
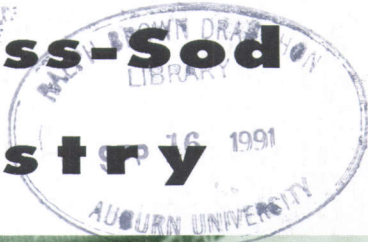




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Alabama's **Turfgrass-Sod** **I**ndustry



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

Alabama's Turfgrass-Sod Industry

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INTRODUCTION

WHEN INITIALLY studied in 1978, the Alabama turfgrass-sod industry was experiencing early growth and expansion and was considered an "infant" industry. The national policies of the late 1960's, such as desegregation, urban and rural development programs, and federal highway construction, led American industries to a rediscovery of the Southeastern United States. Alabama's turfgrass industry responded to the increased demand resulting from population increases and industrial expansion. The number of sod producers and size of farms in the State increased and total production expanded from 500 acres in 1968 to 3,300 acres in 1979.

Alabama's turfgrass industry has changed dramatically since 1979, becoming an important component of the agricultural sector. Expansion and new firm entry into the industry continued, but at a slower rate. Maturation of the turfgrass-sod industry is of considerable importance to both consumers and turfgrass producers. Indications are that improvements in technology and economies of scale have resulted in increased size of operations and larger capital investments. Also, there appears to be greater concern for product certification and regulated standards of quality for the industry. The market itself has evolved from one in which no central market existed, wherein producers supplied primarily local consumers, to one in which regional, central markets exist with greater competition for market share.

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OBJECTIVES AND PROCEDURES

This study was designed to analyze the farm-level economic and agronomic aspects of sod production and marketing practices that characterize the turfgrass-sod industry in Alabama. Specific objectives were to: determine the nature and scope of the commercial turfgrass-sod industry in Alabama, evaluate cultural practices, and define economic/financial relationships for alternative sizes and types of turfgrass-sod production systems.

To achieve these objectives, a census of commercial turfgrass-sod producers in the State was taken with assistance from the Alabama Cooperative Extension Service and the Alabama Department of Agriculture and Industries. Sod producers in each county were also asked to list any producers not reported in the census to ensure completeness and accuracy. The completed census described sod species produced, size of operation, demographic characteristics, and market outlets used for sod. The census data were verified and cross-referenced to a registered sod producer list maintained by the Alabama Department of Agriculture and Industries. A total of 79 producers was identified. All turfgrass-sod producers were included regardless of size of operation.

In the early spring of 1988, Alabama turfgrass-sod producers identified by agents of the Alabama Cooperative Extension Service and the State Department of Agriculture were mailed an industry questionnaire. Detailed information concerning production, harvesting, and marketing practices for 1987 was requested. In addition to survey questionnaires, data were also collected by personal interview from a random sample of turfgrass-sod operation managers and/or owners. Of the 79 verified producers, 30 responded completely, or in part, to the survey and participated in the study. Information was sought about 11 aspects of turfgrass-sod production so that investment, operating costs and returns, and cash flow analyses could be performed to determine the feasibility of commercial turfgrass-sod production. Consideration was also given to alternative firm sizes and types of production units.

These data were used to evaluate the economic status of sod firms and as a base to simulate investment, cost, and return levels for a new sod firm. Alternative levels of technol-

ogy adoption and relative efficiency of operations were evaluated based on estimated average cost relationships for various segments of the industry using the current data set and information collected in the 1979 survey by Adrian et al. (2). Marketing aspects of the industry were ascertained by the survey and included data related to prices received, volume of sales by each turfgrass species, and market outlets. Additional information relative to transportation, sod quality, services, and distribution was collected along with producer opinions relative to certification and market expectations.

HISTORY AND DEVELOPMENT OF ALABAMA'S TURFGRASS-SOD INDUSTRY

Sod production, as an industry, has grown substantially since 1927, when Auburn University first began turfgrass research in Alabama. Sod production in other states such as Pennsylvania (4), Florida (16), and Maryland (10) was a commercially recognized enterprise as early as 1930, with the home lawn being the dominant market outlet. The rural South of the 1930's did not yet have the population density or income needed to support an expanded turfgrass-sod industry. Alabama possessed land, water, labor, and all other natural resources necessary for turf production, but lacked the one essential element that is the purpose of any industry, the customer.

As consumer demand for sod increased in the Northern States, technology advanced the production frontier. In the 1940's, the first self-propelled sod cutters were utilized. There were also improvements in turfgrass species. Consumers expressed a desire for improved turf quality with respect to disease resistance, maintenance requirements, climatic adaptability, and appearance. Research led to the developmental release of varieties having such characteristics.

The Alabama turfgrass industry was slow to develop through the 1940's and 1950's. Primary sod purchasers in Alabama during the post-war period were golf course construction contractors, institutions and government agencies, and landscape contractors. The expansion of subdivision development in the 1950's was experienced first in the Northern States and the turfgrass industry in that area continued to expand. Sod production remained an infant industry in Alabama until the

emergence of the "New South" in the 1960's. As industry developed in the South, so did turfgrass production. The southern migration of industry initiated a boom in many aspects of the economy, as several areas of the rural South gave way to urban growth. The sod customers of the New South were

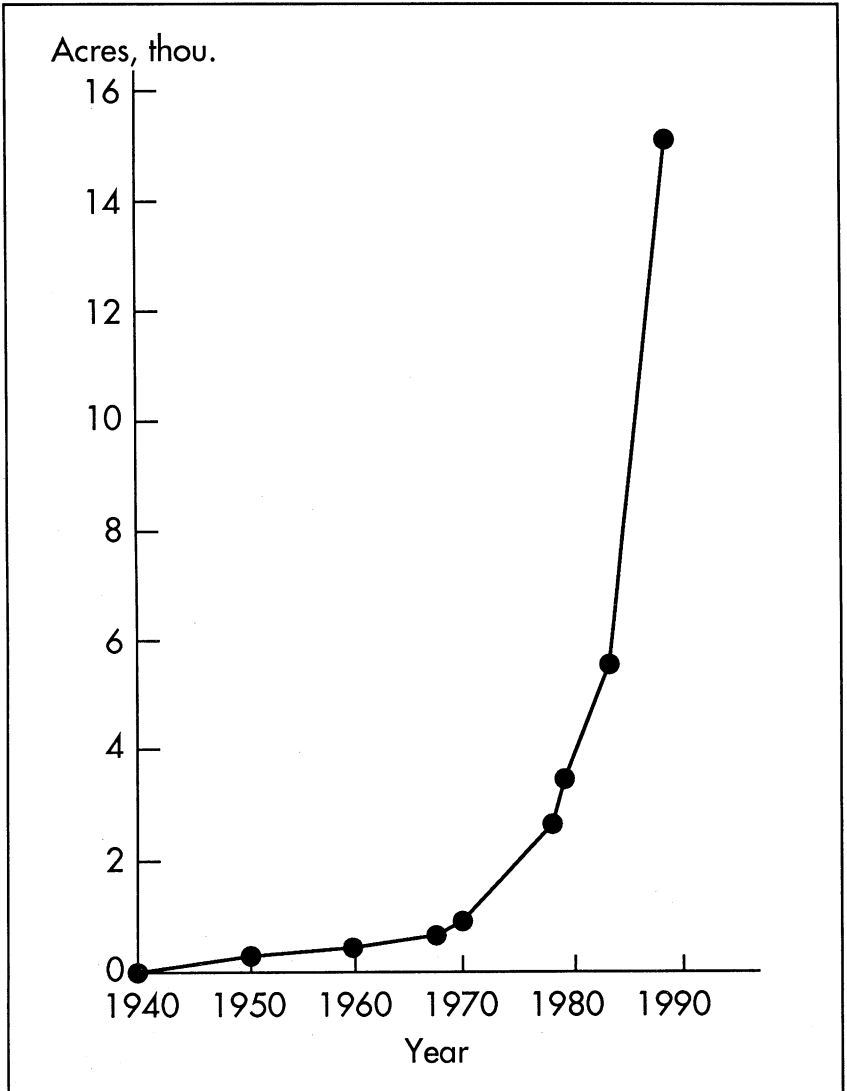


FIG. 1. Estimated sod acreage, Alabama, 1942-88.

new industry, landscapers, real estate developers, and new home buyers.

The new consumer changed demand, created opportunities for the few existing Alabama turfgrass-sod producers to expand, and provided incentive for new producers to enter the market. In 1968, there were approximately 500 acres of sod produced in Alabama. Just 10 years later, there were an estimated 2,900 acres in production. The industry has continued to grow during the 1980's. A study of the Alabama market in 1983 found that total acreage exceeded 5,400 acres (3). In 1988, production was estimated to be in excess of 15,000 acres, figure 1. There are many contributing factors responsible for this incredible growth, such as: (1) the urban and industrial development of Alabama and surrounding states with the associated higher incomes; (2) farm failures in production of historical commodities, with turf considered to be an economic alternative; (3) advances in marketing and distribution, including interstate highway access and retail outlet expansion; (4) improvements in the product and technology; and (5) increased awareness of environmental benefits from the use of sod.

Recent drought conditions affecting the turfgrass market indicate the incremental growth in the turfgrass industry may be slowing, at least temporarily. Producers reported that drought and economic conditions of recent years have led to reduced demand and high inventories, resulting in price competition in diminished markets, especially for bermudagrass.

GENERAL INDUSTRY CHARACTERISTICS

Farm Characteristics

In 1978, most sod farms were operated as part-time businesses; only 4 of 26 producers reported incomes solely from sod operations. In 1988, 5 of 30 producers who responded to the survey reported they operated on a part-time basis, while 25 were full-time businesses. Seven full-time sod farms also reported production of other agricultural products. These other agricultural products accounted for 37 percent of total gross income, on average, per producer. Producers responding to the 1988 survey had farmed for 29 years, on average, and had produced sod for 14 years. The oldest sod operation had been in business for 35 years.

Organization

Five of the 19 producers responding to the survey question regarding business organization maintained their firms as individual proprietorships, while 6 were organized as partnerships and 8 utilized the corporate form of business organization. Among farms with 100 acres or less, individual proprietorship was the most frequently utilized form of business organization. Farms with total production between 100 and 300 acres reported three partnerships and two corporations. Farms greater than 300 acres in size utilized the corporate form exclusively. Adrian et al. (2) reported in 1981 that of 29 producers, 6 farms were organized as corporations. The increase in the number of farms operating as corporations is indicative of overall changes in farm characteristics. Shipping and delivery to the point of sale have increased risks and liability for sod producers. The advantages of corporate organization are well suited to the needs of today's sod farm.

Land

Producers responding to the survey reported maintenance of 5,597 acres in sod production, with 4,540 acres maintained in other agricultural products. Of 10,137 acres total land, growers reported they owned 8,610 acres and rented 1,527 acres. Annual land rents averaged \$48.12 per acre with 4 years being the average length of leases.

Size and Scope of the Industry

Given the level of competition that exists in the sod industry today, perhaps the most significant measure of Alabama's turfgrass-sod industry is the total square yards of sod sold per year. Total acreage of sod production, another commonly used measure of the magnitude of the industry, may be somewhat misleading because certain turfgrass species are often harvested twice in one year, while other species may require multiple growing seasons. Evaluation of the industry in terms of dollar value of sod sales per year may also be misleading. Sod producers often reduce prices to stimulate sales and increase market share. Though total revenues may exceed the previous year's, such increases could be due in large measure to a greater volume of sales at lower prices. Given that prices

change from year to year, perhaps the most useful measure of industry vitality is the measure of total square yards sold annually per acre.

