Turfgrass Sod: An Economic Assessment of the Feasibility of Providing Multiple-Peril Crop Insurance

Prepared by the Economic Research Service, USDA
for the Federal Crop Insurance Corporation

February 23, 1995

Contributors: Agnes Perez, coordinator (202) 501-6779
Joy Harwood (202) 501-8554
Doyle Johnson (202) 219-0296
Agapi Somwaru (202) 219-0812
Glenn Zepp (202) 501-7703

Table of Contents

Executive Summary 4

Introduction 6

The U.S. Sod Market 6
- Supply 6
- Demand 9

Industry Characteristics 9
- Farms with Sod 9
- Income Diversification on Farms with Sod 10

Cultivation and Management Practices 10
- Land Preparation 10
- Planting 11
- Climate 11
- Soil and Air Requirements 11
- Grass Species 13
- Fertilization 13
- Water Management 13
- Mowing 19
- Labor Requirements 19
- Plastic Netting 19

Harvesting 20

Transporting 21

Marketing 21

Costs of Production 23

Production Perils 23
- Excessive Moisture 23
- Excessive Heat and Dry Winds 25
- Drought 25
- Prolonged Flooding 25
- Frosts, Hard Freezes, and Ice Storms 25
- Excessive Fertilization 25
- Thatch 26
- High Salinity 26
- Diseases 26
- Insects 29
- Weeds 31

Regional/State Analysis 32
- New Jersey 32
- Minnesota 33
- Illinois 37

Florida 39
Maryland 42
Alabama 43
Texas 45
California 48

Ad Hoc Disaster Assistance for Turfgrass Sod 50

Turfgrass Sod Insurance Implementation Issues 52
Adverse Selection 52
Setting Reference Prices 52
Estimating Production History 53
Estimating "Appraised Production" 53
Market Prices and Moral Hazard 53
Availability of Individual Yield Data 54
Demand for Insurance 54
Defining "Areas" for the Non-Insured Assistance Program 55

References 57

Executive Summary

The Census reported 218,161 harvested acres of U.S. sod production in 1992, up 19 percent from the prior census year, 1987. The five leading sod-producing states in 1992, ranked by acreage, were Florida, Texas, Alabama, Minnesota, and Georgia. These states represent about half of the total U.S. sod acreage. The most common turfgrass species grown in the U.S. include bermudagrass, bluegrass, centipedegrass, fine fescue, Kentucky bluegrass, ryegrass, St. Augustinegrass, tall fescue, and zoysiagrass.

The housing industry is the primary market for turfgrass sod, and the greatest demand is in metropolitan areas. Other major markets include land developers, golf courses, parks, cemeteries, athletic fields, and schools. Virtually all sod is produced domestically because climatic conditions need to be similar in producing and consuming areas. The average trucking distance from shipping point to landscape site is about 150 to 180 miles. Climatic conditions generally do not change significantly within this radius.

Sod is classified into two general categories: cool-season grasses (such as bluegrass and tall fescue) and warm-season grass (including bermudagrass and zoysiagrass). Cool-season grasses grow best in the northern parts of the U.S., as well as in areas with higher elevations and coastal regions where evening summer temperatures are in the 50- and 60- degree Fahrenheit range. Warm-season grasses are usually grown from lower Florida and along the Gulf Coast northwards, throughout the upper South.

Sod can be established either by vegetative propagation or direct seeding. In general, warm-season grasses are established with vegetative propagation using sprigs or plugs, while cool-season grasses are direct seeded. Sod may be produced in blends or mixtures of two or more grasses, particularly for those species established through seeding. Each type of grass responds differently to various stresses, and when blended or mixed, the more tolerant grass will dominate, increasing overall turf performance.

Generally, grass seed germinates best when soil temperatures are 50^{o} F or less. Root development from sprigs requires higher temperatures. Growers irrigate and fertilize to promote rapid production of quality sod and to protect against stand failure. Mowing is used to control weeds, remove excess growth, improve root growth, and promote lateral growth of the turfgrass. Infrequent mowing can cause the stand to become thin and aesthetically unacceptable. It can also result in increased frequency of losses due to disease.

Marketable sod is typically produced in 6 to 24 months. Sod is ready for harvest when it has both green leaves and an actively growing root system. The actual growing period depends on soil type, moisture, temperature, grass species, fertilization, and other cultivation practices.

Sod is harvested on demand and is cut only to meet a particular days' orders. During periods of low prices, many sod growers put their fields under low maintenance for several years. By using this method, they hope to sell at

higher prices at a later time, rather than harvesting the sod at a loss or abandoning their fields.

Sod is cut with 1/2- to 5/8-inch of soil attached. This thinness allows for easier handling, permits more rapid establishment, and requires less expense in transportation costs than if cut thicker. If cut much thinner, it will be difficult to retain enough moisture to keep the sod fresh until installation.

The two basic techniques for sod harvesting are the ribbon-cut method and the clean-cut method. The application of a particular method depends on the type of grass. Ribbon cutting is normally used for all warm-season grasses and is used to re-establish turf. When ribbon cutting is used, 1- to 2-inch-wide undisturbed turf ribbons or strips are left in the field between the harvested strips. Clear cutting, on the other hand, does not leave ribbons or surface vegetation and is normally used on cool-season grasses which are re-seeded after harvest.

Major production perils include drought, excess heat, and excess moisture. Although many sod growers irrigate, prolonged dry conditions may cause ponds and streams, a major source of water, to dry up. While many insects and diseases may affect turfgrass sod, the problems they create can generally be controlled through management practices.

Disaster payment data indicate which sod-growing areas received large payments relative to their acreage. For example, Missouri's share of U.S. sod acreage in recent years, at about 2 percent, was far less than their share of ad hoc disaster payments, at 18 percent. Similar situations are apparent in analysis of Maryland and Tennessee data. In contrast, Florida, Texas, and Alabama collected a smaller share of ad hoc payments relative to their acreage.

Our assessment is that, although there would likely be moderate interest among turfgrass producers in buying insurance for sod, participation is likely to be lower than for most crops. One reason for lower interest among sod growers is that most sod is irrigated. Production losses from erosion and flooding were also cited as occasional production perils. The acreage subject to losses from flooding, however, is likely to be quite small.

On a regional basis, we judge that participation in a sod insurance program would be greatest in the North Central states. The basis for this judgement is the large amount of ad hoc disaster assistance payments for sod reported for this region over the 1988-93 period. Most of the losses were caused by drought and floods. In addition, the largest amount of non-irrigated sod is located in the North Central region.

Turfgrass Sod Contacts

Turfgrass Producers International:

Douglas H. Fender
Executive Director
Turfgrass Producers International
1855-A Hicks Road
Rolling Meadows, IL 60008
(708) 705-9898
(800) 405-8873

New Jersey:

Dr. J. A. Murphy
Turfgrass Management Extension Specialist
New Jersey Cooperative Extension Service
Rutgers University
(908) 932-9453

Dr. Henry Indyk
Ex-Secretary (retired)
Cultivated Sod Association of New Jersey
(908) 247-8026 (Home)

Minnesota:

Dr. B. Peterson
Turfgrass Specialist
Southern Experiment Station
University of Minnesota
(612) 624-7407 St. Paul Campus
(507) 835-3620 Experiment Station Office

Kurt Klint
Executive Director
Minnesota Turf Association
(612) 755-4244

John Hogdal
Sod Grower
(612) 434-6828

Illinois:

Dr. T. B. Voigt
Turfgrass Specialist
Department of Horticulture
University of Illinois
(217) 333-7847

Dr. H. T. Wilkinson
Turfgrass Specialist
University of Illinois
(217) 333-8707

Maryland:

Dr. T. B. Turner
Professor, Turfgrass Management
Department of Agronomy
University of Maryland
(301) 405-1306

Malcolm Sarna
Turf and Seed Section
Maryland Department of Agriculture
50 Harry S. Truman Parkway
Annapolis, MD 21401
(410) 841-5960

Texas:

Dr. R. L. Duble
Turfgrass Specialist
Texas Agricultural Extension Service
Texas A&M University
(409) 845-3041

Florida:

Alan Hodges
Food and Resource Economics Department
University of Florida
P.O. Box 110240
Gainesville, FL 32611
(904) 392-5072

Dr. John Cisar
Turfgrass Specialist
Florida Agricultural Extension Station
University of Florida
(305) 475-8990

Bob Yount
Executive Director
Florida Turfgrass Association
(407) 898-6721

California:

Dr. V. A. Gibeault
Turfgrass Specialist
Cooperative Extension Service
University of California--Riverside
(909) 787-3575

Dr. Stephen T. Cockerham
Turfgrass Specialist
Cooperative Extension Service
University of California--Riverside
(909) 787-5906

Yurgin Gramckow
Owner--Southland Sod Company
President, California Sod Producers Association
(805) 488-3585

Alabama

Dr. Colemand Y. Ward
Turf Specialist
Extension Division
Auburn University
(334) 844-5479

Turfgrass Sod: An Economic Assessment of the Feasibility of Providing Multiple-Peril Crop Insurance

Introduction

Sod is a horticultural commodity intensively cultivated in most parts of the United States, primarily for its ornamental and environmental qualities. Sod consists of perennial grass plants, soils, and microorganisms. Instant mature lawns can be achieved through the installation of turfgrass sod.

Numerous grass species may be grown as sod. Sod, like other agricultural commodities, is susceptible to production losses due to extremes of wind, moisture, and temperature throughout the production, harvesting, and marketing stages.

This report examines those aspects of the U.S. turfgrass sod industry that relate to the demand for crop insurance and the feasibility of developing a crop insurance policy for sod.

The U.S. Sod Market

Supply

The Census reported 218,161 harvested acres of U.S. sod production in 1992, up 19 percent from the prior census year, 1987 (Table 1). Sod production is increasing more rapidly in the South and West than in the northern states. The South had both the largest number of farms growing sod and the largest volume of sales in 1992.

Growers' sod sales in the southern region amounted to nearly $207 million in 1992. The South accounted for about 44 percent of U.S. total sod sales in that year, up from 40 percent in 1987. Sales in the northeast region, in contrast, fell to 8 percent of the U.S. total, down from 13 percent in 1987. The north central region's share of U.S. sod sales held steady between 1987 and 1992, at about 19 percent. The share held by the western region fell slightly.

The five leading sod-producing states in 1992, ranked by their acreage, were Florida, Texas, Alabama, Minnesota, and Georgia. These states represent about half of the total U.S. sod acreage. Florida accounted for nearly a quarter of the nation's sod acreage. California ranked seventh in terms of acreage, but had the largest volume of sales, amounting to $79.4 million.

Sod supplies are typically abundant from May through October, corresponding to the harvest peak. Sod is not frequently harvested in the remaining months, with the exception of April, when about 9.5 percent of the year's sod supplies are generally harvested (1993 ASPA Membership Profile Survey).

