,000
Roller cultipacker	10 ft.	930
Fertilizer spreader	600 lb.	400
Sprayer	250 gal. w/20 ft. boom	1,500
Flail mower	5 ft.	1,800
Reel mower	3 gang, P.T.O. powered, manual lift	3,480
Tractor	40-45 hp.	11,700
Pickup truck	1/2 allocated to sod	3,200
Sod cutter	Ryan heavy duty with Sulky roller	4,640
Irrigation	Above ground movable pipe	8,000
Buildings	General purpose	5,000
Total machinery and equipment investment		\$42,425

TABLE 16. ESTIMATED MINIMUM MACHINERY COMPLEMENT FOR TURFGRASS FARMS
OF 30-100 ACRES, ALABAMA, 1980

Item	Description	Price
Field cultivator	9 shank	\$ 675
Disk	8 ft.	1,100
Roller cultipacker	10 ft.	930
Scraper	5 ft.	250
Fertilizer spreader	600 lb.	400
Moldboard plow	2-16 in. bottoms	1,000
Sprayer	250 gal. w/27 ft. boom	1,500
Flail mower	5 ft.	1,800
Reel mower	5 gang, P.T.O., manual lift	5,795
Sweeper	5 ft.	4,500
Tractors	40-45 hp.	23,400
Front-end loader w/forks	3,000 lb. capacity	3,000
Truck	1 1/2 ton	12,000
Pickup truck	Medium duty (1/2 allocated to sod)	3,200
Sod cutter	16 in. tractor mounted	21,065
Irrigation	Cable-tow, 660 ft., pump and underground pipe	45,000
Buildings	Shop, storage, etc.	5,000
Total machinery and equipment investment		\$130,615

NOTE: For farms less than 30 acres the machinery complement listed in table 15 may be more suitable.

TABLE 17. ESTIMATED MINIMUM MACHINERY COMPLEMENT FOR TURFGRASS FARMS OF 100-250 ACRES, ALABAMA, 1980

Item	Description	Price
Manure spreader	General purpose, 288 bu. capacity	\$ 5,500
Chisel plow	11 shank-2 bar	1,650
Disk	12 ft. 8 in. tandem	5,200
Rotovator	8 ft. 4 in.	8,000
Roller	5 ft.	2,000
Sprayer	300 gal.-trailer w/40 ft. boom	2,500
Fertilizer spreader	1,000 lb.	1,150
Flail mower	5 ft.	1,800
Reel mowers (2)	5 gang, P.T.O. powered, manual lift	11,590
Sweeper	5 ft.	4,500
Tractors (2)	40-45 hp.	23,440
(2)	80-85 hp.	35,544
Trucks (2)	22 ft. w/boom	65,000
(1)	1 1/2 ton	13,000
(1/2)	Pickup allocated to sod	3,200
Sod cutter	16 in. or 18 in. tractor mounted	21,065
Forklift	Medium duty, general purpose	16,000
Irrigation (2)	Cable-tow, 990 ft. w/pump and underground pipe	90,000
Buildings	Shop, office, etc.	10,000
Total machinery and equipment investment		\$321,139

TABLE 18. ESTIMATED MINIMUM MACHINERY COMPLEMENT FOR TURFGRASS FARMS OF MORE THAN 250 ACRES, ALABAMA, 1980

Item	Description	Price
Sprigdigger		\$6,200
Manure spreader	General purpose, 288 bu. capacity	5,500
Chisel plow	9 shank, 2 bar	1,922
Disk	12 ft. 8 in.	5,200
Roterra	8 ft. 4 in.	9,125
Rotovator	10 ft.	8,900
Roller	5 ft.	2,000
Blower	Model 40	2,692
Sweeper (2)	Model 720, 5 ft.	8,924
Spreader truck	1 1/2 ton	10,500
Fertilizer spreader (2)	1,000 lb.	2,300
Sprayer (2)	300 gal. trailer w/40 ft. boom	5,000
Front-end loader	For 40 hp. tractor, 3,000 lb. capacity	2,950
Reel mower(s) (4)	5 gang, P.T.O. powered, manual lift	23,180
(1)	7 gang, P.T.O. powered, hydraulic lift	10,038
Flail mower (2)		3,600
Tractor(s) (6)	40-45 hp. diesel	58,600
(2)	110 hp. diesel	51,200
Truck(s) (2)	22 ft. w/boom, 2 ton tandem axel	65,000
(2)	40 ft. w/boom, 250 Cummings	105,000
(2)	Pickups	12,800
(2)	1 1/2 ton	13,000
Sod cutter (3)	Mechanical, tractor mounted	63,195
Forklift(s) (2)	Medium duty, general purpose	32,000
Irrigation (3)	Cable-tow, 990 ft. w/pumps and underground pipe	135,000
Buildings	Shop, office, etc.	30,000
Total machinery and equipment investment		\$673,826