Alabama producers supply sod to all Southeastern States. In 1978, there were 26 producers in Alabama with 2,871 acres of sod production (2). In 1982, this had increased to 39 producers with 5,454 total acres maintained in sod (1). In 1988, there were 79 producers with an estimated 15,062 acres in sod production, table 1. There were significant changes

TABLE 1. NUMBER OF GROWERS, ACREAGE, AND VARIETIES OF TURFGRASS GROWN, ALABAMA, 1978 AND 1988

Species	Number of growers		Acres		Percent of identified acres	
	1978	1988	1978	1988	1978	1988
Bermudagrass						
Tifdwarf	2	1	21	8	0.8	0.1
Tifgreen (328)	11	7	896	491	36.0	8.8
Tiflawn	1	0	1	0	—	.0
Tifway (419)	9	11	517	731	20.8	13.1
Tifway II	0	6	0	625	.0	11.2
Subtotal			1,435	1,855	57.6	33.2
Centipedegrass	8	12	541	2,268	21.7	40.5
St. Augustinegrass	1	3	20	393	.8	7.0
Zoysiagrass						
Emerald	7	12	260	605	10.4	10.8
Matrella	4	5	83	57	3.9	1.0
Meyer	4	9	149	419	6.0	7.5
Subtotal			492	1,081	20.3	19.3
Total for responding firms	15	25	2,489	5,597	100.0	100.0
Total for nonresponding firms	11	54	382	9,465		
Total	26	79	2,871	15,062		

reported in production acreage by turfgrass species since 1978. Bermudagrass production reported by producers responding to the questionnaire had increased 29 percent, from 1,435 acres in 1978 to 1,855 acres in 1988. Centipedegrass production was reported to have increased 319 percent, from 541 to 2,268 acres. St. Augustinegrass (all varieties) production increased 1,865 percent, from 20 to 393 acres. Zoysiagrass production increased 120 percent, from 492 acres in 1978 to 1,081 acres reported in 1988.

Sod farms exist in 42 of Alabama's 67 counties, table 2. As

TABLE 2. COUNTY DISTRIBUTION OF CULTIVATED SOD,
ALABAMA, 1978 AND 1988

County ¹	Estimated number of growers ²		Estimated acres of cultivated sod ³		Percent of total acres	
	1978	1988	1978	1988	1978	1988
Baldwin	2	4	250	4,200	8.70	27.88
Barbour	1	3	100	480	3.48	3.19
Bibb	0	2	0	14	.00	.09
Bullock	0	3	0	300	.00	1.99
Butler	0	1	0	10	.00	.07
Calhoun	0	5	0	1,550	.00	10.29
Chambers	0	1	0	10	.00	.07
Cherokee	0	1	0	100	.00	.66
Chilton	0	1	0	25	.00	.17
Cleburne	0	1	0	45	.00	.30
Coffee	0	1	0	25	.00	.17
Colbert	2	2	60	140	2.09	.93
Coosa	0	1	0	10	.00	.07
Covington	3	1	320	650	11.15	4.32
Cullman	0	2	0	75	.00	.50
Elmore	2	3	55	15	1.92	.10
Fayette	0	1	0	5	.00	.03
Franklin	0	2	0	34	.00	.23
Greene	0	1	0	6	.00	.04
Henry	0	2	0	267	.00	1.77
Houston	1	5	40	232	1.39	1.54
Jefferson	1	0	20	0	.70	.00
Lauderdale	1	1	20	9	.70	.06
Lawrence	0	1	0	10	.00	.07
Lee	2	1	724	864	25.22	5.74
Limestone	0	3	0	60	.00	.40
Lowndes	0	1	0	140	.00	.93
Macon	1	2	40	330	1.39	2.19
Madison	0	1	0	350	.00	2.32
Marengo	0	1	0	150	.00	1.00
Marion	0	1	0	10	.00	.07
Marshall	0	1	0	25	.00	.17
Mobile	2	0	32	0	1.11	.00
Monroe	0	1	0	60	.00	.40
Montgomery	1	2	20	350	.70	2.32
Morgan	0	2	0	50	.00	.33
Pickens	1	7	40	336	1.39	2.23
St. Clair	1	3	675	1,450	23.51	9.63
Shelby	4	9	455	2,205	15.85	14.64
Talladega	0	1	0	300	.00	1.99
Tallapoosa	0	1	0	40	.00	.27
Tuscaloosa	1	3	20	130	.70	.86
Total	26	79	2,871	15,062	100.00	100.00

¹The grower's county of residence.²Identified and unidentified growers.³Identified and unidentified acreage.

Standard Metropolitan Statistical Areas (SMSAs) have expanded, the increased demand for land in proximity of such growth centers has boosted land costs for new sod farm development. Since delivery of sod (regardless of distance) is required of all major producers, many newer farms have located further from SMSAs. Concentration of production, however, is apparent. In the four-county area including Calhoun, Talladega, St. Clair, and Shelby counties, there were 18 producers with 5,505 acres in production. In Montgomery County and east to Lee County, there were eight producers with 1,844 acres in production. The South Alabama/Florida border counties had 13 growers with 5,374 acres maintained in sod. The Huntsville area had 16 producers with an estimated 753 acres in sod. These concentrations of acreage indicate that proximity to the interstate highway system is an important factor affecting location of sod firms.

In 1978, there were 4.4 million square yards of sod sold by Alabama producers (2). An average of 4,000 square yards of turfgrass-sod was harvested per acre and total acreage of sod sold was 1,097. Total acres in sod production were estimated at 2,871. Thus, approximately 38 percent of all sod in production was harvested within a given year. In 1988, there were 15,062 acres in production and an estimated 45 million square yards were sold. Some producers have increased the single crop per acre harvest to 4,300 square yards through clean-cutting practices and reduced scrap loss. The state average for all harvested acres, however, remained as 4,000 square yards per acre. Thus, the percent sold of all production increased to 76 percent.

Total gross income at the farm level based on average wholesale prices was \$4 million in 1978 for all Alabama producers (2). The estimated farm level gross for 1988 for all Alabama producers (survey participants and nonparticipants) was \$47.4 million. The average gross return per harvested acre in 1978 was \$3,663, while it was \$4,157 for 1988. Much of this increase in gross returns is a result of higher harvesting percentages and improved turnover of sod per unit of land.

PRODUCTION PRACTICES

Production practices described herein summarize reported practices used by producers throughout Alabama and recommended practices based on turf research at Auburn University and elsewhere. Such practices have proven effective in producing high quality turf in an efficient manner. The success of a turfgrass production venture is primarily determined by two factors: efficient production practices, including site selection, and effective marketing of the product.

Site Selection

Three criteria in site selection which have the greatest influence on production location are: (1) distance to major market area, (2) transportation accessibility, and (3) resource quality and availability. All but two producers who were surveyed delivered to the final point of sale. Producers competing for sales with growers nearer the point of sale may not be able to charge for total associated delivery costs and thus, distance to market represents an increased cost of doing business. Sod is a perishable product and delivery is subject to wind, moisture, and temperature damage from the time of harvest to delivery. Transportation and service accessibility are important because sod deliveries and production are ongoing throughout the year in variable weather conditions and producers must have access to roads which allow uninterrupted service and delivery to market areas.

Resource availability and quality comprise perhaps the most restrictive aspect of site selection. Soil topography, soil type, climate, water supply, labor, and a sufficient support market (including pesticide and equipment dealers) must be evaluated for each site. Soil types used for sod production vary throughout Alabama, but producers reported a preference for sandy loam soils. One-half of the growers responding to the survey produced sod on sand or sandy loam soils, while 39 percent reported having heavy clay (red) soils and 11 percent reported production on high organic soils. Regardless of the soil type, it is essential that the soil be well drained and be as rock free as possible.

Producers in the southern two-thirds of the State reported that climate did not influence selection of turfgrass species.

Producers in the northern one-third of Alabama, however, reported that winter-hardy species such as zoysiagrass and bermudagrass were primary production turfgrasses.

Water is critical to turfgrass production. Every producer surveyed utilized some form of irrigation. A typical cable-tow system servicing 100 acres may require 600,000 gallons of water per day during peak demand. This is equivalent to 1 inch of water over 22 acres of surface area.

Certain aspects of turfgrass production remain labor intensive. Unskilled labor is required in addition to technically trained labor, equipment operators, mechanics, and clerical staff. A support industry is also necessary to avoid delays in the production process due to equipment downtime or needed supplies. Many agricultural supply firms may not provide or maintain specific inventory needed by turf growers.

Turf Establishment

There are two distinct operations encompassed under the general heading of turf establishment. One is initial establishment, which refers to procedures utilized in bringing acreage into sod production for the first time. The other operation is reestablishment. In this process, land is prepared for regeneration of the turfgrass following sod harvest.

Poor site preparation can severely limit turfgrass production. Subsoiling is often necessary to reduce compaction and improve drainage and depth of rooting. The depth of subsoiling is dependent on soil type and equipment limitations. Subsoiling depths reported by producers ranged from as little as 10 inches on smaller farms to as much as 24 inches on some of the larger operations. The soil is then disked and lime and fertilizer are incorporated. The majority of producers preferred not to use preemergence applied herbicides during initial establishment because these materials often inhibit grass root development and slow growth.

Producers were also reluctant to fumigate fields not previously in turf production. Fumigation with methyl bromide by custom applicators costs approximately \$800 per acre. New production fields should be examined for pest populations that require fumigation because most insects, pathogens, and weeds can be more economically controlled with other pesticides. Two pests which generally require fumigation for control are purple nutsedge and common bermudagrass.

In general, producers prefer to apply only nonselective herbicides (primarily glyphosate) for preplant control of weeds such as common bermudagrass. Applications are made before subsoiling and again after grading and rolling is completed if new weeds appear prior to planting. However, control of nutsedge and bermudagrass is often poor and the resulting sod is of poor quality.

A well-prepared soil surface is critical to efficient production and harvesting. Requirements include: (1) free of stones and debris, (2) no furrows or low spots, (3) site developed with the lay of the land, and (4) all surfaces smooth. Producers rated developed cropland as their first choice in site selection. Lands such as flood plains, swamps, and forest acreage ranked in decreasing favor due to higher preparation costs.

Planting

For the majority of growers, sprigging is the preferred method of vegetative propagation. All named cultivars of warm season turfgrass grown in Alabama (St. Augustinegrass, bermudagrass, centipedegrass, and zoysiagrass) must be vegetatively established from sprigs or plugs. Common centipedegrass and bermudagrass can be either established vegetatively or from seed. Tall fescue, the only cool season species used for sod production in Alabama, is established from seed. Sprigs are stolon or rhizome segments about 2 to 4 inches in length that are harvested for vegetative establishment. Though St. Augustinegrass and zoysiagrass may be sprigged, as with bermudagrass and centipedegrass, plugging has generally been more effective and is more commonly practiced by Alabama growers. Sprigs are spread by manure spreaders or sprigging machines at a rate of 250 to 450 bushels per acre. Generally, 1 bushel of sprigs or plugs is obtained from 1 square yard of sod. The sprigs are lightly disked to ensure soil cover and may also be rolled for improved soil contact.

Plugs are sections of harvested sod that are cut into pieces of approximately 2 to 4 square inches. These are planted in the prepared seed bed on 6- or 8-inch centers. Plugs are planted by hand or machine, using 300 to 450 square yards per acre. Rolling is also used to improve soil contact.

Sprigging and plug planting are done "in house" by producers or are available through custom planting contracts. Two producers reported they also do custom planting for other growers. Overall, larger farms preferred to plant "in house," while farms under 300 acres usually contracted for custom planting.

Producers reported the use of frequent, light irrigation to improve establishment. One grower reported successful establishment of sprigs spread at 400 bushels per acre and disked to 4 inches without irrigation. However, frequent irrigation is essential for rapid establishment and helps protect against stand failure.