Table 1--Sod harvested: Farms, acreage, and sales, by region and State, 1992 and 1987

Region and State	1992				1987			
	Farms	Area under glass or other protection	Acreage in the open	Sales	Farms	Area under glass or other protection	Acreage in the open	Sales
	Number	Square feet	Acres	$1,000	Number	Square feet	Acres	$1,000
Northeast:	124	(X)	12,415	36,065	118	(X)	16,359	51,010
Connecticut	9	(X)	931	2,229	13	(X)	1,303	6,116
Maine	3	(X)	(D)	(D)	1	(X)	(NA)	(NA)
Massachusetts	8	(X)	475	855	3	(X)	(D)	(D)
New Hampshire	4	(X)	276	1,035	4	(X)	944	2,850
New Jersey	41	(X)	3,998	11,605	41	(X)	6,370	16,582
New York	19	(X)	2,533	10,745	18	(X)	3,961	14,255
Pennsylvania	23	(X)	2,036	4,089	19	(X)	1,309	3,303
Rhode Island	15	(X)	2,166	5,507	18	(X)	2,472	7,904
Vermont	2	(X)	(D)	(D)	1	(X)	(NA)	(NA)
North Central:	505	(X)	54,720	90,918	457	(X)	44,568	77,401
Illinois	46	(X)	9,320	21,286	46	(X)	9,420	20,223
Indiana	27	(X)	3,445	6,810	27	(X)	2,973	6,461
Iowa	35	(X)	2,399	5,033	34	(X)	1,753	2,498
Kansas	38	(X)	3,705	5,045	26	(X)	2,721	5,344
Michigan	66	(X)	7,072	10,607	64	(X)	6,954	9,736

Minnesota	90	(X)	10,566	12,317	79	(X)	7,951	9,483
Missouri	47	(X)	4,121	6,184	41	(X)	2,883	4,624
Nebraska	26	(X)	1,523	2,647	28	(X)	1,257	1,977
North Dakota	4	(X)	41	91	1	(X)	(NA)	(NA)
Ohio	48	(X)	4,859	7,612	39	(X)	3,959	9,143
South Dakota	7	(X)	508	937	3	(X)	(D)	(D)
Wisconsin	71	(X)	7,161	12,349	69	(X)	4,697	7,912
South:	757	(X)	124,370	206,623	627	(X)	99,246	155,172
Alabama	82	(X)	11,967	17,835	59	(X)	7,494	17,480
Arkansas	36	(X)	2,408	4,102	30	(X)	1,875	3,399
Delaware	9	(X)	621	1,177	1	(X)	(D)	(D)
Florida	154	(X)	52,030	64,215	137	(X)	49,952	72,037
Georgia	53	(X)	10,510	34,643	29	(X)	6,026	12,227
Kentucky	34	(X)	1,942	3,287	24	(X)	1,033	925
Louisiana	15	(X)	1,491	2,379	17	(X)	2,223	3,398
Maryland	30	(X)	3,171	6,674	42	(X)	3,239	5,753
Mississippi	35	(X)	1,585	2,186	24	(X)	878	1,433
North Carolina	25	(X)	1,711	5,987	20	(X)	1,080	3,575
Oklahoma	47	(X)	3,531	6,720	45	(X)	3,398	4,220
South Carolina	28	(X)	6,056	8,718	14	(X)	2,455	4,330
Tennessee	26	(X)	3,304	5,424	13	(X)	814	1,630
Texas	156	(X)	21,515	37,757	156	(X)	16,911	20,678
Virginia	23	(X)	2,459	5,519	14	(X)	1,868	4,087
West Virginia	4	(X)	69	(D)	2	(X)	(NA)	(NA)
West:	228	(X)	25,580	136,601	223	(X)	23,030	106,207

Alaska	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Arizona	7	(X)	1,621	6,505	6	(X)	1,393	8,875
California	62	(X)	8,420	79,357	56	(X)	7,205	60,281
Colorado	36	(X)	4,861	13,517	41	(X)	4,720	11,044
Hawaii	12	(X)	69	862	6	(X)	(D)	450
Idaho	13	(X)	1,185	3,411	14	(X)	912	2,070
Montana	7	(X)	369	1,249	7	(X)	288	774
Nevada	10	(X)	832	3,450	6	(X)	480	1,346
New Mexico	9	(X)	1,278	3,909	11	(X)	1,383	4,385
Oregon	7	(X)	1,522	3,932	9	(X)	1,630	2,975
Utah	34	(X)	2,731	8,007	31	(X)	3,073	6,329
Washington	24	(X)	2,457	11,912	27	(X)	1,736	7,240
Wyoming	7	(X)	235	490	9	(X)	210	438
United States	1,614	(X)	218,161	471,640	1,427	(X)	184,070	391,635

(D) = Data are not published to avoid disclosure, but are included in U.S. totals.
(X) = Not applicable.
(NA) = Not available.

Source: 1992 Census of Agriculture.

Virtually all sod is produced domestically because climatic conditions need to be similar in producing and consuming areas. The average trucking distance from shipping point to landscape site is approximately 150 to 180 miles (Beard). Climatic conditions generally do not change significantly within this radius.

Demand

Turfgrass as a ground cover used in the landscaping of metropolitan areas, housing developments, churches, schools, parks, cemeteries, golf courses, and athletic fields. It has gained popularity because people appreciate open green space. It aids in cooling and erosion control, and in the filtering of groundwater recharge in open areas (Rogers).

Turfgrass sod has become a popular method of groundcover establishment because it provides an instant mature lawn. A professional sod lawn needs no special care because it is a healthy mature lawn when installed. In contrast, a sprigged or seeded lawn requires several years of nurturing to reach maturity (ASPA). Lawns established with turfgrass sod are more effective in controlling runoff than lawns established from seed, even after three years (Watschke).

The housing industry is the primary market for turfgrass sod, and the greatest demand is in metropolitan areas (ISU Cooperative Extension Service). Other markets include land developers, golf courses, parks, cemeteries, athletic fields, and schools.

Industry Characteristics [1]

Farms with Sod

The U.S. sod industry consists of a large number of medium- and small-size operations, although the largest volume of production comes from large farms. In 1987, fifty-one percent of the farms growing sod had sales of $499,999 or less (Appendix table 1a). However, 72 percent of all sod sales were reported by farms with sales of $500,000 or more (Appendix table 2). These farms accounted for only 16 percent of farms growing sod.

Most farms growing sod obtain their gross cash farm income from crop sales. Crop sales accounted for about 95 percent of U.S. gross cash income on farms with sod in 1987. Of that gross income total, more than 60 percent came from the sale of sod (Appendix table 2). In general, livestock income is fairly unimportant on farms with sod.

---

[1] The statistical description of industry structure is based on a special tabulation of Census farms growing sod in 1987. No comparable tabulation for farms with sod in 1992 has been completed at the time this report was prepared.

Farms in the Northeast and North Central states received a slightly larger percentage of their farm income from sod than producers in the South and West. Because of greater specialization, growers in the Northeast and North Central states may have more interest in crop insurance for sod as a risk management tool than growers in the South and West.

A significant proportion of farms with sod are individually- or family-owned operations, with 55 percent of farms growing sod in that category in 1987 (Appendix table 3a). Corporate farming accounted for 27 percent of the sod operations, while partnerships accounted for 12 percent.

Income Diversification on Farms with Sod

Sixty-seven percent of the operators growing sod identified farming as their main occupation in 1987 (Appendix table 4). However, about 45 percent of all sod farms, and 50 percent of small- and medium-size farms (those with less than $500,000 in sales), supplemented their income with off-farm employment.

In 1987, about 45 percent of all farms growing sod had operators who indicated that they worked off the farm at least one day during the year, and 33 percent had operators who worked off the farm for 100 days or more (Appendix table 4). Sixty-eight percent of the farms with less than $25,000 in sales had operators who worked off the farm at least one day during the year, and 55 percent had operators who worked off the farm 100 days or more. For a number of these smaller producers, growing sod may be a part-time or sideline enterprise that supplements their off-farm income.

Other agricultural enterprises also provide income diversification for sod growers. Of the $638.3 million in gross cash farm income reported by the 1987 Census for farms producing sod, 62 percent was from sod sales, 34 percent was from other crop sales, and 4 percent from livestock sales.

The extent of farm income diversification varies by region, however. Sod sales accounted for about 92 and 85 percent of total farm sales on farms with sod in the Northeast and North Central regions, but only 53 and 55 percent in the South and West (Appendix table 2).

Cultivation and Management Practices

Land Preparation

Careful land preparation is necessary to ensure uniform thickness and quality of the sod at harvest. Land preparation may entail rock removal, leveling, plowing, fumigating, and other operations to assure a smooth seed bed free of insects and diseases. Surface irregularities prevent harvesting blades from cutting the sod into pieces of uniform thickness. Low spots can cause holes in the sod pad, rendering it unsalable. In addition, the elimination of low and high spots can improve surface drainage (Cockerham).

Planting

Sod can be established either by vegetative propagation or direct seeding. In general, warm-season grasses are established with vegetative propagation using sprigs or plugs, while cool-season grasses are direct seeded. There are some exceptions, however. For example, some Kentucky bluegrass varieties (a cool-season grass) are planted vegetatively because they are poor seed producers (Cockerham).

Sprigs are stolon or rhizome segments that are about 2 to 4 inches in length. They are spread in the fields by sprigging machines or manure spreaders at a rate of 250 to 450 bushels per acre. Generally, one bushel of sprigs (as well as plugs) can be obtained from 1 square yard of sod (White, et. al.).

Plugs are sections of harvested sod that are cut into pieces of approximately 2 to 4 square inches. They are planted in prepared seed beds on 6- to 8-inch centers. Plugs are planted by hand or machine, using 300 to 450 square yards per acre. The field may be rolled after establishment (following either sprig- or plug- planting) to improve soil contact with the roots (White, et. al.).

Sod may be produced in blends or mixtures of two or more grasses, particularly for those species established through seeding. Each type of grass responds differently to various stresses, and when blended or mixed, the more tolerant grass will dominate, increasing overall turf performance. A blend is the combination of two or more grasses of the same species, while a mixture is a combination of two or more different species.

Climate

Cool-season grasses grow best in the northern parts of the United States, as well as in areas with higher elevations and coastal regions where evening summer temperatures are in the 50- and 60- degree Fahrenheit range (Beard). The cool-season zone (Zone A) is shown in Figure 2. Warm-season grasses are usually grown from lower Florida and along the Gulf Coast northwards, throughout the upper South (Zone C).

There is also a transition zone (Zone B), where both cool-season and warm-season grasses are grown. This zone presents real challenges for turfgrass growth because summer temperatures are generally too high for cool-season grasses and winter temperatures too low for warm-season grasses (Beard). This zone covers the lower elevations of Virginia and North Carolina, west through West Virginia, Kentucky, Tennessee, and Arkansas, as well as southern Ohio, Indiana, Illinois, Missouri, and Kansas.

Soil and Air Requirements

Generally, grass seed germinates best when soil temperatures are 50^{o} F or less. Root development from sprigs requires higher temperatures. Air

temperatures must remain at or above freezing to prevent injury to the grass seedlings once they have germinated.

Good-quality sod can be produced on both muck and mineral soils. Because muck soils are lighter in weight than organic soils, muck sod has a transportation cost advantage over mineral-soil sod. In addition, muck soils are naturally high in nitrogen, which promotes growth of grasses. Except in south Florida, however, very few sod markets are located near muck soil areas.

Clay soils are less desirable for sod production than sandy and loam soils. Clay soils do not drain well and they remain wet for long periods, causing difficulty in soil preparation, mowing, and other maintenance activities. Wet ground also can delay harvesting because equipment cannot be brought into the field. Excessive moisture in the soil increases the weight of the sod and increases hauling expenses (Cockerham).

Grass Species

The most common turfgrass sod species grown in the U.S. are bermudagrass, bluegrass, centipedegrass, fine fescue, Kentucky bluegrass, ryegrass, St. Augustinegrass, tall fescue, and zoysiagrass. Table 2 summarizes the characteristics of these grass species.

Fertilization

The ability of sod to "knit together" depends primarily on the development of its roots and rhizomes. Fertilization is critical to achieving a balance between shoot growth and root development (ISU Cooperative Extension Service). Excessive nitrogen at planting retards root development, while nitrogen applied just prior to harvest may cause burning and death of the blades during transport. Too much nitrogen promotes excessive shoot growth, increases mowing costs, and makes the grass more susceptible to diseases and stress (White, et. al.). Excessive nitrogen rates may also retard root development of the transplanted sod (Duble).