Appendix B
Explanation of Investment and Cost Data Utilized in
Estimating Costs and Returns for Various
Sized Hypothetical Turfgrass Farms

TABLE 19. EXPLANATION OF MACHINERY, EQUIPMENT, AND COSTS UTILIZED IN ESTIMATING COSTS AND RETURNS FOR VARIOUS HYPOTHETICAL FARM SIZES, ALABAMA, 1980

Category	Item	Suggested retail price
Machinery	Bush Hog chisel plow, 11 shank — 2 bar	\$ 1,650 ^d
	Bush Hog disk, 12 ft. 8 in. tandem, 4,000 lb.	5,200 ^d
	New Holland manure spreader, 288 bu. capacity	5,500 ^d
	Lely Rotovator, 100 in. and 120 in.	8,000- 8,900 ⁱ
	Lely Roterra, 100 in.	9,125 ⁱ
	Roller, 5 ft. heavy duty with vibra-action	2,000 ⁱ
	Jacobsen Model 4D blower	2,692 ^f
	Jacobsen Model 720, 5 ft. sweeper	4,462 ^f
	Lely fertilizer spreader, 1,000 lb.	1,150 ^d
	Euraspan fertilizer spreader, 600 lb.	390 ^d
	Sprayer, 300 gal. trailer, with 40 ft. boom	2,500 ^f
	Sprayer, 250 gal. with 27 ft. boom	1,500 ^g
	Ford Model 917, 62 in. flail mower	1,800 ^d
	Brouwer manual lift 3 gang P.T.O. mower	3,480 ^b
	Brouwer manual lift 5 gang P.T.O. mower	5,795 ^b
	Brouwer hydraulic lift 7 gang P.T.O. mower	10,038 ^b
	Ford 3600 diesel tractor, PS, 2 spool value and turf tires (7.50 x 16 11 front and 16.9 x 24 R3 rear) price includes freight	11,720 ^d
	Ford 7600 diesel tractor, PS, dual power and weights	17,772 ^d
	Ford TW-10 diesel tractor, PS, dual power and weights	25,600 ^d
	Mack diesel tractor, 22 ft. bed with boom	32,500 ⁱ
	Mack diesel tractor, and 40 ft. flatbed trailer with boom	52,500 ⁱ
	GMC 1 1/2 ton truck	13,000 ^a
	Chevrolet 1/2 ton heavy duty pickup	6,400 ^c
	Brouwer model A3A 16 in. or 18 in. rolling sod harvester mounted on a Ford 3600 or Massey Ferguson 245 diesel tractor (options extra)	21,065 ^b
	Ryan heavy-duty sod cutter with sulky roller	4,640 ^e
	Clarke medium duty forklift	16,000 ⁱ
	Water-winch cable-tow irrigation system	18,000- 22,000 ⁱ
Heavy duty industrial pump	12,000 ⁱ	
Category	Description and cost	
Herbicides ^h	MSMA and 2,4-D or Atrazine 2,4-D mixture for control of broadleaf weeds and annual grasses. Three applications per year on re-established grass and 2 applications on established sod. One application Simazine during sod dormancy.	
	Rates and cost: MSMA @ 1 qt. per acre @ \$24/gal. 2,4-D @ 1 qt. per acre @ \$11/gal. Simazine @ 1 lb. per acre @ \$3/lb.	