Producers with large acreages of common centipedegrass allow certain fields to produce seed. The seed is harvested and used on the farm to overseed vegetative centipedegrass production or is planted on prepared seed beds for establishment. The seeding rate is approximately 10 pounds per acre. Producers located in the northern two-thirds of the State were reluctant to initiate establishment of warm season grasses after September 1 because of the potential for winter injury to new plantings. Southern producers reported a willingness to establish grasses throughout the year.

There is limited production of cool-season grasses for sod in Alabama. Approximately 75 acres of turf type fescue production were identified in 1988. Tall fescue is seeded at 200 to 250 pounds per acre. All growers producing tall fescue sod reported using plastic netting to improve sod tensile strength and thus harvesting and handling qualities. The majority of tall fescue production was found in the southern half of the State, with growers avoiding the summer months for production.

Plastic netting also has application for some warm season grasses. Five growers had adopted the use of netting in the production of approximately 400 acres of centipedegrass. They reported producing a centipede sod in as little as 8 months using netting over seeded beds. Production time without netting averages 12 to 15 months. An often-mentioned additional benefit from this practice was the ability to harvest in early spring. Centipedegrass sod characteristically has a low tensile strength in early spring. Netting improves the tensile strength and harvest ability of the sod and allows producers to supply the early spring market.

Reestablishment

Reestablishment techniques vary with farm size, species grown, and season. There are two basic methods of harvesting: ribbon-cut and clean-cut.

Ribbon-cutting is the traditional method by which sod is harvested leaving a 1- to 2-inch-wide undisturbed turf ribbon or strip between harvested strips. This method is applicable to all warm season grasses and is used to reestablish the turf.

There were three distinct variations of reestablishment from ribbon-cut propagation strips. With one method, the harvested fields are lightly disked and then rolled to create an even surface. This eliminates the ridges caused by the sod strips that remain between rows of harvested sod. With method two, the fields are disked moderately and then cultivated to pull rhizomes upward near the surface and to ensure an even distribution of propagation stock. Then, the surface is rolled, fertilized, and frequently irrigated. With method three, the fields are fertilized and frequently irrigated, with strips gradually lowered by rolling or mower scalping as reestablishment progresses. Centipedegrass fields are often overseeded to speed reestablishment.

Thirty-nine percent of the producers surveyed utilized the clean-cut harvest subject to species and time of year. With this method, the sod is harvested without leaving any ribbons or surface vegetation. Reestablishment is from intact rhizomes for zoysiagrass or bermudagrass, and by seed for centipedegrass. Fields that are wheel tracked during harvest are fertilized, lightly disked, and rolled, with frequent irrigations following.

Subject to time of year, producers throughout the State may alter their standard harvest and reestablishment procedures. If turf is harvested in late summer and new growth is subject to winter injury, ribbons are often left on all turfgrass species. Growers reported greater winter injury to clean-cut fields than ribbon-cut fields. Producers in the northern two-thirds of Alabama were more likely to prefer reestablishment from ribbons because growing seasons are shorter and winters are more severe than those for the southern growing region.

Primary Cultural Practices

Once the species of turfgrass has been selected and established, production practices should be implemented to produce as rapidly as possible a high quality turf that will hold together during harvesting and handling. Tensile strength is enhanced by cultural practices that stimulate sod knitting, which is the mat-like intertwining of roots, rhizomes, and stolons within the soil and thatch layers.

Mowing

Mowing serves to control weeds, remove excess growth, and promote lateral growth of the turfgrass. Most producers preferred mowing for weed control in newly established turf even though costs may exceed those of herbicide applications. At this early stage of the production cycle, mowing is typically performed only when weeds begin to compete excessively with the turfgrass. Because reel mowers can become overheated in sparse turf or damaged by coarse vegetation and rocks, flail mowers or rotary mowers are most often used on newly planted turf. Mowing frequency on maturing turf is adjusted so that only about one-third of leaf blade length is removed per mowing. This maintains good color and an even appearance to the turf surface. Normal mowing heights for zoysiagrass, centipedegrass, and bermudagrass are 1.0 to 1.5 inches, while St. Augustinegrass and tall fescue are maintained at approximately 1.5 to 2.0 inches.

Use of the mowing equipment on multiple species of turfgrass was reported to be a contributing factor to field contamination with off-types or species of grasses. Seven producers, with total production exceeding 300 acres, each reported they regularly inspected and cleaned mowers as well as other equipment that had common use in multiple species before allowing such equipment to be used in another field. Five producers, each with less than 300 acres in production, reported similar procedures.

Seventy-eight percent of producers reported regular collection of clippings. All producers reported collection when excessive growth removal was required. Equipment utilized for clipping collection included mower baskets, tractor pulled sweeper/vacuums, self-propelled sweeper/vacuums, and hay harvesters. Clipping disposal methods are an economic and

environmental consideration. Seven producers reported clippings were burned, while six used landfill pits, and three reported on-site above ground dumping.

Irrigation

Producers must utilize irrigation to promote rapid production of quality sod. Market demand and production costs have made the production cycle a critical measure of management efficiency. Irrigation is a necessity from initial establishment through field harvest. Many factors must be considered in the selection of an irrigation system. Among these are: scale of operation, field size and shape, terrain, initial system cost, water source, labor supply, and operating cost of the system.

System selection is important because once a system is installed, it becomes a fixed resource and its capacity may limit production. Producers who plan to expand production and foresee a need to reduce labor requirements for irrigation will select systems that can be expanded as the need arises. Such expansion is simple with center-pivot systems. Initial capital investment is high with costs ranging from \$617 to \$1,126 per acre for 40- and 135-acre capacities, respectively.

Seven producers reported utilizing center-pivot systems but none reported these as their only means of irrigation. This was due in part to the need for back-up ability in case of primary system failure. Another reason offered was the need for flexibility that only smaller systems offer, such as syringe irrigation or small area irrigation prior to harvest. Systems most often selected for these alternate purposes were traveling guns.

Traveler systems may be cable-tow or hose-tow. The cable-tow system was utilized by seven growers and hose-tow models were used by three growers. In either case, operation involved application with a rotating sprinkler gun mounted on a traveling body equipped with a drum-type reel. The units must be positioned on each field before application. Growers reported this normally requires 1 hour of labor and tractor time. A complete hose-tow system with 850 feet of 3-inch hose, standard 3-inch nozzle risers, lateral pipe, and pump costs approximately \$54,000 (6). A comparable cable-tow unit costs approximately \$46,000 (6). On a per acre cost basis, this amounted to \$538 and \$463, respectively. Either

system can irrigate 7 acres per setup or up to 100 acres on a weekly basis.

Traveler systems have replaced above ground systems of moveable pipe because the latter systems require considerably more labor and reduce efficiencies of other operations, such as mowing and harvesting. Nine producers reported use of solid set systems. These systems using sprinklers mounted on risers on underground pipe were most frequently used on older farms where turf species and cultural practices were stable and well established. Such systems offer complete flexibility for these acres and require little labor. Many growers utilized labor during off seasons to gradually install solid set irrigation systems.

Selection of an irrigation system is subject to the natural constraint of water availability. Of the producers responding to the survey, 17 reported utilizing continuous flowing rivers or creeks, 10 utilized natural or constructed lakes and ponds, 6 utilized ground water from wells, and 1 utilized a public water utility for the primary water source. Producers reported similar rates and frequency of irrigation within growing regions and production phases.

Typically, producers applied 1 inch of water per irrigation to established turf, with applications being made in early morning, if possible. Applications before sunrise provide adequate moisture for growth and are usually accomplished with minimum wind disturbance and evaporation losses. Night applications may favor development of disease pathogens and may also require additional labor expense. Daytime applications interfere with other cultural practices and management operations and may result in uneven water distribution due to winds. Producers with predominantly clay soils reported they irrigated one time per week during extended dry periods and producers with predominantly sandy soils reported two applications during the same time period. All producers reported the common practice of light syringe applications to newly established turf.

Fertilization

Fertilizer perhaps contributes more to sod production than any other single resource. Growers generally agreed that the rate of fertilizer used was constrained more by the limits of plant response than by cost of fertilizer. Growers reported

satisfactory growth response at a maximum rate of 60 pounds available nitrogen per acre per application to zoysiagrass and bermudagrass turf. Beyond this rate, turf response deteriorates because the ratio of shoot growth to root growth becomes excessive and results in increased costs of additional mowing, decreased harvest quality, and increased susceptibility to disease and stress. Most producers were satisfied with application of no more than 50 pounds of available nitrogen per acre per growing month from April through September.

During soil preparation for seeding or vegetative propagation, balanced ratio fertilizers such as 8-8-8 or 13-13-13 are often incorporated at 400 and 300 pounds per acre rates, respectively. Applications of comparable rates may also be made following harvest to promote reestablishment. Application of high potassium fertilizer was common in late fall in an attempt to enhance winter survival.

Thirteen producers reported annual soil testing and 4 reported periodic testing at 2- to 3-year intervals. Overall, growers followed recommendations for pH adjustments and nutrient balancing for field preparations. Producers frequently relied on experience and observations of turfgrass color and growth for determination of nitrogen requirements. Only one grower reported satisfaction with fertilizer applications made through the irrigation system. Although ammonium nitrate was the preferred nitrogen source fertilizer, two producers reported using urea (45-0-0), three used ammonium sulfate (21-0-0), and one used calcium nitrate (15-0-0). No producers utilized urea-formaldehyde (IBDU) and two reported use of sulfur-coated urea. Three producers reported regular use of chicken manure as a plant nutrient source during the growing season. One producer reported use of processed sewage sludge. Growers with predominantly sandy soils or calcereous soils with a pH greater than 7.5 found it necessary to make supplemental applications of iron, as ferrous sulfate or chelated iron applied through irrigation or by sprayer.

Pest Management

Pests are defined as organisms which are present at some point in production and represents economic loss due to quantity and/or quality deterioration. The primary purpose of pest

management is to ensure a high-quality, uniform turf which will reduce scrap or waste and make harvesting more efficient. Gaps and breaks in the sod surface delay harvest and ultimately affect reestablishment.

INTEGRATED PEST MANAGEMENT. Integrated Pest Management (IPM) is the implementation of cultural practices designed to control pests considering the additional cost of control relative to the additional revenues such control measures generate. Turfgrass producers are implementing such cultural practices with respect to both profits and environmental concerns such as water quality. At some point, most producers find it necessary to control pests. Populations of pests may exist such that field sterilization is required. Though fumigation is expensive (producers reported cost per acre using methyl bromide at \$750 to \$950), it is an effective way to control such pests as nematodes, nutsedge, common bermudagrass, and insects, as well as pathogens. Ten percent of producers reported fumigating some fields prior to initial establishment. The average time interval between fumigations was 7 years.

Among producers surveyed, 3 reported they fumigated using their own personnel; 5 utilized custom applicators; and 12 reported they did not fumigate. All fumigation reported utilized methyl bromide. By far the most common preplant herbicide application was glyphosate. Unless nematodes, disease, insect populations, or perennial weeds existed at levels that restricted profitable yields, producers applied this herbicide alone with satisfactory results.

INSECT CONTROL. Insects may damage turf growth, interfere with harvesting, or render sod unmarketable. Insects are classified as subsurface feeding, surface feeding, or sod inhabiting.

Subsurface-feeding insect pests can have a significant economic impact due to their feeding on roots and rhizomes. Mole crickets, bill bugs, ground pearls, and grubs were the primary subsurface feeding insects reported in sod. Producers utilize acephate, ethoprop, isazophos, carbaryl, and chlorpyrifos for control. Ninety-five percent of the producers applied insecticides themselves, while 5 percent utilized custom applicators.

Surface-feeding insect pests cause damage to grass shoots, leaves, or stolons. Sod webworms, army worms, chinch bugs, and grasshoppers were the most often reported pests in this

grouping. Control chemicals include ethoprop, chlorpyrifos, acephate, isofenphos, and carbaryl.