Water Management

Producers irrigate to promote rapid production of quality sod and to protect against stand failure. The best time to irrigate sod is before sunrise, so that there will be minimum wind disturbance and evaporation losses. Evening applications may promote the development of diseases, as the grass remains wet throughout the night. Daytime applications interfere with other cultural practices, and may result in an uneven water distribution due to winds (White, et. al.).

The intensity of irrigation is important. Light and frequent applications of water promote shallow rooting. Shallow-rooted grass is susceptible to drought and cold injury, both of which can cause significant yield losses (Duble).

Finally, sod should be irrigated several days prior to harvest so that it reaches its destination in good condition.

Table 2--Characteristics of selected grass species

Species	Type	Adaptation	Temperature Tolerance	Drought Resistance	Shade Adaptation	Other Characteristics and Limitations
Bermudagrass	Warm-season	Grows best in hot, dry, tropical climates.	Excellent performance up to 110° F; has a winter dormancy period; turns tan to brown at temperatures below 55°F; poor cold hardiness.	Highly drought resistant; can go into summer dormancy when irrigation is withheld; will green up again after moisture supply is returned.	Requires full sun for most of the day.	Dense and low growing rhizomes and stolons; some varieties tolerate very low maintenance; tolerates alkaline and slightly acidic soils; has good salt tolerance; Some varieties have resistance to diseases such as Helminthosporiums and rusts; insects are more likely to be a problem than diseases; some varieties are resistant to bermudagrass mite.
Bluegrass	Cool-season	Grows best in cool, humid, temperate regions.	Tolerates very cold winter weather; undergoes stress during extremely hot weather.	Can go into summer dormancy when irrigation is withheld; will green up again with the return of moisture.	Moderately tolerant to partial shade; thrives in sunny areas.	Recovers quickly from occasional abuse; performs best in fertile, non-acid soils with good drainage; fair tolerance to saline soils; new varieties have improved resistance to diseases such as leaf spot, stripe, smut, blight, summer patch and rust.

Table 2--Characteristics of selected grass species

Species	Type	Adaptation	Temperature Tolerance	Drought Resistance	Shade Adaptation	Other Characteristics and Limitations
Centipede-grass	Warm-season	Grows where rainfall is high and summers are warm and humid.	Grows well in full sun; very tolerant of high temperatures, but sensitive to low temperatures; goes dormant through winter months.	Sensitive to drought but has a rapid recovery rate.	Moderate to good shade tolerance.	Slow growth pattern; recovers slowly from damage; deep root system; well adapted to infertile, sandy, well-drained soil; aggressive enough to compete strongly with weeds; resistant to chinch bugs, St. Augustine decline, and brown patch.
Fine Fescue	Cool-season	Adapted to cool summers and high altitudes and can do well in cold and arid climates.	Tolerates hot and cold weather well; has good winter hardiness; can be used in areas that are subject to wide temperature fluctuations.	Very good drought tolerance; can go dormant in summer when irrigation is withheld.	Best cool-season grass for dry, shady lawns but also needs some sun.	Does not recover well from severe injury; tolerates acid soils well (within range of pH 5.0-6.5); most varieties have good resistance to many turfgrass diseases; mixed with other grasses, it adds disease resistance to the turf; occasional susceptibility to summer diseases in hot climates, especially in moist, fertile soil; grows well in dry soils.

Table 2--Characteristics of selected grass species

Species	Type	Adaptation	Temperature Tolerance	Drought Resistance	Shade Adaptation	Other Characteristics and Limitations
Kentucky Bluegrass	Cool-season	Widely adapted in cool, humid, semi-arid and temperate regions.	Will tolerate very cold winters; undergoes stress during extremely hot weather, but will maintain good color and appearance if properly watered and managed.	Medium tolerance to drought.	Thrives in sunny areas; fair to poor shade tolerance; a few varieties are moderately adapted to partial shade.	Forms strong sod via rhizomes; recovers quickly from occasional abuse; grows well in fertile, non-acid soils with good drainage; new varieties have improved resistance to diseases such as leafspot, stripe smut, powdery mildew, dollar spot, Typhula blight, summer patch, and rust.
Ryegrass	Cool-season	Adapts well in regions with mild winters and cool, moist summers.	Most vigorous when cool and moist.	Good drought tolerance.	Moderate.	Compatible in mixes with bluegrass and fine fescue to make a hardier turf; highly adaptable to a wide range of soils, from light and sandy to heavy and clayey; most new varieties have good resistance to brown patch, leaf spot, stem and crown rust; used in warm climates in combination with bluegrass to reduce the spread of major summer diseases.

Table 2--Characteristics of selected grass species

Species	Type	Adaptation	Temperature Tolerance	Drought Resistance	Shade Adaptation	Other Characteristics and Limitations
Tall Fescue	Cool-season	Very well adapted to cold winters and warm summers.	Grows well in a wide range of temperatures.	Very good; extensive root system protects against drought.	Prefers full sun.	Adapts to a wide range of soil types; good tolerance to saline salt conditions; very trouble-free sod--very high disease resistance, especially to brown patch, leaf spot, and crown rust; not generally vulnerable to insect pests.
Zoysiagrass	Warm-season	Adapts to hot, humid, and tropical climates.	Tolerates heat exceptionally well up to 100° F; subject to winter dormancy at temperatures below 55° F.	Moderate to good--resists short periods of drought; can go into summer dormancy when irrigation is withheld.	Slow growing in partial shade.	Spreads by stolons and rhizomes; shoot growth rate is slow; has best wear resistance of any grass; tolerates high salinity and infertile soil well; some varieties have good resistance to diseases such as rust and leaf spot, and to billbugs; dense turf prevents weeds from appearing.

Table 2--Characteristics of selected grass species

Species	Type	Adaptation	Temperature Tolerance	Drought Resistance	Shade Adaptation	Other Characteristics and Limitations
Bahiagrass	Warm-season	Adapts to hot, humid, and tropical climates.	Very tolerant of high temperatures.	Sensitive to drought.	Sensitive to shade.	--
Creeping Bentgrass	Cool-season	Grows best in cool, humid, and temperate regions.	Tolerates very cold winter weather; undergoes stress during extremely hot weather.	Poor to good drought tolerance.	Tolerant of shade.	spreads by stolons; high salinity tolerance; some varieties have resistance to insect pests.
St. Augustine-grass	Warm-season	Well adapted to coastal regions with hot, tropical climates.	Adjusts well to temperatures up to 105° F; very poor low-temperature hardiness.	Excellent to fair; can go into summer dormancy when irrigation is withheld.	Wide range of shade adaptation.	Creeping growth habit via stolons; thrives on wet sites; prefers neutral to alkaline soils; excellent saline salt tolerance; some varieties resistant to chinch bugs and St. Augustine decline (SAD) virus.

Mowing

Sod growers mow their fields to control weeds, remove excess growth, improve root growth, and promote lateral growth of the turfgrass. Infrequent mowing can cause the stand to become thin and aesthetically unacceptable. It can also result in increased frequency of losses due to disease.

Generally, about one-third of the leaf blade should be removed per mowing to maintain good color and an even appearance to the turf surface (White, et. al.). Excessively low mowing, or scalping, weakens root growth, while mowing at a higher level encourages a healthy root system. However, mowing heights that are too high near harvest may cause the sod to heat after cutting, so mowing heights should be decreased gradually during the weeks before harvest (ISU Cooperative Extension Service). This is also practiced to maintain a better product appearance.

The following list shows the suggested mowing heights for different turfgrass species:

Bermudagrass	1/2 to 1 inch
Bluegrass	1 1/2 to 2 inches
Centipedegrass	1 to 2 inches
Fine Fescue	1 to 2 1/2 inches
Kentucky Bluegrass	1 1/2 to 2 inches
Ryegrass	1 to 2 1/2 inches
St. Augustinegrass	2 to 3 inches
Tall Fescue	2 to 3 inches
Zoysiagrass	3/4 to 1 1/2 inches

The use of mowing equipment on different species of turfgrass may cause field contamination with off-types or unintended species of grasses. Clippings are also collected because they can also contribute to field contamination.

Labor Requirements

Sod production is a labor-intensive process. While machines, such as the sod harvester, have been developed and adapted over the past few years, manual labor is still required in rolling the cut sod, identifying damaged pieces, and gathering and loading the sod for transport.

Plastic Netting

Sod tensile strength is enhanced by cultural practices such as plastic netting that stimulate sod knitting. Plastic netting is typically used with cool-season grasses that do not produce rhizomes. It also can be used with some warm-season grasses.

Netting allows the harvesting of much younger sod and cuts 25 percent or more from the time to crop maturity (Cockerham). Five Alabama sod growers reported producing a centipedegrass sod in as little as 8 months using netting over

seeded beds, versus an average of 12 to 15 months without netting. Growers who use netting have an advantage because they can supply the early spring market (White, et. al.).

Harvesting

Marketable sod is typically produced in 6 to 24 months. Sod is ready for harvest when it has both green leaves and an actively growing root system. The actual growing period depends on soil type, moisture, temperature, grass species, fertilization, and other cultivation practices. As noted above, netting allows earlier harvesting by adding tensile strength.

Sod is harvested on demand and is cut only to meet a particular days' orders. When a sod harvester is used, harvesting requires that less soil be attached to the roots than when sod is harvested by hand. Of course, it also requires less hand labor to cut the sod.

Sod is cut with 1/2- to 5/8-inch of soil attached. This thinness allows for easier handling, permits more rapid establishment, and requires less expense in transportation costs than if cut thicker. If cut much thinner, it will be difficult to retain adequate moisture to keep the sod fresh until installation (Cockerham).

Sod harvesting involves order takers, dispatchers, a harvesting supervisor, production people, a harvesting crew, and truck drivers. The turf is groomed and irrigated to keep the soil moist enough for the sod harvester. Once the sod is moved out of the fields, the soil is immediately prepared for the next planting (Cockerham).

Sod harvesting machines have conveyors that carry the sod up to a rolling or folding attachment. Part of a sod pad is being drawn up the conveyor before the rest of it is severed from the field. On hot days, the pallets of cut sod are hosed down every hour or so to prevent dehydration. In some cases, the sod may be hosed down again after loading on a trailer (Cockerham).

The two basic techniques for sod harvesting are the ribbon-cut method and the clean-cut method. The application of a particular method depends on the type of grass. Ribbon cutting is normally used for all warm-season grasses and is used to re-establish turf (White, et. al.). Clear cutting, on the other hand, is normally used on cool-season grasses which are re-seeded after harvest (Peacock). However, there are also some exceptions. For example, bermudagrass, a warm-season grass, is normally clear cut (Peacock).

When ribbon cutting is used, 1- to 2-inch-wide undisturbed turf ribbons or strips are left in the field between the harvested strips (White, et. al.). One problem with this method is that it compromises the uniformity and texture of the turfgrass. It also makes harvesting more difficult, and can reduce turf quality due to unevenness between the old and new growth (Haydu and Cisar).

Clean cutting does not leave ribbons or surface vegetation. Re-establishment is from intact rhizomes for grasses that grow rhizomes, and by seed for those that do not produce rhizomes (White, et. al.). This method usually results in a more uniform thatch or turf, easier harvesting, and more flexibility in the scheduling of production and harvesting activities. However, re-sodding a clear-cut field involves land preparation and sprigging costs that are unnecessary when the ribbon-cut method is used (Haydu and Cisar).

Harvested sod is arranged in overlapping layers so that the layers can be tied together. If stacked improperly, sod can fall off the pallet during handling and transport.