Insecticides ^h	Chlordane (one application during re-establishment) for fire ant control. Three applications Toxaphene per year on all sod. Rates and cost: Chlordane @ 1 qt. per acre @ \$34.48/gal. Toxaphene @ 2.5 qt. per acre @ \$6.30/gal.																
Fertilizer & Lime ⁱ	600 lbs. 13-13-13 on all sod during spring; 400 lb. ammonium nitrate applied per year @ 45 lb. N per application. Lime applied @ 1.5 tons per acre to re-establish turf. Cost: 34-0-0 @ \$160/ton 13-13-13 @ \$160/ton lime @ \$23/ton																
Fuel & lubrication	Calculated at \$1.10 per fuel equivalent; 2,000 gal. for small farms; 20,000 gal. for medium-sized farms; and 80,000 gal. for large farms.																
Labor	Small farms: 1,200 hours part-time labor @ \$3.50/hr. and 960 hours full-time labor @ \$4.80/hr. Medium farms: 1,320 hours part-time labor @ \$3.50/hr. and 9,400 full-time labor @ \$4.80/hr. Large farms: 12,500 hours part-time labor @ \$3.50/hr.; 26,000 hours full-time labor @ \$4.80/hr.; and 6,000 supervisory labor hours @ \$8.50/hr.																
Management charge	Small farms: 500 hours @ \$3.50/hr. Medium farms: 1250 hours @ \$3.50/hr. Large farms: 1820 hours @ \$3.50/hr.																
"Other" variable costs	15 percent increase from 1978 values																
"Other" fixed costs	10 percent increase from 1979 values																
Depreciation	Formula used: $\frac{\text{Purchase price} - \text{salvage value}}{\text{number years life}}$ Small farms: 20% salvage value and 10 years useful life Medium-sized farms: 20% salvage value and 8 years useful life Large-sized farms: 20% salvage value and 6 years useful life Buildings @ 10% salvage value and 20 years life																
Interest	Formula: $I = \text{purchase price} \times \text{annual interest rate}$ Rates: 12.5% for fixed and 14.0% for variable capital (6 months)																
Insurance	Annual insurance = purchase price \times .005																
Repairs	Formula: $\text{Purchase price} \div \$1,000 \times \text{machinery coefficient}$ (if known); repairs estimated for those items without machinery coefficients																
Taxes	Property: \$2 per acre base rate ^j FICA: .0613 of employees' earnings on a maximum of \$25,900 annually per employee ^k FUTA: 0.34 on first \$6,000 paid each employee if: (1) more than 10 employees are hired, or (2) if more than \$20,000 are paid in wages per year ^k Road taxes and tags: 1/2 ton pickup @ \$36.15 1 1/2 ton pickup @ \$70.45 2 ton pickup (22 ft.) @ \$88.35 Tractor with 40 ft. trailer @ \$354.40 ^j																
Returns	Farm sizes used were: 35 acres, 180 acres, and 550 acres for small, medium, and large farms, respectively. All farms were assumed to sell 33 percent of their maintained average per year at reported 1979 average wholesale prices for each turf species by farm size. Yields used were: 4,450 sq. yd./acre for bermudagrass and 4,200 sq. yd./acre for zoysiagrass and centipedegrass.																
Sod sales & prices	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Size</th> <th style="text-align: left;">Bermudagrass</th> <th style="text-align: left;">Zoysiagrass</th> <th style="text-align: left;">Centipedegrass</th> </tr> </thead> <tbody> <tr> <td>Small</td> <td>36,700 @ \$0.88</td> <td>6,930 @ \$1.47</td> <td>6,930 @ \$1.20</td> </tr> <tr> <td>Medium</td> <td>185,030 @ \$0.80</td> <td>37,420 @ \$1.20</td> <td>37,420 @ \$1.08</td> </tr> <tr> <td>Large</td> <td>565,370 @ \$0.77</td> <td>114,350 @ \$1.15</td> <td>114,345 @ \$1.15</td> </tr> </tbody> </table>	Size	Bermudagrass	Zoysiagrass	Centipedegrass	Small	36,700 @ \$0.88	6,930 @ \$1.47	6,930 @ \$1.20	Medium	185,030 @ \$0.80	37,420 @ \$1.20	37,420 @ \$1.08	Large	565,370 @ \$0.77	114,350 @ \$1.15	114,345 @ \$1.15
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Acreage & varietal composition of hypothetical turfgrass farms	Based on State production averages (70% bermudagrass and 15% each for zoysiagrass and centipedegrass): Small farms were composed of: 25 acres bermudagrass; 5 acres zoysiagrass, and 5 acres centipedegrass.																

Medium-sized farms were composed of: 126 acres bermudagrass;
27 acres zoysiagrass, and 27 acres centipedegrass.

Large-sized farms were composed of: 385 acres bermudagrass;
82.5 acres zoysiagrass, and 82.5 acres centipedegrass.

Prices used in this table were supplied by the following:

^aBence-Morris Motors, Inc., Opelika, Alabama

^bBrouwer Turf Equipment Limited, Keswick, Ontario, Canada

^cDyas Chevrolet, Inc., Auburn, Alabama

^dMelson Tractor Company, Opelika, Alabama

^eOMC Lincoln (Cashman-Ryan), Lincoln, Nebraska

^fTieco Corporation, Inc., Birmingham, Alabama

^gTuskegee Farm Implement Company, Inc., Tuskegee, Alabama

^hWoolfolk Chemical Corporation, Inc., Fort Valley, Georgia

ⁱIndividual sod farmers

^jLee County Tax Assessor's Office, Opelika, Alabama

^k*Farmer's Tax Guide*, IRS, pp. 52-53

^lSt. Clair County Farmers Co-op, Pell City, Alabama

Prices quoted are manufacturer's suggested retail prices. Various options and taxes are not included unless specified. All prices are subject to change without notice from the manufacturer.

NOTE: Trade names are used in this section for the purpose of providing specific information and no specific endorsement is implied. No discrimination of comparable products is intended.