Sod-inhabiting insect pests are those that have no direct damaging feeding habits on turfgrass but cause other problems with production, harvesting, or sales. The primary pest in this group was the imported fire ant. In addition to handling problems, producers are restricted by law from shipping sod infested with fire ants to areas where the ant is not reported to exist. Currently, only one insecticide (chlorpyrifos) can be used for preparing sod for shipment out of infested areas into ant-free areas.

WEED CONTROL. In general, a weed is any plant growing where it is not desired. Weed control in turfgrass-sod production utilizes both chemical and cultural controls. Weeds can be classified as broadleaf or grasses and may be annual or perennial. Producers relied on cultural practices, such as mowing, to a great extent for control of both types of weeds, but these practices were not always effective. Close mowing of turf was found to suppress broadleaf weed activity while favoring sod production, but control of grasses was poor. Selective herbicides were also effective when correctly applied.

Broadleaf weed species most frequently reported to be of economic significance were buttercup, carpetweed, clovers, henbit, spurge, wild onion, wild garlic, and thistles. Producers reported using 2,4-D, dicamba, mecoprop, and imazaquin for postemergence control and bensulide and simazine herbicides for preemergence weed control. The most frequently reported annual grass type weeds were crabgrass, annual bluegrass, and goosegrass. Producers reported using simazine, atrazine, or DCPA for preemergence control. Selective postemergence herbicides were applied to control established annual grass type weeds. Producers reported satisfactory results with applications of MSMA, DSMA, metribuzin, asulam, or sethoxydim. Producers in the northern two-thirds of Alabama reported using glyphosate to control winter annuals in dormant warm season turf. More often than not, producers in the southern one-third of the State reported incomplete turf dormancy and, thus, only selective herbicides could be used.

The most often reported perennial grass weed of economic significance (by 11 producers) was common bermudagrass. Glyphosate applications were made as spot sprays for con-

trol. Resulting dead spots may interfere with harvesting and result in greater losses due to increased scrap waste or patches of sod too small to harvest. Many producers reported that sod infested with common bermudagrass was sold at a discount and was classified as utility or commercial grade.

DISEASE CONTROL. There were no observations of substantial reductions in turfgrass-sod yields due to diseases and only four producers reported that pesticide applications were required for disease (primarily brown patch in centipedegrass and St. Augustinegrass) control in established sod fields. No producer utilized preventive fungicide applications. The production cycle for turfgrass-sod is completed within 6 months to 2 years, during which the sod receives adequate fertilizer and water, timely mowing, full sun, and adequate air circulation on a well prepared soil. Thus, it is less subject to disease damage than landscape turf which often competes with trees, shrubs, and weeds for sunlight, water, and nutrients in areas with high humidity, poor air circulation, and ineffective water drainage.

HARVESTING AND MARKETING PRACTICES

Harvesting

Proper cultural practices help ensure good harvest characteristics which include: a balance of shoot growth and root growth, strong knitting of root rhizomes and/or stolons, and uniform coverage with no bare soil surfaces. The sod should be free of pests, mowed to desired height, and slightly moist at harvest.

Growers reported a 3 percent average scrap loss. Higher percentages are expected in fields where the soil surface is uneven or rocky or where pests and their control have resulted in thin, nonuniform sod. Improper mowing height or irregular mowing can weaken sod strength. Excessive fertilization, irrigation, or herbicide applications can inhibit root formation or sod knitting.

Producers reported the average per acre yield for ribbon-cut harvest was 4,000 square yards and the average per acre yield for clean-cut harvest was 4,300 square yards. Inefficient harvesting of a poor quality sod can result in a 10 to 20 percent reduction in yield.

Farms with 50 acres and less used walk-behind harvesters and reported an ability to harvest a maximum 1,240 square

yards per day per harvester. Farms in the 50- to 300-acre range utilized at least one tractor-mounted harvester and were able to harvest a maximum of 2,500 square yards per day per harvester. Farms with greater than 300 acres in size utilized two or more tractor-mounted harvesters. Producers reported they could harvest a maximum of 4,000 square yards per day per harvester.

Asked if they irrigated prior to harvest, 16 producers stated that they did and 4 said they did not. The most commonly reported size of sod roll or flat cut was 16 inches x 24 inches, reported by 13 producers. Twelve producers cut sod to order and 7 did not.

The growth cycle time to harvest has been reduced on average for all turfgrass sod since 1979. Bermudagrass averaged 9.6 months from initial establishment to harvest and 7.3 months to harvest from time of reestablishment. This compares with respective times of 16.6 and 15.5 months for centipedegrass, 13 and 11 months for St. Augustinegrass, and 18 and 10 months for zoysiagrass. In general, producers maintained a market-ready inventory equal to about one-third of their annual total productive capacity.

Market Growth

Population in Alabama for 1980 and 1986 was recorded as 3,893,888 and 4,053,000, respectively (11). The percentage increase in sod production has exceeded that of population growth. When asked about their ability to satisfy consumer demand for sod in 1988, 65 percent of the producers stated that at some point in the year they could not meet quantity demand. However, many producers reported they believed the market for bermudagrass sod was saturated and that surpluses were common. One producer listed shipping and another producer listed consumer relations as additional problems of marketing. Acquiring and maintaining market share was the greatest marketing problem faced by 75 percent of responding producers.

Market Outlets

The turfgrass-sod market is divided into several categories of buyers. Producers reported sod sales as follows: 51 percent to landscapers, 20 percent to homeowners, 13 percent to gar-

den centers, 7 percent to other growers, 2 percent to golf courses, 0.9 percent to government agencies, and 6 percent to others, table 3. The landscaper/contractor category included landscapers and building contractors. Government agencies included athletic departments, recreation or park facilities, and school systems.

TABLE 3. VOLUME AND VALUE OF SALES BY MAJOR MARKET OUTLETS FOR SURVEYED TURFGRASS GROWERS, ALABAMA, 1988¹

Type of buyer	Volume of sales (square yards)	Percent of total sales	Value of sales (dollars) ²
Landscapers/contractors	7,438,704	51	7,661,865
Home owners	2,994,555	20	3,084,392
Garden centers	1,914,696	13	1,972,137
Other growers	1,027,040	7	1,057,851
Other	924,336	6	952,066
Golf courses	234,752	2	241,794
Government agencies	137,917	1	142,054
Total	14,672,000	100	15,112,159

¹Based on responses from 30 of 79 total growers in Alabama, 1988.

²Average of \$1.03 per square yard for all sod with no transport charges included.

Market Distribution

Forty-one percent of the sod sold by Alabama producers in 1988 was distributed within the State. The majority of these sales was attributed to three primary in-state market areas: the greater Huntsville area; the north central portion of the State, including Tuscaloosa, Birmingham, and Anniston metropolitan areas; and the east-central region, including the area from metropolitan Montgomery to the Georgia line.

Alabama's exports to border state markets have also grown substantially. Export sales in 1979 were approximately 22 percent of total annual production (2). Out-of-state sales for 1988 accounted for approximately 59 percent of total sales, table 4. Georgia was, by far, the largest customer, with 67 percent of total exports. Atlanta and the west Georgia area of Columbus were the two most frequently accessed markets. Seventeen percent of exports went to Florida, while 14 and 2 percent went to Tennessee and Mississippi, respectively.

TABLE 4. MAJOR OUT-OF-STATE MARKETS FOR SURVEYED TURFGRASS GROWERS, ALABAMA, 1988¹

State	Total out-of-state sales (square yards)	Approximate value of sales (dollars) ²	Percent of total sales	Percent of out-of-state sales
Georgia	3,377,472	2,478,796	39	67
Florida	889,171	915,846	11	17
Tennessee	708,235	729,482	8	14
Mississippi	87,021	89,632	1	2
Total	8,619,800	5,213,756	59	100

¹Based on responses from 30 of 79 total growers in Alabama, 1988.

²Average of \$1.03 per square yard for all sod with no transport charges included.

Shipping Practices

The sod industry is largely a service industry. Sales are subject to product price and quality and also delivery capabilities. Deliveries to the point of sale normally included on-site distribution. In general, boom trucks that off-load in one location have been replaced with flatbeds that carry piggy-back forklifts for on-site distribution. Buyers demand both delivery and distribution. Producers must supply both services or discount sod price accordingly.

Smaller operations, 100 acres or less, reported they market 63 percent of all sales for field pick-up and 37 percent delivered to the point of sale. The average delivery area was reported to be less than 35 miles, with \$45 per 500-square-yard load or \$0.12 per square yard being the standard transportation charge. Larger operations reported an average delivery range of 175 miles with a standard charge of \$250 per 1,000-square-yard load or \$0.25 per square yard. These producers reported that 85 percent of all sales were delivered to the point of sale and 15 percent was sold as field pick-up.

Promotion and Pricing Practices

Only 16 percent of producers employed salespersons other than themselves. In order of preference, 50 percent of producers utilized the telephone directory Yellow Pages, 20 percent used the local newspaper, 20 percent used billboards, and 10 percent used direct mail to promote their product.

TABLE 5. AVERAGE WHOLESALE AND RETAIL PRICES REPORTED BY SURVEYED TURFGRASS GROWERS,
BY SPECIES AND FARM SIZE, ALABAMA, 1978 AND 1988

Farm size and turfgrass species	Price per square yard										
	1978				1988				Percent change		
	Wholesale		Retail		Wholesale		Retail		1978 to 1988		
	Average	Range	Average	Range	Average	Range	Average	Range	Wholesale	Retail	
	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Pct.</i>	<i>Pct.</i>
Greater than 250 (300) acres											
Bermudagrass	0.73	0.65-0.85	1.03	1.00-1.05	0.85	0.65-1.20	0.95	—	16.4	-7.8	
Zoysiagrass	1.10	—	—	—	1.80	1.60-2.50	—	—	63.6	—	
Centipedegrass	1.10	—	—	—	1.40	.80-2.10	—	—	27.3	—	
100-250 (300) acres											
Bermudagrass .....	.75	—	—	—	.83	.75-.90	1.20	—	10.7	—	
Zoysiagrass	1.13	1.05-1.20	—	—	1.80	1.60-2.50	2.25	—	41.6	—	
Centipedegrass	1.05	1.00-1.10	—	—	1.30	—	1.75	—	14.3	—	
Less than 100 acres											
Bermudagrass .....	.87	.60-1.00	.95	.75-1.25	.90	—	1.05	1.00-1.30	3.4	10.5	
Zoysiagrass	1.27	1.00-1.40	1.50	1.00-2.00	2.00	—	2.15	1.50-2.75	57.4	43.2	
Centipedegrass	1.20	1.00-1.35	—	—	1.00	—	1.43	1.20-1.50	-16.7	—	
All growers											
Bermudagrass .....	.82	.60-1.00	.98	.75-1.25	.90	.65-1.20	1.13	.95-1.30	9.7	15.3	
Zoysiagrass	1.21	1.00-1.40	1.50	1.00-2.00	1.80	1.60-2.50	1.93	1.50-2.75	48.7	28.7	
Centipedegrass	1.12	1.00-1.35	—	—	1.13	.80-2.10	1.86	1.20-1.50	.9	—	

Small firms averaged an annual expenditure for advertising of \$434. Medium-sized operations spent an average of \$500 annually and large operations expended an average of \$16,750 annually for advertising. As a percent of sales, advertising amounted to less than 1 percent of sales for the small, medium, and large firms.