Transporting

Turfgrass sod is perishable and very heavy. It has a shelf life of only about 36 hours, and heavy-duty equipment must be used for its transport (Cockerham). Sod heating within the pallet can reach lethal temperatures due to respiration (Peacock). Given these limitations, producing sod close to a market is important, particularly since shipping is expensive and sod can be damaged if not installed promptly.

The laws governing the weight each axle of a truck can carry over the road varies with each state. In most states, a three-axle tractor with a trailer 40 feet long and a forklift can carry no more than 18 pallets with 500 square feet of sod each (Cockerham).

Marketing

Market outlets for sod in the U.S. include landscapers, landscape contractors, homeowners, nursery and garden centers, golf courses, cemeteries, airports, athletic departments, recreation or park facilities, and schools.

In a 1993 survey conducted by Turfgrass Producers International (TPI), 85 percent of their farm membership sold sod at the wholesale level, while 15 percent sold directly to retail markets (1993 ASPA Membership Profile Survey). Of these sales, about 80 percent were delivered and 20 percent were picked up in the fields by buyers. The majority of the sod that was delivered was not installed by the grower. It was estimated that their 650-plus farm members represented 75 to 80 percent of U.S. sod acreage. Table 3 lists marketing outlets for the American Sod Producers Association (ASPA) membership and the corresponding shares of sod sales.

Marketing practices and characteristics vary across states and by firm size. In Florida, for example, very large operations have found it more economical and less risky to hire independent shippers to distribute their sod. Smaller producers, on the other hand, avoid head-to-head competition with the large firms, and serve small landscape contractors and retail firms (Haydu and Cisar).

Table 3--Percentage of sod sold by marketing outlet, 1988 and 1993

Customer-type	1988	1993
	--------Percent--------	
Landscape architects	1.7	0.8
Landscape contractors	44.6	40.0
Builders	12.0	9.0
Land developers	2.6	2.0
Homeowners	15.0	14.0
Commercial building owners	2.2	---
Golf courses, parks, cemeteries	4.7	8.0
Nursery/garden centers	7.9	12.0
Sod brokers	7.1	6.0
Government bid projects	---	4.0
Other	2.0	4.0

Source: 1993 ASPA Membership Profile Survey.

California sod growers often sell to landscape contractors or sod installers, who then sell their services to consumers. Growers also commonly sell to nurseries. In both cases, the sod is ordered by the installer or the nursery, which has already sold it to the consumer. Direct retail outlets are also used, and may include do-it-yourself, custom-installed, or grower-installed groups (Cockerham).

Evidence indicates that smaller operations rely more on field pick-up than do larger operations. In Alabama, sod growers with 100 acres or less marketed 63 percent of their sales by field pick-up. The remaining 37 percent of sales were delivered to the point of sale. The larger operations sold 15 percent of their sod by field pick-up, while 85 percent was delivered to the point of sale (White, et. al.).

Costs of Production

Moral hazard may arise if high harvesting costs and low market prices create a situation where receiving an indemnity is more profitable than selling at low market prices. In general, sod harvesting costs account for less than 50 percent of total production costs (Table 4). This may create a lesser moral hazard problem in developing an insurance policy than for certain other commodities, such as fruits and vegetables, where harvesting costs are a higher proportion of total production costs. Detailed cost of production budgets are presented in the appendix.

Marketable sod is continuously maintained in the field and harvested only when there is a purchase order ready. During periods of low prices, many sod growers put their fields under low maintenance for several years. By using this method, they are hoping to sell at higher prices, rather than harvesting the sod at a loss or abandoning their fields. However, the viability of the sod decreases in delayed-harvest circumstances.

Production Perils

Major production perils cited in certain states include drought, excess heat, and excess moisture. Although many sod growers irrigate, prolonged dry conditions may cause ponds and streams, a major source of water, to dry up. While many insects and diseases may affect turfgrass sod, the problems they create can generally be controlled through management practices.

Excessive Moisture

Excess rain can cause wash-outs and gullies, and may promote weed invasions that take several years to eliminate (Beard). Excessive moisture can cause other problems. Because sod will not cut cleanly in very wet fields, and sod harvesters have difficulty tracking straight under such conditions, sod pads will not be uniform. Loaded forklifts and trucks tend to get stuck in wet fields and occasionally must be unloaded. Wet sod also causes problems for the stackers, because of the weight and accumulation of mud on conveyors,

Table 4--Sod: Variable harvesting costs per acre, selected states [1]

State	Output	Variable harvest cost [2]	Total cost	Variable harvest percent of total
	Sq. yds/acre	-------$/acre-------		Percent
Alabama	4,000	743	2,505	30
California	4,840	1,840	4,482	41
Iowa	4,840	450	1,040	43
Texas	2,786	460	2,156	21
Florida	4,840	806	2,034	40

[1] Costs may not be comparable among states because budgets may be for different seasons and turfgrass species, and may not include the same cost items.
[2] May include sales costs.

Note: For California, per-acre costs were estimated from a general budget showing sales of 110 acres of Elite tall fescue and Santa Ana hybrid bermudagrass. For Iowa, all costs are variable. For Florida, per-acre costs were estimated from total cash expenses of 46,000 acres of sod. Items included in Florida's variable harvesting costs were fuel, rentals, hourly wages, contract labor, and transportation.

Sources: White, et. al.; Cockerham; Iowa State University; Duble; Hodges, et. al.

rollers, and platforms. Also, extra-heavy sod reduces the number of pallets a truck can haul (Cockerham).

Excessive Heat and Dry Winds

High temperatures and drying winds can be a problem, especially during the harvest period. When the soil is dry and hard, sod harvesters are difficult to operate. The sod has little strength (if it can be cut at all), and the turf may be dead by the time it gets to the customer (Cockerham). Also, the need for additional watering can interrupt harvesting.

During very warm and dry conditions, harvested sod that remains on the pallet for more than 36 hours will deteriorate very quickly. Pallets can be watered with sprinklers or with a hose and can be moved into the shade to help reduce drying. Exposed sod on the pallet will die if allowed to dry out (Cockerham).

Drought

The first symptom of drought stress is wilting of the grass blades, which may roll or fold up lengthwise and turn bluish-green or slate gray. The blades of drought-stressed turf do not spring back after they have been compressed, so that footprints make a long-lasting imprint (Smith).

During early stages of stress, the turf can recover with immediate irrigation. With prolonged drought, turf plants will die, and the density of the planting will decline. Seemingly minor drought stress can cause heavy waste losses at harvest, even weeks or months after the dry period occurs (Cockerham). Grass seedlings affected by drought may fail to establish.

Prolonged Flooding

Turfgrasses can usually withstand floods better than other plants. However, when submerged in water for an extended period, grass plants may die because waterlogged soils have very little oxygen available for root growth and rot-causing pathogens may become established.

Young seedlings are more sensitive to flooding than established plantings. Sod fields that have been recently seeded or sprigged may fail to establish. Grass seedlings are sensitive to drowning, and may die within hours, even three to four weeks after planting (Wilkinson).

Frosts, Hard Freezes, and Ice Storms

Frosts, hard freezes, and ice storms can cause similar damage to sod. These natural perils injure newly planted seeds or sprigs of turfgrasses. They may prevent seed germination, and stunt (or kill) young plants.

Excessive Fertilization

Fertilizer is applied to mature sod strictly to maintain or enhance color. There is a high risk of burning the turf both in the field and after harvest

when nitrogen is applied during the week before harvest. Ammonia and urea fertilizers can volatilize inside the sod rolls or folded pads, acting almost as fumigants and killing the grass. Nitrogen fertilizers also stimulate pathogens that can kill grass plants in the short time between harvest and installation. The risk decreases with lower temperatures, but is always present (Cockerham).

Thatch

Thatch is a layer of partially decomposed grass stems and roots, normally 1/4- to 1/2-inch thick, that accumulate over many years between the live grass and the soil. Thatch may interfere with the flow of nutrients, water, and air to the grass roots, harbor insects and plant diseases, and interfere with the action of insecticides and fungicides.

Thatch builds up rapidly with the use of excessive fertilizer, the frequent use of irrigation, and in conditions where the soil is too acidic. Since thatch accumulates over many years, it becomes a particular problem when the sod is left unharvested for a number of years due to unfavorable market conditions.

The best time to de-thatch is late spring for warm-season grasses and in the fall for cool-season grasses (Smith). Thatch is removed with a de-thatching machine, often called a verticutter, that has vertical rotating blades that slice through the turf, cutting out the thatch.

High Salinity

Soil salinity is a frequent problem in arid climates. Irrigation can leach the soil and correct problems with excessive soil salinity. The salts wash out of the soil if the water has a lower salinity level than the soil (Cockerham). However, a field cannot profitably produce sod if the water is more saline than the soil.

Alkali soils occur when sodium is present in very high concentration. Sodium-affected soils become so tight that water cannot move through. Although gypsum applications correct the condition, growers should not try to produce sod on alkali soils (Cockerham).

Diseases

Most of the diseases attacking turfgrasses are caused by fungi. Fungi are simple plants that prefer moist conditions, and are usually controlled by keeping the plant leaves or the soil dry. However, frequent irrigation is necessary for turf because of its shallow root system. In addition, grass blades are usually surrounded by humid air because they are packed so closely together and are close to the soil. Turfgrasses also have the capacity to store nutrients, especially nitrogen, making the grass an inviting target for fungi.

Leaf Spot

Leaf spot is caused by several fungi. They cause the grass to turn brown and thin out in irregular patches that are 2 or more feet in diameter. Both the green and brown grass blades have small oval spots with straw-colored centers and dark maroon borders.

The most devastating leaf spot damage usually occurs in warm summers. It can kill the grass blades, spread to the base of the plant, and kill the entire plant. Turfgrasses that are rich in nitrogen, under stress from short mowing, and that receive frequent and light waterings are the most susceptible to leaf spot attack. Fungicides and resistant varieties are available for control.

Rusts

Rusts are caused by a fungus of the *Puccinia* species, and occur most often on Merion Kentucky bluegrass, ryegrass, and zoysiagrass. Rusts are most active during moist, warm weather with temperatures between 70° F to 75° F, and in shady areas, but can be active all winter in mild areas. Moisture stress, nitrogen deficiency, and close mowing increase susceptibility to rust.

Grasses affected by rust turn light green or yellow, and the stand thins out. An orange powder coats the grass blades and rubs off easily, while reddish-brown lesions under the powder do not rub off. The orange powder is composed of millions of microscopic spores that spread easily in the wind. Turfgrasses severely affected by rust are more likely to suffer winter damage. Fungicides and the use of resistant varieties are control measures (Smith).

Leaf Smut

This disease is caused by the fungus *Ustilago striiformis* (or stripe smut) and *Urocystis agropyri* (or flag smut). Leaf smut is most prevalent on Kentucky bluegrass. It causes grass blades to turn pale green to yellow, with long yellowish streaks that later turn gray to black. Blades that curl, wither, and shred in thin strips from the tip downward are likely under the attack of leaf smut. Spores causing this disease infect the plant's crown and adjoining underground stems. The fungus then grows throughout the plant's tissues.

The disease is most active in cool weather, with a temperature range of 50° F to 60° F. The diseased plants then die during the next period of hot weather. Although difficult to eliminate completely, the severity of its infection can be lessened by applying a fungicide, followed by thorough watering, so that the fungicide will reach the roots and can be absorbed into the plant. Also, resistant varieties are available (Smith).

Pythium Blight

This disease is also called grease spot or cottony blight. Turfgrasses most susceptible to their attack are those under stress from heat (85° F to 95° F) and that are grown in poorly-drained soils. Ryegrass is the most susceptible turfgrass to pythium blight.

Pythium blight causes grass sections to wilt, shrivel, and turn light brown in irregular spots that are 1/2- to 4-inches in diameter. The spots can enlarge rapidly, forming streaks that are 1 foot wide (or wider) and patches that are 1- to 10-feet in diameter. Blades are often meshed together by white, cobweb-like threads in the early morning before the dew dries. Severely-infected areas often never recover, and affected grass can die within 24 hours.

The fungal spores causing pythium blight spread easily in free-flowing water or on the wheels of mowers. The disease is hard to control because it spreads rapidly, killing large areas in hours. Fungicides are used to control the disease as soon as it is noticed and during hot, humid weather. The avoidance of over-watering during hot, humid weather is also a preventative measure (Smith).

Fusarium Blight

Fusarium blight is caused by several fungal organisms that are active during the summer at temperatures between 75° F and 100° F. It primarily attacks Kentucky bluegrass. Fusarium blight causes crescent-shaped or streaked patches of varying sizes to appear on the grass blades. They are first light green and then turn straw-colored. Often the center patch remains green, resulting in a "frog-eye" pattern. The basal portions of dead stems dry out and turn brown or black.

Grasses that are under moisture stress, exposed to hot dry winds, or that are scalped by mowing are most susceptible to the disease. Although new grass may fill the dead areas during cool weather in the fall, the disease may recur the following year.

Fungicides containing benomyl or iprodione can be applied before the disease recurs the following year, followed by thorough watering. Resistant varieties are also available (Smith).

St. Augustinegrass Decline

St. Augustinegrass decline is a viral disease that weakens St. Augustinegrass for several years, yielding low-quality sod. The grass, however, can recover from the damage, and it does not result in death of the sod (Duble).

Brown Patch

Brown patch is a disease caused by the fungus *Rhizoctonia solani*. It is one of the most prevalent diseases attacking turfgrasses in warm and humid areas with temperatures that range between 75° F and 85° F. The lush, tender growth that results from excessive nitrogen fertilization is the most susceptible to attack.

Symptoms of the disease include circular patches of dead grass that may be of varying diameters, and that are surrounded by dark-purplish smoky rings and filmy-white tufts that cover the blades in the early morning before the dew dries. Sometimes, only the blades are affected, allowing the turf to recover.

However, when warm weather continues, the disease attacks the plant's crowns and kills the grass completely.

Fungicides are used to control brown patch. Keeping the turf as dry as possible also can prevent spread of the disease (Smith).

Powdery Mildew

Powdery mildew, caused by the fungus *Erysiphe graminis*, is most prevalent when the nights are cool (in the 65° F to 70° F range) and damp, and the days are warm and humid. Shady areas also favor development of powdery mildew. It is most severe on Merion Kentucky bluegrass, but also attacks other varieties of bluegrass, fescues, and bermudagrass.

Powdery mildew causes a whitish-gray mold to appear on the upper surfaces of grass blades during cool, rainy weather. The mold turns into powdery spores that spread easily in the wind, and grass plants can become infected in 2 to 4 hours. Severely-infected plants wither and die. Benomyl can be used when the disease is first detected (Smith).

Dollar Spot

Also known as small brown patch, the fungus that causes dollar spot is most active during warm (60° F to 85° F), moist days and cool nights, particularly during May to June, and September to October. The disease mainly attacks Kentucky bluegrass and bermudagrass, and is easily spread by shoes, hoses, mowers, and other equipment.

Grasses under moisture- and nitrogen-deficiency stress are most susceptible to dollar spot attack. The turf turns light brown to straw-colored, and covers a circular area ranging in size from a silver dollar to 6 inches in diameter. Although an infection seldom causes permanent damage, it may take several weeks or months for the grass to recover. For control, fungicides may be applied. Dollar spot is avoided if the turfgrass is kept as dry as possible, and proper nutrient levels are maintained (Smith).

Insects

Insects can damage turf growth, interfere with harvesting, and render the sod unmarketable. Insects are classified as subsurface feeding (those that feed on roots and rhizomes), surface feeding (those that cause damage to grass shoots, leaves, and stolons), or sod inhabiting (those whose feeding habits have no direct damage to the turf, but that cause production, harvesting, or sales problems).

Bermudagrass Mites (surface feeding)

Bermudagrass mites (*Eriophyes cynodoniensis*) are related to spiders, and are a major pest only to bermudagrass. They suck sap from the base of the blades, the blade sheaths, and the stems. Their feeding habits produce tight rosettes or knots on the plant, causing the grass to turn yellow and then brown.

Eventually, the plant may die. Green growth does not appear when populations are high. The mites are most prevalent on well-fertilized bermudagrass and during humid weather, particularly with temperatures of 75° F and above. They reproduce rapidly.

Chinch Bugs (surface feeding)

This surface-feeding bug is of the *Blissus* species. They feed on many kinds of turfgrass, but are the most serious problem for St. Augustinegrass. They are sun- and heat-loving insects. Both the adults and the nymphs suck the juices out of the grass blades. At the same time, they inject a poison that causes the blades to turn brown and die. Heavy infestations may completely kill the turfgrass field. Insecticides are used for control. Irrigation should precede insecticidal spraying to bring the insects to the surface (Smith).

Nematodes (subsurface feeding)

Nematodes are microscopic worms that live in the soil. They damage the grass roots, preventing the uptake of sufficient water and nutrients to the leaf blades, causing stunted growth or death. They thrive best in moist, sandy loam soils and are most severe in the South. They may be carried long distances by soil, water, tools, or infested plants. There are no easy-to-use nematicides to control their populations. It is best, therefore, to test the roots and soil for their presence, and to fumigate the soil before turfgrass establishment.

Billbugs (subsurface feeding)

Billbugs are of the *Sphenophorus* species. Newly-hatched larvae hollow out the grass stems and crown, leaving fine sand-like excrement. Older larvae can chew the roots. They can cause the grass to turn brown and die in expanding patches from mid-June to late August. Insecticides are used for control. However, once the larvae have moved to the roots and inside the crown, chemical control is not effective.

Mole Crickets (subsurface feeding)

Mole crickets prefer bahiagrass and bermudagrass stands, but also feed on St. Augustinegrass, zoysiagrass, and centipedegrass. They tunnel through the top 1 to 2 inches of soil, loosening it and uprooting plants, causing them to dry out. They also feed on grass roots, resulting in stunted growth. Large areas of the stand may turn brown and die. They are active at night, and in the daytime, they return to their underground burrows. Insecticides are used for control after the eggs hatch and before the young nymphs cause damage. Mowing and watering the field should precede insecticide application because mole crickets are not active in dry soil.

Sod Webworms (surface feeding)

In the adult stage, sod webworms are night-flying moths. The moths drop eggs into the grass as they fly. The eggs hatch and turn into light brown or gray worms with black spots, and are 1/4- to 3/4-inch long. These worms feed on grass blades at night or on cloudy, rainy days, forming brown patches in the turf that are about the size of a saucer. Grass blades are chewed off at the soil level. In the daytime, the worms hide in white, silky tubes in the soil. A field may die in several days if the infestation is severe. Insecticides are used for control.

Grubs (subsurface feeding)

Grubs are the larvae of different kinds of beetles. They feed on turf roots 1 to 3 inches deep in the soil, causing the turf to turn brown in large patches. They may kill an entire field. The adult beetles do not damage the turf, but they lay eggs in the soil in the spring and summer. In late fall, the grubs move deep in the soil to over-winter and resume feeding in the spring. For preventive control, insecticides are applied at the first appearance of a problem (Smith).

Armyworms (surface feeding)

Armyworms are light tan to dark brown caterpillars (with yellow, orange, or dark brown stripes) that chew on grass blades. They may completely strip a turfgrass area in 2 to 3 days. They are most prevalent after cold, wet spring weather, with the greatest damage occurring around mid-May. They do not over-winter in cold areas, although the moths migrate great distances in search of places to lay eggs. Insecticidal sprays may be used for control.

Ants (sod-inhabiting)

Ants live underground in hot, dry areas. Even though they do not feed on the grass, they may damage the plants in several ways. As they tunnel among the grass roots, small mounds or hills of soil occur in the turf. In addition to uprooting plants, the mounds of soil may dry out and kill the plants. Ants feed on newly-planted grass seeds and sometimes store seeds in their nests. Growers are restricted by law from shipping sod infested with fire ants to fire ant-free areas. Currently, only one insecticide (chlorpyrifos) can be used for preparing sod for shipment out of infested areas into ant-free areas (White, et. al.).

Weeds

Turf contaminated with weeds is not of high quality. Weeds can be classified as broadleaf weeds and grass-type weeds. Broadleaf weeds that may invade a sod field include buttercup, carpetweed, clovers, henbit, spurge, wild onion, wild garlic, and thistles. Grass-type weeds can be annuals such as crabgrass, annual bluegrass, and goosegrass, or perennials such as common bermudagrass.

Weed control in turfgrass sod production may include chemical controls, hand weeding, and mowing. Close mowing of turf suppresses broadleaf weed activity, but does not control grassy weeds. Selective herbicides are effective when applied correctly (White, et. al.).

A hand-weeding crew can weed a turfgrass field if few weeds are present. This is at times a preferred method because it takes several weeks for a herbicide to be effective, and the risk of injury due to improper herbicide application may at times be high. Some herbicides can also inhibit the rooting of newly-installed sod, by as much as 6 to 10 weeks (Cockerham).

Regional/State Analysis

New Jersey (Northeast Region)

The Census of Agriculture reported 41 farms in New Jersey with 3,998 acres of sod in 1992 (Table 1). The value of sod production in that year was $11.6 million. In the Northeast region, New Jersey is the dominant state both in terms of acreage and total market value. Nearly a quarter of New Jersey's sod acreage is located in Monmouth County, while about 19 percent is in Burlington County.

Sixty-one percent of the farms with sod in New Jersey had $100,000 or more in sales in 1987 (Appendix table 1b). Thirty-nine percent of New Jersey's sod farms were individual- or family-owned operations in 1987, 32 percent were partnerships, and 29 percent were corporate-type farms (Appendix table 3b).

Cultural Practices

New Jersey growers usually plant sod in late summer or early fall. The most common turfgrass species planted are Kentucky bluegrass and tall fescue. Both are cool-season grasses that are established through seeding. New Jersey sod growers have stopped producing warm-season grass sod in recent years (Murphy).

Almost all of the farms growing sod are irrigated, typically using a sprinkler irrigation system. Sod growers usually practice crop rotation. Some growers rotate their fields every year, while others rotate every three to four years, depending on market conditions (Murphy).

All New Jersey growers harvest sod mechanically using the clean-cut method. Both Kentucky bluegrass and tall fescue sod are ready for harvest about a year after planting. There is some flexibility, however, in the harvest period. When market conditions are not favorable, growers allow their sod fields to remain under low maintenance for up to 3 or 4 years (Murphy). When this is done, difficulties may arise in harvesting, and the risk of insect and disease problems is higher.

New Jersey sod growers often deliver turfgrass to landscapers, contractors, and other buyers. Growers usually own their own trucks. Occasionally, they also install the sod at the delivery site (Murphy).

New Jersey has a Certified Sod Program run by the New Jersey Department of Agriculture. This program is voluntary and currently, less than half of the sod growers have requested sod certification (Murphy).

Production Perils

The most common weather-related production peril encountered by New Jersey growers is drought. This situation may result in higher expenses due to the need for increased irrigation or, at the other extreme, the actual loss of a sod field if ponds run dry.

The most damaging insect pests are white grubs, while the most common diseases include pythium blight and brown patch. Damage due to these insects and diseases is most prevalent during the summer.

Industry Organizations

The Cultivated Sod Association of New Jersey is comprised of about 40 growers and associated industry representatives. They hold quarterly meetings, at times with the assistance of the Farm Bureau. Their main function lies in sharing information, the offering of educational programs, and updates on industry rules and regulations.