Improved transportation and increased sod supply have eliminated much of the local or regional variation in price. Forty-six percent of all sod sold in 1988 was sold at wholesale. Average wholesale prices per square yard in 1988 for sod species were: \$0.90 for bermudagrass, \$1.13 for centipedegrass, \$1.30 for St. Augustinegrass, and \$1.80 for zoysiagrass. The retail/wholesale price spread amounted to only 10 percent, on average, for all turfgrasses. Discounts were based on quantity purchased and/or customer pick-up at the field. Of all reporting producers, however, 3 sold wholesale only, 1 sold retail only, and 21 sold wholesale and retail. Retail prices for all sod species in 1988 averaged: \$1.13 per square yard for bermudagrass, \$1.93 for zoysiagrass, and \$1.86 for centipedegrass, table 5.

Sales Volume

Farm level sales of approximately \$47 million were generated from 11,402 acres in 1988. This compares with about \$7 million in sales from 1,810 acres for 1983 (1) and \$4 million in sales from 1,097 acres in 1978 (2). As reported by responding producers in 1988, the leading turfgrass-sod species was bermudagrass which accounted for 52 percent of total sales, down from 64 percent in 1978. Centipedegrass accounted for 24 percent, while zoysiagrass and St. Augustinegrass accounted for 19 and 5 percent of total sales, respectively, table 6. In terms of acreage sold, centipedegrass remained constant at 13 percent, while bermudagrass and zoysiagrass declined by 9 percent and 4 percent, respectively.

Producers also reported their estimated percentages of harvest/sales for each month, figure 2. The spring months of April, May, and June were the months of greatest volume, with peak sales in June. Sales in late fall and winter increased from levels noted for 1983. Expanded production in central and southern counties has improved the ability of producers to supply the market year-round.

TABLE 6. ESTIMATED FARM INCOME BY SPECIES OF TURFGRASS SOLD, ALABAMA, 1978 AND 1988

Turfgrass species	Acres sold		Gross farm revenue		Average revenue per acre ³		Percent of total revenue ⁴	
	1978	1988 ¹	1978	1988 ²	1978	1988	1978	1988
	<i>Acres</i>	<i>Acres</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Pct.</i>	<i>Pct.</i>
Bermudagrass	680.0	2,319	2,216,800	8,348,400	3,260	3,600	64	52
Centipedegrass	123.1	790	551,488	3,792,000	4,560	4,800	16	24
St. Augustinegrass	—	131	—	733,600	—	5,600	—	19
Zoysiagrass	147.9	428	715,836	3,081,600	4,840	7,200	20	5
Subtotal of participating growers	951.0	3,668	3,484,124	15,955,600	3,664	4,350	100	100
Subtotal of nonparticipating growers	146.0	7,734	524,360	31,447,600	3,660	4,066		
Total ⁵	1,097.0	11,402	4,018,484	47,403,200	3,663	4,157		

¹Winter stock of 33 percent total acreage. Average crops per year: 1.25 for bermudagrass, 0.55 for centipedegrass, 0.5 for St. Augustinegrass, and 0.6 for zoysiagrass.

²Reported average wholesale prices for 1988 were \$0.90 per square yard for bermudagrass, \$1.20 per square yard for centipedegrass, \$1.40 per square yard for St. Augustinegrass, and \$1.80 per square yard for zoysiagrass.

³All yields were given as 4,000 square yards per acre harvested.

⁴Percentages calculated for total revenue of identified acreage.

⁵Estimated from statewide production reported by the Alabama Cooperative Extension Service, assuming sales comparable to producers responding to the industry survey, approximately 66 percent of total production.

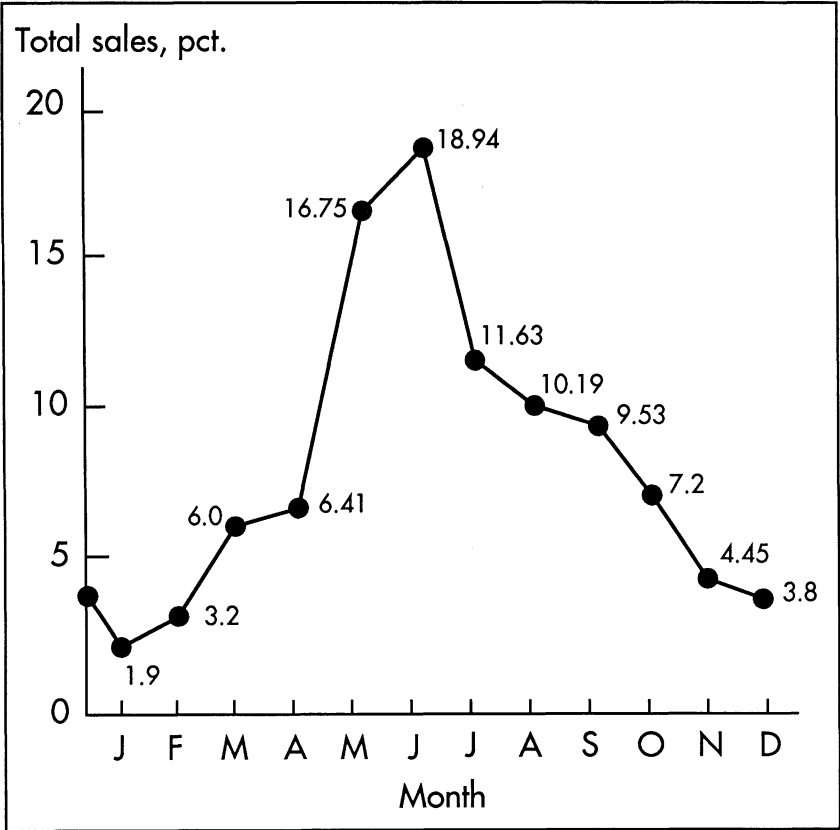


FIG. 2. Sales volume of commercial turfgrass by month, Alabama, 1988.

Market Share

Large farms (greater than 300 acres) dominate the Alabama sod market. As demonstrated in table 7, there were four participating firms in the large-farm category with a combined total of 3,975 acres in sod production. Participating large operations accounted for 78 percent of reported production acreage and 72 percent of square yard sales, table 8. Medium-sized farms held 14 percent of the acreage and 19 percent of production while small farms had 8 percent of the acreage and 9 percent of the total reported square yards.

TABLE 7. IDENTIFIED ACREAGE OF CULTIVATED TURFGRASS FOR ALL GROWERS,
BY SIZE OF FARM, ALABAMA, 1978 AND 1988

Farm size ¹	Numbers of growers		Acres of cultivated sod		Average acres of sod per farm		Percent of total cultivated sod		Percent change in cultivated acreage	
	1978	1988	1978	1988	1978	1988	1978	1988	1978	1988
	<i>No.</i>	<i>No.</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	
Less than 100 acres	9	9	310	382	34.4	45.0	12	8	23	
100 - 200 (300) acres	3	4	540	725	180.0	189.0	22	14	34	
More than 250 (300) acres	3	4	1,639	3,975	546.3	1,050.0	66	78	143	
Total participating growers	15	17	2,489	5,082	165.9	—	100	100	104	
Less than 100 acres	—	40	—	1,194	—	29.8	—	12	—	
100 - 300 acres	—	18	—	3,097	—	172.0	—	31	—	
More than 300 acres	—	4	—	5,689	—	1,422.3	—	57	—	
Total nonparticipating growers ²	—	62	—	9,989	—	160.9	—	100	—	

¹Values in parentheses represent sizes used in the 1988 survey if different from 1978.

²There were no nonparticipating growers in 1978 survey.

TABLE 8. MARKET SHARE OF TURFGRASS SALES AND GROSS REVENUE, BY FARM SIZE, PARTICIPATING GROWERS, ALABAMA, 1978 AND 1988

Farm size and turfgrass species	Total sales		Market share		Revenue share	
	1978	1988	1978	1988	1978	1988
	<i>Sq. yd.</i>	<i>Sq. yd.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>
> 250 (1978) and 300 (1988) acres						
Bermudagrass	2,175,000	6,585,960	85	71	54	27
Zoysiagrass	400,000	907,360	68	53	14	15
Centipedegrass	100,000	2,686,000	20	85	4	30
Subtotal	2,675,000	10,179,320	74	72	72	72
100 - 250 and 300 acres						
Bermudagrass	140,000	1,947,960	5	21	3	8
Zoysiagrass	125,000	667,680	21	39	4	10
Centipedegrass	342,000	94,800	68	3	9	1
Subtotal	607,000	2,710,440	17	19	17	19
Less than 100 acres						
Bermudagrass	231,000	742,080	9	8	7	3
Zoysiagrass	66,750	136,960	11	8	3	3
Centipedegrass	55,250	379,200	11	12	2	3
Subtotal	353,000	1,258,240	10	9	11	9
Total	3,635,000	14,148,000	100	100	100	100

Certified Sod

Producers were asked to indicate their preference for a voluntary certification system of enforced grades similar to that utilized by the egg industry. Ten producers (4 in the large category, 4 in the medium category, and 2 in the small-sized category) favored the formation of a certification program. Five small firms opposed certification. Thirteen growers (4, 5, and 4 for large-, medium-, and small-sized firms, respectively) stated they would be willing participants in a voluntary certification program. Four firms, all small-sized operations, stated they would not.

ANALYSIS OF INVESTMENT, COSTS, AND RETURNS FOR SURVEYED FARMS Capital Investment

Capital investment represents nonhuman durable input components of production, such as land, equipment, machinery, and buildings. Each producer was asked to list all equipment, land, and machinery utilized for production, maintenance, harvesting, and distribution of turfgrass-sod. Building costs were estimated for each of the three farm size categories at 5 percent of total machinery capital investment. Required equipment and machinery were listed and described by size and/or horsepower. Estimates for machinery and equipment investment were based on list prices. Machinery and equipment complements for sod farms of less than 100 acres, 100 to 300 acres, and greater than 300 acres were developed from producer information. These machinery complements and the corresponding average new purchase prices are found in the Appendix, tables 1-3, for small-, medium-, and large-sized farms, respectively.

Producers utilized various methods of depreciation and, in general, purchased used equipment or extended the use of equipment and machinery beyond the estimated useful life at the expense of higher repair costs. It was assumed that producers fully depreciated new equipment and machinery over an 8-year period and that salvage value was 20 percent of new purchase price. Producers were asked to estimate the market value of their productive sod acreage. The average value of land in sod production was estimated by surveyed producers to be \$1,293 per acre.

Producer survey responses were utilized to develop capital investment requirements for small, medium, and large farm sizes, table 9. In 1988, total capital investment for participating growers was \$19,120,740. By farm size, small producers represented 13.5 percent of total capital investment, while medium- and large-sized farms accounted for 18 and 68 percent, respectively. Land and production equipment were dominant capital items, requiring 20 to 28 percent each of the total across the three farm size groupings. Delivery (trucking) and irrigation equipment became relatively more important as farm size increased.

TABLE 9. TOTAL CAPITAL INVESTMENT FOR LAND, BUILDINGS, AND EQUIPMENT
BY ALTERNATIVE TURFGRASS-SOD FARM SIZES, SURVEYED
GROWERS, ALABAMA, 1988

Item	Investment by farm size						All growers	
	<100 acres		100-300 acres		>300 acres		Dol.	Pct.
	Dol.	Pct.	Dol.	Pct.	Dol.	Pct.		
Land	675,135	26	798,000	23	3,639,972	28	5,113,107	27
Buildings	91,035	4	129,756	4	446,232	3	667,023	3
Equipment								
Harvesting	375,993	15	438,224	12	1,007,868	8	1,822,085	9
Maintenance and establishment	683,811	26	816,488	23	2,621,296	20	4,121,595	21
Irrigation	270,000	10	444,000	13	2,080,000	16	2,974,000	16
Trucking	490,986	10	896,432	25	3,215,512	25	4,602,930	24
Total capital investment	2,586,960		3,522,900		13,010,880		19,120,740	
Percent of total	13.5		18.4		68.1		100.0	

Average capital investment per acre was estimated to be \$6,387, \$4,635, and \$3,098 for small, medium, and large category firms, respectively, table 10. The per acre capital investment differences estimated for each farm size were primarily due to marketing and distribution aspects of firms in a highly competitive market. Large firms invested heavily in the ability to satisfy market demand at all times and to deliver sod on demand, with support services including portable forklifts for point of sale, on-site distribution. Medium-sized firms generally offered these same services to compete in a central market, such as Atlanta, but could reduce such investments if they served a large local market. Small farms generally did not rent land, and capital investment reflected this preference for land ownership. Small farms, however, had less total investment in equipment and machinery, especially for harvesting and distribution.