Demand For Crop Insurance

There probably would be minimal interest among New Jersey growers in a sod crop insurance policy. Because of the widespread use of irrigation, drought causes major losses only in the event of a severe and prolonged dry period. Insects and diseases can be controlled using current cultural practices. In addition, New Jersey growers produce mainly Kentucky bluegrass and tall fescue, which are well adapted to the state's climate.

The small amount of ad hoc disaster assistance paid for sod between 1988 and 1993 indicates that losses due to weather-related perils are minor. While New Jersey accounted for 2.6 percent of the average U.S. sod acreage, disaster assistance payments for sod were only 0.1 percent of the U.S. total during the 1988 to 1993 period (Table 5). The $9,000 paid in disaster assistance to New Jersey growers during that period amounted to only 0.07 percent of the state's estimated value of sod production (Table 6).

Minnesota (North Central Region)

The Census of Agriculture reported 90 farms in Minnesota harvesting 10,566 acres of sod in 1992. The total value of the crop in that year was $12.3 million (Table 1). Sod acreage in Minnesota ranked as the fourth largest in the U.S., and accounted for nearly 5 percent of U.S. total sod acreage. The value of Minnesota's crop accounted for about 3 percent of the U.S. total.

Production is concentrated mainly in Anoka (33 percent of Minnesota's sod acreage), Dakota (13 percent), and Chisago (11 percent) counties. Sod farms usually are near metro areas, which are their major markets (Peterson). The

Table 5--Disaster assistance payments for sod, by region and State, 1988-93

Region and State	Average sod acreage 1987-92	Share of U.S. Acreage	Total sod disaster payments, 1988-93	Share of U.S. sod disaster payments
	Acres	Percent	Thousand Dollars	Percent
Northeast	14,387	7.2	427	4.9
Connecticut	1,117	0.6	0	0.0
Maine	NR	--	157	1.8
Massachusetts	396	0.2	27	0.3
New Hampshire	610	0.3	0	0.0
New Jersey	5,184	2.6	9	0.1
New York	3,247	1.6	52	0.6
Pennsylvania	1,673	0.8	28	0.3
Rhode Island	2,319	1.2	153	1.8
Vermont	NR	--	0	0.0
North Central	49,644	24.7	3,364	38.7
Illinois	9,370	4.7	174	2.0
Indiana	3,209	1.6	0	0.0
Iowa	2,076	1.0	419	4.8
Kansas	3,213	1.6	326	3.7
Michigan	7,013	3.5	61	0.7
Minnesota	9,259	4.6	366	4.2
Missouri	3,502	1.7	1,577	18.1
Nebraska	1,390	0.7	0	0.0
North Dakota	34	0.0	0	0.0
Ohio	4,409	2.2	67	0.8
South Dakota	423	0.2	0	0.0
Wisconsin	5,929	2.9	374	4.3
South	111,808	55.6	4,848	55.8
Alabama	9,731	4.8	198	2.3
Arkansas	2,142	1.1	266	3.1
Delaware	518	0.3	100	1.2
Florida	50,991	25.4	779	9.0
Georgia	8,268	4.1	8	0.1
Kentucky	1,488	0.7	0	0.0
Louisiana	1,857	0.9	268	3.1
Maryland	3,205	1.6	1,330	15.3
Mississippi	1,232	0.6	132	1.5
North Carolina	1,396	0.7	139	1.6
Oklahoma	3,465	1.7	1	0.0
South Carolina	4,256	2.1	39	0.5
Tennessee	2,059	1.0	1,054	12.1
Texas	19,213	9.6	334	3.8
Virginia	2,164	1.1	193	2.2
West Virginia	58	0.0	8	0.1

West	24,305	12.1	52	0.6
Alaska	NR	--	0	0.0
Arizona	1,507	0.7	0	0.0
California	7,813	3.9	0	0.0
Colorado	4,791	2.4	0	0.0
Hawaii	58	0.0	0	0.0
Idaho	1,049	0.5	0	0.0
Montana	329	0.2	0	0.0
Nevada	656	0.3	0	0.0
New Mexico	1,331	0.7	0	0.0
Oregon	1,576	0.8	0	0.0
Utah	2,902	1.4	2	0.0
Washington	2,097	1.0	50	0.6
Wyoming	223	0.1	0	0.0
United States	201,116	100.0	8,691	100.0

NR= Not reported.

Note: Sod acreage is averaged for the years 1987 to 1992 only. A linear trend was used to estimate acreage data for 1988 through 1991 utilizing 1987 and 1992 Census of Agriculture data. Disaster assistance data are averaged over the 1988-93 period.

Sources: 1987 and 1993 Censuses of Agriculture and ASCS data files.

Table 6--Sod: Estimated crop value and disaster assistance, by region and State

	Estimated cumulative crop value 1988-92	Total disaster payments 1988-93	Disaster payments, percent of crop value
	------1,000 dollars------		Percent
Northeast	42,043	427	1.01
Connecticut	3,784	0	0.00
Maine	NR	157	--
Massachusetts	855	27	3.17
New Hampshire	1,761	0	0.00
New Jersey	13,596	9	0.07
New York	12,149	52	0.43
Pennsylvania	3,775	28	0.74
Rhode Island	6,466	153	2.36
Vermont	NR	0	--
North Central	85,511	3,364	3.93
Illinois	20,861	174	0.84
Indiana	6,670	0	0.00
Iowa	4,019	419	10.43
Kansas	5,165	326	6.31
Michigan	10,259	61	0.59
Minnesota	11,183	366	3.27
Missouri	5,560	1,577	28.37
Nebraska	2,379	0	0.00
North Dakota	91	0	0.00
Ohio	8,224	67	0.82
South Dakota	937	0	0.00
Wisconsin	10,574	374	3.54
South	186,043	4,848	2.61
Alabama	17,693	198	1.12
Arkansas	3,821	266	6.97
Delaware	1,177	100	8.50
Florida	67,344	779	1.16
Georgia	25,677	8	0.03
Kentucky	2,342	0	0.00
Louisiana	2,787	268	9.62
Maryland	6,306	1,330	21.10
Mississippi	1,885	132	7.00
North Carolina	5,022	139	2.76
Oklahoma	5,720	1	0.01
South Carolina	6,963	39	0.56
Tennessee	3,906	1,054	26.98
Texas	30,925	334	1.08
Virginia	4,946	193	3.90
West Virginia	NR	8	--

West	124,443	52	0.04
Alaska	NR	0	--
Arizona	7,453	0	0.00
California	71,727	0	0.00
Colorado	12,528	0	0.00
Hawaii	697	0	0.00
Idaho	2,875	0	0.00
Montana	1,059	0	0.00
Nevada	2,608	0	0.00
New Mexico	4,099	0	0.00
Oregon	11,030	0	0.00
Utah	7,336	2	0.02
Washington	10,043	50	0.50
Wyoming	469	0	0.00
United States	439,638	8,691	1.98

NR= not reported.

Note: A linear trend was used to estimate crop values during 1988 through 1991 utilizing 1987 and 1992 Census of Agriculture data on sod sales.

Sources: 1987 and 1992 Censuses of Agriculture. Disaster payments are from ASCS data files, compiled by the General Accounting Office.

Census of Agriculture reported that, in 1987, 44 percent of Minnesota's farms with sod had sales of $100,000 or more (Appendix table 1b).

Cultural Practices

Sod growers in Minnesota usually plant in late summer or early fall, with August the most common planting month. Most of Minnesota's sod production is established from seeds. The time from planting to harvest is at least one year.

Because of cold winters, Minnesota produces only cool-season grasses for sod. Kentucky bluegrass accounts for about 99 percent of the state's production. A small proportion of farms also grow ryegrass and other bluegrasses. About 15 to 20 percent of the farms are irrigated, with sprinkler irrigation systems the most common. Most growers plant in August because they do not need to irrigate in the following months, which are often cool and moist (Peterson).

Plastic netting is not a common practice among Minnesota growers. This is because Kentucky bluegrass produces rhizomes, and therefore has the ability to "knit together" well. A few growers use netting to reduce the time needed for establishment, and when growing ryegrass, which does not produce rhizomes.

Harvesting is done mechanically with a tractor-mounted harvester and a sod roller. Harvesting can be delayed for up to three years if market conditions are not favorable (Fender). According to one sod grower, harvesting expenses are about 50 percent of total sod production costs (Hogdal). Harvested sod is not inspected unless exported to Canada (Klint).

Sod is marketed through varying channels. While almost every producer sells sod at the production site, some growers also haul sod to the sites of buyers who have their own crews for installation. Garden centers and retailers typically use their own trucks and load pallets at the production site.

Production Perils

Heat and drought are the most severe production perils in Minnesota. During the last two years, sod producers also experienced excessive rains and cold summers that promoted weed development (Jensen; Peterson). The most common weeds include bentgrass, quackgrass, or contamination by another bluegrass. These grass-type weeds affect the marketable quality of sod because they are difficult or even impossible to eradicate.

Damage due to insects and diseases is not usually a major problem on Minnesota sod farms because the fields are usually large and located in open areas where there is free air movement (Peterson).

Ad hoc disaster payments to turfgrass sod producers were reported in Minnesota for losses due to frost and ice in October of 1991, and to excessive rains and a relatively cold summer in 1993.

Industry Organizations

The Minnesota Turf Association (MTA) offers education, marketing, and outreach to sod growers. Growers account for about 90 percent of MTA's membership. According to Kurt Klint, Executive Director of MTA, sod producers do not need to have their sod inspected prior to marketing, except for export to Canada. There is also a Minnesota Turf and Grounds Association, to which MTA sends a representative.

Demand For Crop Insurance

Minnesota growers will probably have an interest in a crop insurance policy for sod. Even though insect and disease problems do not appear to be a major threat to their production, they have experienced rather significant losses due to weather-related perils. Drought, excessive heat, excessive rains, ice storms, and frost were among those mentioned. Losses due to drought can be severe, as 80-85 percent of Minnesota's sod farms are not irrigated.

Disaster assistance payments for sod losses between 1988 to 1993 amounted to about 4 percent of the U.S. total, and were slightly over 3 percent of the state's estimated value of sod production (Tables 5 and 6). Ad hoc disaster payments to Minnesota growers totalled $366,000 over that six-year period.

Illinois (North Central Region)

According to the Census of Agriculture, Illinois had 46 farms that produced sod in 1992 (Table 1). These farms had 9,320 acres in sod production, with a total value of sod production of $21.3 million. About 32 percent of the sod acreage was in Kankakee County, 21 percent was in McHenry County, and 15 percent was in Will County. These counties are all in the northeastern part of the state.

In 1987, the Census of Agriculture reported that 73 percent of Illinois farms with sod had sales of $100,000 or more (Appendix table 1b). Forty-eight percent of the farms with sod were corporations, 39 percent were individual- or family-owned operations, and 11 percent were partnerships (Appendix table 3b).

Cultural Practices

Cool-season grasses dominate sod production in Illinois, where winters are cold and summers are warm and humid with frequent thunderstorms. The most common turfgrass sods are Kentucky bluegrass and creeping bentgrass. Sod producers usually seed fields in late summer or early fall at a rate of 30 to 45 pounds per acre. Sod can be seeded in the spring, although weed control is more of a problem than for fall seeding. A few bluegrass growers allow their stands to propagate vegetatively, rather than through the seeding method. However, this practice is used only by a very few growers (Voight).

The majority of Illinois growers irrigate. Illinois sod is typically ready for harvest about 12 to 18 months after seeding. Most of the harvesting is

done mechanically, and the fields are then re-seeded the following fall. If sod prices are low, growers sometimes postpone their harvesting activities until profitable market conditions return (Fender).

Some growers use plastic netting, particularly for grasses that do not produce rhizomes, such as tall fescue. Tall fescue sod is not, however, commonly grown in Illinois.

Production Perils

Because of the hot, humid summers, weeds and insect damage (particularly by white grubs and billbugs) are the most common production perils encountered by sod producers in Illinois. However, intensive field management generally provides adequate control (Fender).

In more recent years, excessive rains and flooding have been a problem. As an example, during July 1993, three levies in Adams County broke due to excessive rains, leaving an estimated 40,000 cropland acres (including farms with sod) under water. Sod growers usually re-seed their fields in August or September, but the fields remained very wet until the first of 1994 (Dingerson).

Industry Organizations

Turfgrass Producers International (TPI), formerly the American Sod Producers Association (ASPA), is an international, independent, non-profit association. It is the leading organization promoting the turfgrass sod industry, with offices based in Illinois. The organization is comprised of 940 members with 227 international members in 35 countries. Membership includes sod producers and others involved in the production of turfgrass sod.

The organization has over 650 farm members, representing 75 to 80 percent of the acres in sod production in the United States. Approximately 70 percent of the farm members own and operate sod farms of less than 200 acres, while approximately 11 percent own and operate farms of over 500 acres.

The organization has assumed a leadership role in research, legislative and regulatory issues affecting the industry. It is especially concerned with the benefits of turfgrass sod, to better acquaint the public with their product, and to provide suggestions and instructions for the planting and proper care of their product.

Demand For Crop Insurance

Illinois sod growers may have an interest in a crop insurance policy for sod. Current management practices appear adequate to solve problems caused by insects, diseases, and weeds, the most common problems encountered by their growers (Voigt). Flooding, however, was a major threat in 1993.

Ad hoc payments to Illinois sod growers were about $174,000 during the 1988-93 period, about 2 percent of the U.S. total (Table 5). These payments amounted

to less than 1 percent of the estimated value of sod production in the state (Table 6).

Florida (Southern Region)

The Census of Agriculture reported 154 farms in Florida producing 52,030 acres of sod in 1992. The value of Florida's sod production in that year totalled $64.2 million (Table 1). Florida ranked first in U.S. sod acreage, accounting for about 24 percent of the U.S. total. Florida ranked second to California in the value of sod production, with 14 percent of the U.S. total.

About 70 percent of Florida's sod acreage is in the southern portion of the state. Forty-three percent of Florida's sod acreage was located in Palm Beach County in 1992, 7 percent in Osceola County, 5 percent in Hendry County, and 4 percent each in Polk County and Hillsborough County. Highlands, Lake, and Orange counties accounted for an aggregate of 7 percent of the state's sod acreage.

Thirty-five percent of Florida farms producing sod in 1987 had $500,000 or more in sales, while 26 percent had sales of $100,000 to $499,999 (Appendix table 1b). The very largest farms produce over 60 percent of the industry's total output (Hodges, et. al.). About 45 percent of Florida farms with sod were corporations (mostly family-held), 36 percent were individual- or family-owned farms, and about 17 percent were partnerships (Appendix table 3b).

A recent University of Florida study indicates that small sod farms averaged about 200 acres in size in 1988, medium-sized farms were 660 acres, and large farms were 1,245 acres. The largest category averaged 4,755 acres in 1988 (Hodges, et. al.)

Cultural Practices

St. Augustinegrass and bahiagrass are the two dominant grass species grown in Florida. About 72 percent of Florida's sod acreage in 1991-92 was identified as St. Augustinegrass, 20 percent was bahiagrass, 4 percent was bermudagrass, and 4 percent was centipedegrass (Hodges, et. al.). Both bahiagrass and centipedegrass are established mainly by seed, while St. Augustinegrass and bermudagrass are propagated vegetatively from freshly-harvested sprigs.

About 75 percent of Florida's sod acreage is irrigated. Common irrigation methods include the use of fixed units such as pivot irrigation, portable units such as tractor-mounted or self-propelled travelling guns, and seepage irrigation from ditches or high-maintained water tables. The use of these methods depends upon the size of area to be irrigated and the farm's location (Haydu and Cisar).

The most common harvesting method leaves strips or "ribbons" of sod that are about 2 to 3 inches wide in the field. These ribbons are used to regenerate the sod for future harvest (Haydu and Cisar). In 1987, sod growers harvested about 70 percent of the total area under production. The significant amount of unharvested acreage may be attributed to bahiagrass producers, who harvest

sod less frequently than other growers. Some growers also leave their fields unharvested for years when market conditions are not very favorable (Hodges, et. al.).

Between 1963 and 1987, the number of firms entering the sod industry roughly doubled in Florida. Medium and large producers experienced the most dramatic shifts in varietal emphasis and planted acres between 1963 and 1987, resulting in a doubling of their harvesting ratio (Haydu and Cisar).

St. Augustinegrass accounted for ninety-five percent of Florida's 1991-92 sod sales, with the remaining sales consisting of bermudagrass, bahiagrass, and centipedegrass (Table 7). Farm-gate prices vary according to grass species, with bermudagrass and centipedegrass sod the most expensive, and bahiagrass the cheapest. Bahiagrass sod is used mainly as ground cover for roadsides, airports, and cemeteries (Haydu and Cisar).

Most Florida sod is marketed with the buyer making arrangements for pickup, delivery, and installation. Contract growing is also used, where the grower plants and manages the grass, but is not necessarily responsible for harvest and delivery. Some sod producers provide delivery and installation services. In 1991-92, sod sales accounted for 73 percent of the estimated products and services provided by the sod production industry, with the remainder including transportation, landscaping, and laying sod (Haydu and Cisar).

The smallest growers often ship their sod directly to retail outlets. Rather than specialize, some small growers are vertically integrated so that they can supplement their farm income. They do not have the economies of size in sod production that can be realized by the larger producers (Haydu and Cisar).

Production Perils

Drought has been the most common production peril for Florida sod growers. Drought was the main reason for disaster payments for sod in Pasco County in 1991 and in Union County in 1993. In Union County, growers who applied for assistance said they were unable to irrigate prior to harvesting and following planting, causing death of the sprigs (Roberts).

Diseases affecting Florida sod include fusarium blight, brown patch, pythium blight, and leaf spot. The most common insect perils include mole crickets, fire ants, and nematodes. Disease and insect damage is not typically a serious threat because most sod growers use intensive pest management and land cultivation practices.

Industry Organizations

The Florida Turfgrass Association includes both sod growers and others who are involved in the turfgrass business. The association's main purpose is to keep its membership informed of the latest developments in the turfgrass industry.

Table 7--Florida sod industry revenues: total sales, sales by grass species, and prices received, 1991-92.

Turfgrass	Value of sales	Percent of Florida total	Farm price
	1,000 dollars	Percent	Cents/Sq. Ft.
St. Augustinegrass	113,117	95	8
Bermudagrass	3,451	3	9
Bahiagrass	813	1	6
Centipedegrass	938	1	9
Total	118,318	100	--

Source: Hodges, et. al.

Demand For Crop Insurance

There will likely be interest in crop insurance for sod among Florida growers, particularly if the policy covers drought. While continuous cultivation and management practices lessen the threat of losses due to insects and diseases, drought remains a threat, particularly for the 25 percent of Florida's farms with no irrigation.

Ad hoc disaster payments for sod in Florida over the 1988-93 period totalled $779,000. However, Florida's payments were low relative to the state's sod acreage. Florida's payments amounted to 9 percent of the U.S. total over the six-year period, while Florida's acreage accounted for 25 percent of the U.S. sod acreage (Table 5). Disaster assistance payments amounted to 1 percent of the state's estimated value of sod production over the six-year period (Table 6).

Maryland (Southern Region)

The Census of Agriculture reported 30 farms in Maryland producing 3,171 acres of sod. The value of the state's sod production in 1992 was $6.7 million (Table 1). Twenty-seven percent of Maryland's sod acreage was located in Anne Arundel and Montgomery counties, with about 7 percent in Carroll and Harford counties.

Cultural Practices

Tall fescue and Kentucky bluegrass are the most common turfgrass species used for sod production in Maryland. Some growers also plant bermudagrass. Sod farms in Maryland range from 10 acres to 800 acres in size (Turner).

Sod growers usually establish tall fescue fields through seeding in August and September for harvest the following fall. In general, sod in Maryland takes 6 to 18 months to reach maturity, depending on whether or not irrigation is used (Turner). Growers typically use the clean-cut method for harvesting tall fescue sod and the ribbon-cut method for Kentucky bluegrass.

Maryland has a certified sod program, which is administered by the Maryland Department of Agriculture. Sod that is certified contains only recommended cultivars for Maryland and Virginia, has been seeded in recommended percentages, is of high quality, and is guaranteed free of insects, weeds, and diseases. Grower participation in the program is voluntary.

Production Perils

Excessive heat and drought are the most common weather-related perils faced by Maryland sod growers. During the last few years, numerous farms lost hundreds of acres due to drought (Turner). Disaster payments during 1991 and 1993 were mostly due to losses caused by drought. Some sod producers did not harvest any sod in 1986 because of a dry period in the spring (USDA-MA). Problems due to winterkill have also been encountered with bermudagrass (Turner).

Industry Organizations

The Maryland Turfgrass Association is comprised of sod producers and others in the sod industry. Currently, the association has between 30 and 40 members. Its main function is to disseminate information on the agronomic and business aspects of the sod industry, and on methods for improving sod quality. The association also helped establish the sod certification program in Maryland.

Demand For Crop Insurance

Maryland growers will probably have an interest in a crop insurance policy for sod. Since Maryland is located in the transition zone where grass climates overlap, growers tend to face more uncertainties in sod farming. Selection of grass type and good management practices are very critical.

In recent years, Maryland sod growers have incurred losses caused mainly by drought. While Maryland's share of U.S. sod acreage is only 1.6 percent, disaster assistance payments over the 1988-993 period amounted to about $1.3 million, 15.3 percent of the U.S. total (Table 5). Disaster assistance to Maryland sod growers was the second largest reported in the United States during that period, and accounted for over 21 percent of the state's estimated value of sod production (Table 6).

Alabama (Southern Region)

The Census of Agriculture reported 82 farms with 11,967 acres in sod in 1992 (Table 1). The total market value for Alabama's sod production during that year was $17.8 million. Alabama's sod acreage ranked third in the United States, accounting for slightly more than 5 percent of the total.

Alabama's sod production is clustered in Baldwin, St. Claire, and Barbour counties (Ward). In 1992, about 25 percent of Alabama's sod was grown in Baldwin County, which has sandy soils and a long growing season (Census of Agriculture). Other counties in the state each have smaller sod acreages.

Forty-five percent of Alabama's farms with sod had sales of less than $25,000 in 1987 (Appendix table 1b). About 68 percent of the state's sod farms were individual- or family-owned operations, 24 percent were corporate-type farms, and 7 percent were partnerships (Appendix table 3b).

Cultural Practices

Alabama produces mostly warm-season grasses, including hybrid bermudagrass, centipedegrass, zoysiagrass, and St. Augustinegrass. A few producers also grow turf-type tall fescue, the only cool-season grass grown in the state. The tall fescue grown in Alabama is mostly for out-of-state shipment (Ward).

All of Alabama's warm-season grass production is vegetatively established from sprigs or plugs, except for common centipedegrass and bermudagrass, which can also be established from seed. A majority of growers prefer to plant using

sprigs, although plug planting is often used for St. Augustinegrass and zoysiagrass because of its greater effectiveness (White, et. al.).