TABLE 10. AVERAGE PER ACRE CAPITAL INVESTMENT IN LAND, BUILDINGS, AND EQUIPMENT, BY ALTERNATIVE TURFGRASS-SOD FARM SIZES, SURVEYED GROWERS, ALABAMA, 1988

Item	Investment by farm size			All growers
	<100 acres	100-300 acres	>300 acres	
	<i>Dol. per acre</i>	<i>Dol. per acre</i>	<i>Dol. per acre</i>	<i>Dol. per acre</i>
Land	1,667	1,050	867	1,006
Buildings	225	171	106	131
Equipment ¹				
Harvesting	928	577	240	359
Maintenance and establishment	1,688	1,074	624	811
Irrigation	667	584	495	585
Trucking	1,212	1,179	766	906
Average total investment per acre	6,387	4,635	3,098	3,762

¹Estimated for all farms as new purchases.

Fixed Costs

Fixed costs are those costs or expenses required to maintain farm capital ownership and employed resources regardless of productive output. These costs may be recorded as cash or noncash expenses, but must be accounted for in cost estimates. Accounting, by whatever method chosen, records

all transactions, cash expenses, and receipts, as well as the noncash expense of depreciation. Total accounting receipts less total accounting costs is total accounting profit.

Implicit costs or opportunity costs should also be recognized in order to evaluate economic profit. Opportunity costs should include charges for operator labor, operator management, and equity capital, including all productive resources owned and utilized in sod production. In table 11, these costs are recorded as operator labor/management, interest on fixed capital, and land charges.

TABLE 11. ANNUAL TOTAL COSTS OF PRODUCTION PER ACRE OF MAINTAINED TURFGRASS, BY FARM SIZE, ALABAMA, 1988

Item	Per acre costs, by farm size			All growers Dol.
	<100 acres Dol.	100-300 acres Dol.	>300 acres Dol.	
Variable costs				
Herbicides ¹	19.99	33.26	16.66	18.39
Insecticides ¹	5.54	10.61	25.47	18.70
Fertilizer and lime ¹	53.32	102.16	66.98	94.57
Fuel and lubrication ²	99.81	86.18	45.07	63.55
Repairs	132.73	131.91	113.33	122.05
Hired labor	765.55	460.85	275.87	344.25
Other variable costs ³	52.91	96.71	65.65	69.66
Int. on var. capital @ 10%	56.49	46.08	30.45	36.56
Subtotal	1,186.34	967.76	639.48	767.73
Fixed costs				
Land rent ⁴	17.50	79.36	47.50	48.12
Insurance	132.77	59.79	30.12	32.61
Taxes	21.11	98.30	42.00	64.37
Depreciation	472.05	358.54	223.12	309.85
Int. on fixed capital @ 12%	439.90	321.15	212.64	300.67
Operator labor management	431.11	102.10	18.47	65.54
Miscellaneous ⁵	1.48	13.15	32.38	20.18
Subtotal	1,515.92	1,032.39	606.23	841.34
Total costs	2,702.26	2,000.15	1,245.71	1,609.07

¹Includes custom applied services.

²All fuel (gasoline, diesel fuel, butane, etc.).

³Includes pallets, loading, etc.

⁴Prorated charge based on lease agreements reported by sod growers.

⁵Includes legal fees, etc.

Operator labor/management costs are a measure of foregone wages that could have been received had this resource been employed in its next best alternative. In this case, each producer was asked to report the annual hours spent in turfgrass-sod production by supervisory personnel and their annual wage. The average annual wage for supervisors was \$19,400, not including FICA, social security, insurance, or bonuses. The charge for capital was figured as the annual interest charge on the average capital investment for each farm size category. Once capital is invested in the sod business, it is fixed and is unavailable for other alternatives. Interest is either paid as a cash expense or foregone as income which is a noncash expense. Either way, it exists and was included as a charge determined by the average annual capital investment times the average annual interest rate. For this purpose, the interest rate utilized was the average Federal Land Bank interest rate for new loans during 1988, approximately 12 percent. The average value of capital assets was computed by dividing the summation of annual beginning and ending values of assets by two.

The land charge was established as the average rent paid by Alabama sod farmers. For 1988, that rate, as an average of rents paid by producers responding to this survey, was \$48.12 per acre.

Remaining fixed costs are explicit costs, primarily cash expenses, but also include depreciation. In table 11, depreciation per acre was estimated for each farm size category using the straight line method over a useful life of 8 years with an assumed salvage value of 20 percent.

Insurance is an important component of fixed costs. Insurance for sod farms was utilized to manage risk associated with production and distribution of sod. The expense reported here is for market value replacement protection as well as personal liability coverage. Producers reported an average annual expenditure of \$9,652 on insurance in 1988. Generally, annual insurance costs were estimated to be 0.5 percent of machinery purchase price and, as an average based on estimates of Alabama Insurance Companies, \$27.31 per every \$100,000 of liability coverage.

Variable Costs

Otherwise known as direct or production costs, variable costs are incurred when resources are allocated for the maintenance, production, or distribution of the sod product. Variable costs include pesticides, fertilizers, fuels and lubricants, repairs, hired labor, miscellaneous, and interest on operating capital. Large producers are estimated to spend \$640 per acre in variable expenses, table 11. This is 51 percent less than for medium-sized operations and 85 percent less than for small operations. Small firms utilized labor as a substitute for capital, with such allocation being primarily for harvesting.

Total Costs

In comparison with total costs estimated in the 1981 publication on commercial turfgrass-sod production in Alabama (2), per acre total costs for the largest farms have risen approximately 32 percent while per acre total costs for small- and medium-sized farms have tripled. Large firms have managed to hold down the increase in per acre total costs by expansion of farm size and more efficient use of the land resource. In 1978, the average per farm acreage in the small firm category was 35 acres. Medium-sized and large firms were reported as having 180 and 550 acres, respectively. Estimated average acreages by farm size category in the 1988 survey were 45 acres for small farms, 190 acres for medium-sized farms, and 1,050 for large farms. Average total costs per acre were estimated to be \$2,702, \$2,000, and \$1,246 for small-, medium-, and large-sized farms, respectively, table 11.

Labor Requirements

Farms of less than 100-acre size utilized an average 3,958 hours of combined labor per farm. Average number of labor hours required to operate a medium-sized farm was 14,614 hours. Large farms, on average, utilized 52,386 hours of combined labor for annual operation. On a labor-hours per acre basis, small firms required 88 hours, medium-sized firms required 77 hours, and large firms required 50 hours. In all, those producers responding to the survey reported employing

74 part-time or seasonal employees, 91 full-time labor personnel, 30 foremen or supervisory employees, 17 full- or part-time secretarial personnel, 9 sales persons, 10 full-time mechanics, and 34 family members during 1988. On average, part-time laborers were paid \$4.27 per hour for all firm sizes. Full-time wage rates, on average, were reported at \$5.66 per hour for all firm sizes. Other stated average wages included mechanics at \$7.80 per hour, foremen at \$9.66 per hour, secretarial personnel at \$6.45 per hour, and family labor at \$4.50 per hour. In table 12, total labor expenses are dollar values as reported. These expenses represent only actual dollars paid and do not include such items as FICA, social security, and bonuses. For 1988, large operations averaged spending \$289,667 (\$276 per acre) for all labor per farm. Medium-sized operations spent an average \$87,562 (\$461 per acre) per farm and small operations spent an average \$34,450 (\$766 per acre) for all labor per farm.

TABLE 12. AVERAGE ANNUAL LABOR REQUIREMENTS AND LABOR EXPENSE, BY ALTERNATIVE TURFGRASS-SOD FARM SIZES, ALABAMA, 1988

Item	Unit	Requirements, by farm size			All farms
		<100 acres	100-300 acres	>300 acres	
Part-time employees	No.	3.25	2.17	9.00	4.42
Hours/year employee	Hr.	600	1275	968	947
Part-time wage/hour	Dol.	3.89	4.48	4.45	4.27
Full-time employees	No.	1.00	4.30	17.75	7.0
Full-time wage/hour	Dol.	4.50	6.92	5.00	5.66
Supervisory employees ¹ ...	No.	—	1.60	4.00	2.73
Average total labor expense	Dol.	34,450	87,562	289,667	123,368
Total labor expense	Dol.	137,800	350,250	869,000	1,357,250
Percent of total labor expense	Pct.	10.15	25.81	64.03	100.00
Average total labor expense/acre	Dol.	765.55	460.85	275.87	416.78

¹The owner/operator is not included.

Estimated Returns

Annual gross returns were estimated on a per acre basis for all three farm size categories using average wholesale prices for each species of turfgrass-sod sold in 1988, table 13. Sod prices by species were \$0.90 per square yard for bermudagrass, \$1.13 per square yard for centipedegrass, \$1.30 per square yard for St. Augustinegrass, and \$1.80 per square yard for zoysiagrass. Producers were assumed, on average, to harvest and market two-thirds of reported annual sod production. The average reported annual yield per acre was 4,000 square yards for all species. (The fact that these returns are averages and that there were important differences in the range of values reported for prices, waste, and yield by farm size should be noted.)

TABLE 13. ESTIMATED AVERAGE ANNUAL RETURNS PER ACRE TO MANAGEMENT, FOR ALTERNATIVE TURFGRASS FARM SIZES, ALABAMA, 1988

Item	Returns/acre, by farm size ¹			
	<100 acres	100-300 acres	>300 acres	All growers
	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>
Gross receipts ²	3,198.11	3,198.11	3,198.11	3,198.11
Variable costs	1,186.34	967.76	639.48	767.73
Income above variable costs	2,011.77	2,230.35	2,558.63	2,430.38
Fixed costs	1,515.92	1,032.39	606.23	841.34
Return to management	495.85	1,197.96	1,952.40	1,589.04

¹Average farm sizes were: 45 acres, 190 acres, and 1,050 acres for small, medium, and large farms, respectively.

²Gross receipts at the farm level do not include delivery charges.

Gross receipts per acre for all farm size categories were estimated to be \$3,198. This estimate represented the average of gross receipts reported by producers responding to the 1988 industry survey. The estimated actual per acre yield over all sod acres was considered to be 2,640 square yards. Actual total production per acre was 4,840 square yards. Production losses, harvest inefficiencies, and turfgrass stock required for sod reestablishment reduced the actual production of marketable turfgrass-sod to an average of 4,000 square yards per acre. Producers reported they normally maintained one-third of their marketable sod supply as inventory, thus

two-thirds of all marketable sod was sold annually, which was effectively 2,640 square yards per acre. Returns to management were \$496, \$1,198, and \$1,952 for small-, medium-, and large-sized farm categories, respectively, table 13.

CAPITAL REQUIREMENTS, COSTS, AND RETURNS FOR SOD AS AN ALTERNATIVE ENTERPRISE

Because of recent interest in sod production as an alternative enterprise to improve overall farm profitability, data from the study were used to develop costs and returns for a hypothetical farm situation.

Production Assumptions

In the example, an owner/operator of a 300-acre field-crop operation has decided to take 50 acres out of soybean/wheat production and use it for turfgrass-sod production. Several simplifying assumptions, each of which could have a significant impact in an actual farm situation, are presented as follows: financing is available for capital and operating expenses, the farmer could supply turf production skills, there is a local market for sod, existing farm equipment including an irrigation system is utilized, and sod production does not affect the remaining farm operations. Additional assumptions are that prices for sod are stable, weather conditions are suitable for sod production, and all production occurs according to schedule. All additional resources are obtainable and costs and prices are held at 1989 levels.

Hypothetical Turfgrass-Sod Production

The farmer was assumed to have decided to produce 50 total acres of sod, with 30 acres being allocated to hybrid bermudagrass (Tifway) and 10 acres each being allocated to common centipedegrass and Meyer zoysiagrass. Initial establishment was accomplished by contracting for custom planting. Bermudagrass establishment was by custom sprigging, while zoysiagrass was custom plug-planted and centipedegrass was custom seeded. Establishment was in well-prepared soil that was limed, graded, and free of rocks. Soil

preparation was done by the farmer. Additional equipment required included a 5-foot scraper blade and a 10-foot roller cultipacker, Appendix table 4. Prior to planting, the field was fumigated by custom application at \$900 per acre. Fixed costs of establishment per acre were amortized over the 7-year production period. Additional machinery was also required for production following initial establishment, Appendix table 4. This included a 5-gang reel mower, a 5-foot sweeper/vacuum, and a 6-foot flail mower, all purchased new.

Since the farmer intends to produce and market three different species of turfgrass that have varying growth and maturity rates, it is not anticipated that more than 25 acres of sod will be harvested in either of the first 2 years of production. The farmer will need to purchase only a manually operated sod harvester. This is purchased new and is listed in Appendix table 4. The farmer intends to sell for field pick up and to deliver locally within a 75-mile radius of the farm. For this purpose, a field forklift, a portable forklift, and a dual rear axle, 2.5-ton flatbed truck are needed. The farmer can utilize an existing farm front-end loader as a field forklift but will purchase the delivery truck and portable lift as new equipment, Appendix table 4.

The farmer intends to harvest by the ribbon-cut method for all species. Turf is expected to reestablish from these ribbons with cultural practices scheduled as previously outlined.

Variable Costs

Stated costs per acre were based on 50 acres of total production and represented composite average annual costs over a 3-year period, including establishment and reestablishment, table 14. Expenses included initial establishment, harvest, and reestablishment of 30 acres of hybrid bermudagrass, 10 acres of zoysiagrass, and 10 acres of centipedegrass. Equipment expenses were for the entire machinery and equipment complement required to operate a sod farm of 100 acres or less, Appendix table 4. All variable expenses for each year were made from gross receipts to the sod operation, short-term financing, or personal funds. Interest on operating capital was charged at 10 percent for total variable costs as

stated (1989 Production Credit Association estimate) and was figured for half-year borrowing.

TABLE 14. TOTAL ANNUAL COSTS OF PRODUCTION PER ACRE OF MAINTAINED TURFGRASS AS AN ALTERNATIVE ENTERPRISE ON AN EXISTING FARM WITH 50 ACRES OF TURFGRASS-SOD, CENTRAL ALABAMA, 1989

Item	Dollars per acre
Variable costs	
Herbicides	22.15
Insecticides and fungicides	11.38
Fertilizer and lime	115.29
Fuel and lubrication	81.66
Repairs	108.60
Hired labor	626.36
Irrigation	35.00
Other variable costs	43.29
Interest on variable capital @ 10 percent	52.19
Subtotal	1,095.92
Fixed costs	
Land rent	133.90
Insurance	55.70
Taxes	18.00
Depreciation (new equipment only)	164.60
Machinery charge ¹	262.83
Land preparation and planting charge (prorated) ²	249.96
Miscellaneous	2.00
Interest on fixed capital @ 12 percent	522.53
Subtotal	1,409.52
Total costs	2,505.44

¹Machinery charge represented annual depreciation on equipment owned prior to the turfgrass-sod enterprise but used in the production of sod.

²All custom planting and fumigation costs were spread over the 7-year period.

Fixed Costs

Fixed costs for this operation were derived from table 11 for the small-size category farms of less than 100 acres. Insurance and depreciation were taken for the complete machinery and equipment complement required to operate this size farm. Interest on fixed capital was charged at 12 percent for total fixed costs as stated (1989 Federal Land Bank average).

Estimated Returns

Gross receipts in table 15 were a composite average for the 7-year production period for all species produced with prices stable. Prices for each species were assumed to be \$1.00 per square yard for bermudagrass, \$1.25 per square yard for centipedegrass, and \$1.75 per square yard for zoysiagrass. Yields for all species were assumed to be 4,000 square yards per harvested acre and sales in any year were not to exceed 66 percent of total marketable production for each species considered. Total acres harvested in the seventh-year production period were estimated to be 20 acres of bermudagrass, 7 acres of zoysiagrass, and 7 acres of centipedegrass. The farmer anticipated sales of 10 acres of bermudagrass in year one. Zoysiagrass and centipedegrass were not expected to mature for harvest until year three. Return to management can be evaluated as return to an established sod farm because this estimate is an annual estimate for the 7-year period.

TABLE 15. ESTIMATED RETURNS PER ACRE TO CAPITAL AND MANAGEMENT
FOR 50-ACRE ALTERNATIVE TURFGRASS ENTERPRISE,
ALABAMA, 1989

Item	Dollars per acre
Gross receipts	3,280.00
Variable costs	
Herbicides	22.15
Insecticides and fungicides	11.38
Fertilizer and lime	115.29
Fuel and lubrication	81.66
Repairs	108.60
Hired labor	626.36
Irrigation	35.00
Other variable costs	43.29
Interest of variable capital @ 10 percent	52.19
Subtotal	1,095.92
Income above variable costs	2,184.08
Fixed costs	
Land rent	133.90
Ownership costs (tax, interest, depreciation, insurance, misc.)	1,275.62
Subtotal	1,409.52
Return to management	774.56

TABLE 16. ESTIMATED ANNUAL CASH FLOW PROJECTIONS FOR A HYPOTHETICAL 50-ACRE TURFGRASS
ENTERPRISE, ALABAMA, 7-YEAR PERIOD

Item	Cash flow projection, by year						
	1	2	3	4	5	6	7
	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>	<i>Dol.</i>
Receipts							
Bermudagrass	40,000	80,000	80,000	80,000	80,000	80,000	80,000
Zoysiagrass	0	0	49,000	49,000	49,000	49,000	49,000
Centipedegrass	0	0	35,000	35,000	35,000	35,000	35,000
Total	40,000	80,000	164,000	164,000	164,000	164,000	164,000
Expenses							
Cash operating expenses	54,000	54,000	54,000	54,000	54,000	54,000	54,000
Annual payment:							
principal and							
interest, fixed							
and variable	69,870	157,933	208,400	173,190	136,219	97,400	69,870
Cumulative cash							
inflow/outflow	-83,870	-131,933	-98,400	-63,190	-26,219	12,600	52,730
Yearly cash needs:							
borrowing	83,870	131,933	98,400	63,190	26,219	0	0

Annual Cash Flow Summary

An annual summary of estimated cash receipts and expenses is presented in table 16. Debt repayment was an annual payment which included total principal and interest on operating capital and interest and principal repayment for all machinery required to operate the sod farm. All equipment was assumed to be financed at 12 percent simple interest for 7 years with no down payment. Table 16 also presents a cumulative cash excess or shortage for each year. Where cash shortages occurred, annual borrowing was permitted and repayment was made when surplus monies became available or from additional borrowing.

As demonstrated in table 16, the farmer cannot expect any cumulative cash excess until year six. All subsequent years were expected to generate an adequate cash balance to provide for reinvestment or production expansion. Again, these estimates are based on assumptions that serve well for simplifying the economic analysis but should be closely examined for particular farm situations.

Partial Budget Analysis

In the hypothetical example, the farmer decided by personal preference to take 50 acres of soybeans double cropped with wheat out of production and place these resources in sod production. Having reviewed expected annual costs and returns, a comparison was made by partial budget analysis of the foregone soybean/wheat enterprise with that of the proposed turfgrass production. Expected additional returns from the proposed enterprise and the reduced costs of the foregone enterprise are combined for total added income. Expected added costs associated with the new enterprise are combined with the estimated reduced returns of the foregone enterprise to establish total reduced income. The completed partial budget analysis is presented as follows: (1) added income for annual sod production was \$145,984, which included reduced costs of foregone soybean/wheat production, (2) reduced income for annual soybean/wheat production foregone was \$132,624, which included added costs of sod production for that period, and (3) estimated change in annual net farm income was \$13,359. Thus, the shift of resources to sod production contributed positively to net farm income.

Additional Comments

Market availability and strategies are critical factors affecting farming success. The number of turfgrass-sod farms in Alabama has increased from 26 in 1978 to 79 in 1988. Average farm size has increased from 110 to 191 acres. Average total costs per acre in 1978 were estimated to be \$901 and estimated gross returns were \$1,317. In 1988, the per acre estimated total costs were \$1,609 and gross returns were \$3,198. The ability to effectively market products and services as a new firm entrant into the sod market is much more critical than in previous years. Producers reported "price wars" as an annual occurrence and considered any significant delay in production schedules as a serious threat to expected profits.

Prospective producers should carefully consider the assumptions as earlier stated and must consider the available market when deciding what turfgrass to produce and what level of operation to develop and sustain. The choice to produce sod is a long-term investment decision and returns must be expected to reflect the risks associated with long-term production. Sod prices and sales are subject to variation due to changing economic conditions, such as interest rates and housing starts. Producers should evaluate the long-run economic outlook for the general economy when making production decisions in the sod industry.

Table 16 presents the cash flow analysis for the farm for years one through seven. As developed, the farm showed a positive cash flow with excess cumulative cash in year six. Annual borrowing was assumed possible in all years and was repaid in the following year. The annual rate of return to average invested capital for the 7-year period was estimated to be 3.2 percent.

Prospective growers should consider alternatives to the farm as modeled. Purchasing used equipment and renting land would greatly reduce the capital investment required. Additional consideration should be given to producing less centipede grass or zoysiagrass in the first 5 years to improve the cash flow. Contracting for custom services could also reduce the capital investment and labor expense. Producers may also find it to their advantage to consider contract growing for other sod farms.

Prospective producers should also consider that sod prices have failed to keep pace with inflation, although costs have. In 1978, bermudagrass sold at \$0.82 per square yard, centipedegrass sold for \$1.12 per square yard, and zoysiagrass sold for \$1.21 per square yard wholesale market average. In 1988, these average market prices were reported as \$0.90 per square yard for bermudagrass sod, \$1.13 per square yard for centipedegrass, and \$1.80 per square yard for zoysiagrass. If the 1978 estimate of \$901 per acre costs were evaluated in 1988 dollars, the present value based on 7 percent inflation alone would be \$1,775 per acre. This is comparable to the estimated 1988 costs of production as determined from the analysis (\$1,609). Converting 1978 prices to 1988 dollars, prices would be \$1.65, \$2.25, and \$2.43 per square yard for bermudagrass, centipedegrass, and zoysiagrass, respectively. Such expectations for market adjustments did not materialize.

SUMMARY AND CONCLUSIONS

The turfgrass industry in Alabama has experienced extensive growth in the past 10 years. Total sod production increased 425 percent from 1978 to 1988; acreage in sod production increased from 2,871 total acres in 1978 to 15,062 total acres in 1988. Average farm size increased (100 acres in 1978 to 191 acres in 1988), as did the number of producers (26 in 1978 to 79 in 1988). As of 1988, there were 79 producers located in 42 counties in Alabama. Approximately 11,402 acres of sod valued at \$47,403,200 (farm level) were sold in 1988. Producers reported harvesting 76 percent of annual farm production, with harvest by two general methods, ribbon-cut or clean-cut. The method selected was dependent on turfgrass species, intensity of cultural practices, and time of year.

Producers who commonly employed more intensive cultural practices and were located in the southern two-thirds of Alabama frequently utilized the clean-cut harvest method in which reestablishment of the turfgrass was from rhizomes remaining in the soil. Producers in the northern one-third of the State preferred to harvest by the more traditional method of ribbon-cutting, with reestablishment of the turfgrass from complete and intact vegetative strips of turf remaining in the soil after harvest. Per acre yields by the ribbon method were

estimated to be 4,000 square yards, while per acre yields for the clean-cut method were reported to be 4,300 square yards on average. Producers in the northern third of the State reported that approximately 14 months were required to produce a marketable bermudagrass sod, 22 months were required for centipedegrass, and as much as 30 months were needed for zoysiagrass. These producers also reported that their latest safe harvest month for all turfgrass species was September. Producers in extreme southern portions of the State reported that they expected to harvest all year and mid-state growers considered October to be the latest safe harvest month. Southern firms reported a requirement of approximately 5 months to produce a marketable bermudagrass sod and 10 to 14 months to produce marketable centipedegrass and zoysiagrass, respectively.

Building contractors have become a significant factor in the turfgrass market. Producers reported that building contractors and landscapers represented 51 percent of the primary sales market. Other market outlets included: garden centers (accounted for 13 percent), home owners (20 percent), golf courses (2 percent), and government agencies (1 percent). A total of 14.6 million square yards of sod was reported sold in 1988 by producers responding to the survey. Of these total sales, 59 percent was sold in out-of-state markets, with Georgia being the primary market state. Other out-of-state market areas were Florida, Mississippi, and Tennessee. Major in-state market areas were Birmingham, Huntsville, and Montgomery.

Pricing policies varied by farm size and nearness to market. Large farms were primarily wholesale operations, with prices being set by market discovery processes in such central market areas as Atlanta. Mid-sized firms followed prices set by larger firms, but also were in the retail market. Small-sized firms reported they were primarily in retail sales in local markets only. Average total capital investment per firm responding to the 1988 survey for land, machinery, and buildings was estimated to be \$1,124,749.

Machinery investment accounted for 70 percent; land, 27 percent; and buildings, 3 percent of total capital investment. Per acre investment for firms was estimated to be \$6,387 for small firms, \$4,635 for medium-sized firms, and \$3,098 for large-sized firms.

Average per acre total costs of production for all firms were \$1,609. By firm size, average total costs of production were \$2,702, \$2,000, and \$1,246 per acre for small, medium, and large firms, respectively. For these firm sizes, variable costs constituted 43, 47, and 50 percent of total costs, respectively.

Returns to management were estimated for each farm size. For farms of 100 acres or less, return to management was estimated to be \$496 per acre. Firms of medium size (100 to 300 acres production) were estimated to have \$1,198 per acre net returns and firms in the large category (greater than 300 acres) were estimated to generate \$1,952 per acre net returns.

A hypothetical model 50-acre sod production operated as an alternate enterprise on an existing farm was estimated, given simplifying assumptions, to require an additional \$82,299 of capital investment. Partial budget analysis demonstrated that \$134,286 in average annual returns were generated by turf production and that \$14,048 in total returns were foregone. Additional costs for the production of turf were estimated to be \$118,577 and reduced costs associated with soybean/wheat production foregone totaled \$11,698. The net change for enterprise substitution was \$13,359. The annual rate of return on investment for turf was estimated to be 3.23 percent.

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

1. Total sod acreage and number of producers is expected to grow less rapidly the next 10 years, though medium and large firms will expand. An economic downturn would be expected to cause an exit from the market of marginal firms, mergers of smaller firms with larger firms, and a reduction in output by firms in general.

2. Given that there exists a saturated market for bermudagrass and that there has been an increase in consumer demand for other species, acreage in zoysiagrass, tall fescue, and improved centipedegrass is expected to increase. Well established, larger firms will lead the market in increases in production of these species.

3. Vertical integration in the turfgrass market is expected to increase. Large producers will utilize wholesale/retail outlets in major market centers and small- to medium-sized firms will continue to expand contract production and sod-laying opportunities.

4. Price wars and service competition are expected to continue and become more intense. The maintenance of market share for operations with no vertical integration will become even more critical to firm survival. A voluntary certification program will be established, most likely based on quality grades.

5. It is estimated that the most efficient size turfgrass operation was 1,050 acres for 1988. Average farm size is expected to increase gradually over the next 10 years, but the magnitude of the increase will be highly dependent on new housing starts and general economic growth.

6. A greater data base for the turfgrass industry would facilitate application of advanced econometric models in future industry analysis. This survey is only the second such analysis undertaken, and there does not exist sufficient data to make statistical forecasts for the industry. Yearly surveys concerning marketing data would benefit present and future sod producers.

7. As sod supply and price competition continue to grow, producers will become more efficient in all aspects of turfgrass-sod production and marketing. Producers will more closely evaluate the marginal relationship of input costs and output value. Continued improvements in technology, efficiency, and marketing skills will lead to lower unit production costs. This will further stimulate farm expansion, but will also contribute to an intensified cost/price squeeze.

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APPENDIX — MACHINERY COMPLEMENTS FOR ALTERNATIVE SIZES OF TURFGRASS-SOD FARMS

APPENDIX TABLE 1. ESTIMATED MINIMUM MACHINERY COMPLEMENT FOR TURFGRASS FARMS OF LESS THAN 100 ACRES, ALABAMA, 1989

Item	Description	Price
		<i>Dollars</i>
Tractor	60 HP	18,072
Trucks (1).....	3/4-ton pickup	13,900
(1).....	20-foot, 2.5-ton dual rear	25,500
Forklifts (1)	Delivery w/truck mount	29,054
(1)	Front end loader w/forks	28,011
Harvesters (1)	16-inch hand operated w/sulky	6,500
(1)	16- or 18-inch tractor mounted	35,277
Reel mowers	5-gang	11,050
Rotary mower	6-foot	2,087
Flail mower	6-foot	2,795
Sweeper	5-foot	5,500
Spin spreader	1,000-lb. capacity	3,000
Boom sprayer	250-gal. w/28-ft. boom	3,500
Irrigation	Cable tow 660 feet w/pump and supply pipe	46,000
Field cultivator	9 shank	475
Disk	8-foot	6,500
Cultipacker	10-foot	1,400
Scraper blade	5-foot	500
Blower	Tractor mounted	2,800
Roller	5-foot	1,000
Chisel plow	9-shank	1,900
Moldboard plow	2-bottom, 16-inch	1,500
Buildings	Shop, office, storage, etc.	12,316
Total machinery and equipment investment		258,637

APPENDIX TABLE 2. ESTIMATED MINIMUM MACHINERY COMPLEMENT FOR TURFGRASS FARMS OF 100-300 ACRES, ALABAMA, 1989

Item	Description	Price
		<i>Dollars</i>
Tractors (2)	40 HP	15,701
(2)	60 HP	18,072
Trucks (2)	3/4-ton pickup	13,900
(1)	1.5-ton utility	17,900
(2)	20-foot, 2.5-ton dual rear	25,500
(1)	40-foot tractor trailer	115,000
Forklifts (1)	Field fork	33,268
(2)	Delivery w/truck mount	29,054
(1)	Front end loader w/forks	28,011
Harvesters (2)	16-inch hand operated w/sulky	6,500
(1)	16- or 18-inch tractor mounted	35,277
Reel mowers (1)	5-gang	11,050
(1)	7-gang	14,030
Rotary mower	10-foot	6,606
Flail mowers (2)	6-foot	2,795
Sweeper	5-foot	5,500
Spin spreaders (2) ..	1,000-lb. capacity	3,000
Boom sprayer	300-gal. w/40-ft. boom	6,200
Irrigation (1)	Cable tow 660 feet w/pump and supply pipe	46,000
(1)	1,100-foot center-pivot w/pump and supply line	65,000
Disk	12-foot	8,000
Rotovater	10-foot	14,000
Blower	Tractor mounted	2,800
Roller	5-foot	1,000
Chisel plow	11-shank	2,100
Moldboard plow	2-bottom, 16-inch	1,500
Landplane	12-foot	6,500
Buildings	Shop, office, storage, etc.	32,439
Total machinery and equipment investment		681,225

APPENDIX TABLE 3. ESTIMATED MINIMUM MACHINERY COMPLEMENT FOR TURFGRASS FARMS OF MORE THAN 300 ACRES, ALABAMA, 1989

Item	Description	Price
		<i>Dollars</i>
Tractors (3)	40 HP	15,701
(6)	60 HP	18,072
(2)	121 HP	41,527
Trucks (5)	3/4-ton pickup	13,900
(3)	1.5-ton utility	17,900
(1)	20-foot, 2.5-ton dual rear	25,500
(5)	40-foot tractor trailer	115,000
Forklifts (2)	Field fork	33,268
(7)	Delivery w/truck mount	29,054
(1)	Front end loader w/forks	28,011
Harvesters (1)	16-inch hand operated w/sulky	6,500
(2)	16-inch tractor mounted	35,277
(2)	18-inch tractor mounted	40,183
Reel mowers (2)	5-gang	11,050
(4)	7-gang	14,030
(2)	11-gang	17,325
Rotary mowers (2) ...	10-foot	6,606
(1) ...	15-foot	8,290
Flail mowers (1)	6-foot	2,795
(2)	12-foot	5,400
Turf vacuums (2)	10-foot	21,584
Spin spreaders (3) ..	1,000-lb. capacity	3,000
Boom sprayers (2) ..	300-gal. w/40-ft. boom	6,200
Irrigation (1)	Solid set	30,000
(5)	Cable tow 990 feet w/pump and supply pipe	46,000
(4)	1,100-foot center-pivot w/pump and supply line	65,000
Disk	12-foot	8,000
Rotovater	10-foot	14,000
Rotera	8-foot	12,000
Landplane	20-foot	12,000
Blower (2)	Tractor mounted	2,800
Roller (2)	5-foot	1,000
Sprig digger	Bermuda king 60-inch	8,400
Sprig spreader	Bermuda king 8-foot	9,400
Chisel plow	11-shank	2,100
Moldboard plow	2-bottom, 16-inch	1,500
Moldboard plow	4-bottom	6,000
Buildings	Shop, office, storage, etc.	111,558
Total machinery and equipment investment		2,342,727

APPENDIX TABLE 4. ESTIMATED MINIMUM MACHINERY COMPLEMENT FOR 50-ACRE
TURFGRASS ALTERNATE ENTERPRISE, ALABAMA, 1989

Item	Description	Price
		<i>Dollars</i>
Field cultivator	9-shank	475
Disk	8-foot	6,500
Roller cultipacker ¹	10-foot	1,400
Scraper ¹	5-foot	500
Fertilizer spreader	1,000 lb.	3,000
Moldboard plow(2)	16-inch bottoms	1,500
Sprayer	250-gal. w/27-foot boom	3,500
Flail mower ¹	6-foot	2,795
Reel mower ¹	5-gang	11,050
Sweeper ¹	5-foot	5,500
Tractor	60 HP	18,072
Front end loader		
w/forks	3,000-lb. capacity	28,011
Delivery truck ¹	2.5-ton, 20-foot bobtail	25,500
Pickup truck	3/4-ton	13,900
Delivery forklift ¹	Portable w/truck mount	29,054
Sod cutter ¹	16-inch hand operated	6,500
Irrigation	Cable tow 660 feet w/pump and line	46,282
Buildings	Shop, storage, etc.	10,177
Total machinery and equipment investment.....		213,716

¹These items must be purchased new for this enterprise.