Vegetative propagation is either done "in house" by producers or through custom planting contracts. Some producers also do custom planting for other growers. Overall, larger producers prefer to plant "in house," while farms with less than 300 acres usually contract for custom planting (White, et. al.).

Sod growers usually plant warm-season grasses between mid-April and mid-July. Tall fescues are planted in September. Warm-season grasses are planted in the spring so that the plants become well established before winter. Producers in the northern two-thirds of the state are reluctant to initiate establishment of warm-season grasses after September 1 because of the potential for winter injury to new plantings (White, et. al.).

The growing period ranges from 4 to 20 months. Zoysiagrass can be harvested 18 months after planting, while bermudagrass has a relatively faster growth period. A grower in northern Alabama can harvest 3 bermudagrass crops every two years. In southern Alabama, growers can harvest 5 bermudagrass crops every two years (Ward).

Producers with large common centipedegrass acreages also produce seed. The seed is harvested and used on the farm to over-seed vegetative centipedegrass production or is planted on prepared seed beds for establishment (White, et. al.). Growers who produce tall fescue sod use plastic netting to improve the tensile strength and thus, harvesting and handling qualities.

All of Alabama's sod farms are irrigated, and often use a sprinkler system. Sources of water for irrigation are natural streams, rivers, or ponds.

Sod harvesting is done mechanically, with the majority of growers using the ribbon-cut method. If turf is harvested in late summer and new growth is subject to winter injury, ribbons are often left in the field. Growers have reported greater winter injury to clean-cut fields than ribbon-cut fields. Growers in the northern two-thirds of Alabama prefer re-establishment from ribbons because the growing season is shorter and the winters are more severe than in the southern part of the state (White, et. al.)

Over 50 percent of Alabama's sod production is shipped out of state to coastal cities in Florida, to New Orleans, and to Atlanta, where there is a greater demand for sod (Ward). Alabama does not have a large population, and about 30 percent of the population is from rural areas. The average delivery area for small Alabama sod operations is reported at less than 35 miles and for the larger operations, at 175 miles (White, et. al.).

Alabama's sod industry is largely a service industry. Deliveries to the point of sale normally include on-site distribution. Producers must supply both services or discount their sod prices accordingly. For smaller operations that have less than 100 acres, most sales are for field pick-up, although some deliveries are also made to the point of sale.

Forty-six percent of all sod sold in Alabama in 1988 was at the wholesale level (White, et. al.). Table 8 lists the major market outlets for sod in Alabama.

Production Perils

The most common natural perils to sod production in Alabama are floods and droughts. Mole crickets, billbugs, grubs, sod webworms, armyworms, chinch bugs, and fire ants are some of the insects causing damage to sod fields. Mole crickets are the greatest insect threat to sod growers because they chew off the tops and roots of the grass and produce tunnels in the soil, making the sod difficult to lift (Ward). Growers use acephate, ethoprop, isazophos, carbaryl, and chlorpyrifos for insect control. Diseases are not a major threat, except to tall fescue and St. Augustinegrass, which may be affected by brown patch and gray leaf spot.

Industry Organizations

The Alabama Turfgrass Association's membership consists of sod growers, golf course superintendents, professional lawn care companies, and other service turfgrass-related companies. The association provides education on turfgrass production and is a vehicle for legislative initiatives. The association does not provide a marketing program.

Demand For Crop Insurance

There will likely be some interest in a crop insurance policy for sod among Alabama growers, particularly one which covers droughts and floods. Sod producers experienced about 12 inches of rain in 1994, causing flooding in some areas (Ward). There may also be interest in sod insurance if the policy covers losses due to mole crickets. Other disease and insect problems can be handled using current management practices.

Drought was the cause of disaster payments for sod in 1991, even though all of Alabama's sod farms are irrigated. Growers may experience inadequate water supplies for irrigation if natural streams, rivers, and ponds dry up during prolonged periods of drought (Ward).

During the period from 1988-93, Alabama sod growers received $198,000 in ad hoc payments. Alabama growers did not, however, collect disproportionate payments relative to their acreage. Alabama accounted for about 5 percent of U.S. sod acreage, while ad hoc payments to the state amounted to about 2 percent of the U.S. total (Table 5). Alabama's disaster payments over the six-year period amounted to about 1.1 percent of the state's estimated value of sod production (Table 6).

Texas (Southern Region)

The Census of Agriculture reported 156 farms in Texas growing sod on 21,515 acres in 1992. The value of Texas sod production in that year was $37.8 million (Table 1). Texas had the largest number of farms producing sod in

Table 8--Volume and value of sales by major market outlets for surveyed turfgrass growers in Alabama, 1988 [1]

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
Gov't. agencies	137,917	1	142,054
Total	14,672,000	100	15,112,159

[1] Based on responses from 30 (of 79) Alabama growers, 1988.
[2] Average of $1.03 per square yard for all sod, with no transport charges included.

Note: Government agencies include athletic departments, recreation or park facilities, and school sytems.

1992, and the state ranked second in U.S acreage, accounting for nearly 10 percent of the U.S. total. About 34 percent of Texas's sod acreage was in Wharton County in 1992, 17 percent was in Harris County, and 12 percent was in Matagorda County. All of these counties are in the southeast coastal portion of the state.

More than half of the farms growing sod in Texas in 1987 had a total value of crop sales less than $100,000 (Appendix table 1b). Sixty percent of Texas's sod farms were individual- or family-owned operations, 26 percent were corporate farms, and 12 percent were partnerships (Appendix table 3b).

Cultural Practices

St. Augustinegrass and bermudagrass are the most common turf species produced in Texas. Currently, about 70 percent of the sod produced and marketed in the state is St. Augustinegrass. Zoysiagrass and centipedegrass are other warm-season grasses produced in Texas. Growers usually plant in the spring or early summer. Plastic netting is not used by growers.

All Texas's sod farms are irrigated, with sprinklers the most common method. Sprinkler systems usually consist of either permanent (underground) pipes or portable irrigation tubing that is moved by hand or mechanically.

Because most of Texas's sod is St. Augustinegrass, the ribbon-cut method of harvesting is widely practiced. With proper fertilization, St. Augustinegrass takes about 12 to 14 months to reach maturity after planting. Bermudagrass is ready for harvest in the fall of the year it is planted. If sod prices are low, growers can forego harvesting for up to a year (Duble).

The primary markets for sod include construction associated with new homes, businesses, and institution. Other markets include new athletic fields, golf courses, roadsides, parks, and existing turfgrass areas undergoing renovation. Approximately 75 percent of the sod produced in Texas is marketed within 200 miles of the production site, and 98 percent is sold in-state (Duble).

Texas has a certification program for sod that is handled by the Seed Division of the Texas Department of Agriculture. Turfgrasses presently approved for certified production include the Raleigh and Floratam types of St. Augustinegrasses, and the Tifdwarf, Tifgreen, Tifway, and Texturf-10 types of bermudagrass. Certified sod insures genetic purity and identity and guarantees reasonable standards of sod quality.

Production Perils

Production perils encountered by Texas sod growers vary by the type of grass. Brown patch damage is a peril for St. Augustinegrass, while white grubs and fire ants are a peril for bermudagrass production (Duble). St. Augustine decline, a viral disease that weakens the grass for a number of years, is not a problem in Texas because growers plant resistant varieties. In general, insect and disease damage is kept at a minimum with proper turf management

practices. Some sod farms incurred losses due to a hard freeze in 1990 (Quinn).

Industry Organizations

The Texas Sod Producers Association has about 50 members. The association provides education, marketing, and promotion assistance to sod producers.

Demand For Crop Insurance

Sod growers in Texas may have some interest in a crop insurance policy for sod. Between 1988 and 1993, disaster assistance payments were made only in 1990, when sod was injured by a hard freeze (Quinn). In Matagorda County, some of the farmers who applied for assistance that year were not able to prevent further deterioration of their sod because they were financially unable to provide the recommended care.

Ad hoc payments made to Texas sod growers amounted to $334,000 over the 1988-93 period. Texas accounted for nearly 10 percent of U.S. sod acreage during that period, and only 3.8 percent of the total disaster assistance payments made for that period (Table 5). Disaster assistance payments to Texas sod growers accounted for only about 1 percent of the estimated value of sod production (Table 6).

California (Western Region)

The Census of Agriculture reported 62 farms in California producing 8,420 acres of sod in 1992. The total crop value was estimated at $79.4 million in that year (Table 1). Ventura County has the largest concentration of sod production in the state, with substantial production also located in Riverside County (Gibeault).

Seventy percent of the farms growing sod in California in 1987 had sales of $100,000 or more (Appendix table 1b). About 48 percent of California's sod farms were corporate-type farms, 34 percent were individual- or family-owned operations, and 16 percent were partnerships (Appendix table 3b).

Cultural Practices

Tall fescue is the major type of sod produced in California, and is seeded mostly in blends of two or three varieties (Gibeault). Kentucky bluegrass and perennial ryegrass are cool-season sods that are also grown in the state. They are generally established from seeds, and produced in mixtures. However, a few Kentucky bluegrasses are established vegetatively. Cool-season grasses can mature in as few as 3 months in California (Cockerham).

In the warmer sections of the state, hybrid bermudagrass, St. Augustinegrass, and centipedegrass are also produced (Fender). These warm-season grasses are usually established by vegetative propagation using sprigs.

Seeding is usually done in the spring or fall, with most growers preferring fall seeding. When temperatures exceed 90° F during periods of dry winds, sod fields may require irrigation 2 or 3 times a day to cool and moisten the soil after seeding (Cockerham).

Seeding is often performed using a drop seeder with rollers. One-half of the seeds are planted in parallel rows, with the remaining half planted in rows perpendicular to the first planting. This seeding method appears to increase stand uniformity (Cockerham). Netting is used for tall fescue seedings.

All of California's farms growing sod are irrigated. The most common method uses a sprinkler system, with portable pipes or movable structures. Sod fields are generally fumigated every 5 years to eliminate weeds, nematodes, and many turf diseases (Cockerham). The broadleaf weeds that thrive after fumigation are controlled with selective weed killers.

Harvesting is done mechanically. Sod harvesting machines have conveyors that carry the sod to a rolling or folding attachment. Most grasses are harvested without leaving ribbons or strips. Ribbons are generally left in the fields with St. Augustinegrass, as it is a less costly method than replanting.

Sod is either loaded directly onto delivery trucks in the field or hauled to a distribution yard. There, the pallets are arranged by order number, held until all trucks are ready, and then loaded onto the delivery trucks. Some growers have built shade covers with sprinklers for their holding areas to keep the sod cool and the outside sod pieces moist.

Most of California's sod is delivered by growers to marketing outlets. In some instances, customers may pick up their own orders.

Production Perils

Drought is the most common weather-related peril encountered by California sod producers. However, this is not a serious threat because all of the sod farms are irrigated. Earthquakes can also be a problem (Gibeault). Floods can create harvesting and maintenance problems, or may prevent the establishment of newly seeded or sprigged fields.

Diseases are not typically a problem because California has low humidity and low rainfall. The most common diseases affecting sod production, however, are Pythium blight and brown patch. Grubs, sod webworms, and cutworms are insect pests of sod, but are more of a problem in maintained turfgrass sod areas, such as parks or home lawns, than in sod fields.

Industry Organizations

The California Sod Producers Association has 40 to 50 members. Although they are not strongly organized, the association represents growers concerning the use of natural resources. Water allocation is their major concern.

Demand For Crop Insurance

There probably will be very minimal interest in a crop insurance policy for sod among California producers. While they experience relatively dry weather year-round, there have been no indications of significant losses due to drought. There were no disaster assistance reported for California sod growers during the period 1988-93.

Ad Hoc Disaster Assistance for Turfgrass Sod

Ad hoc disaster assistance legislation was made available for losses of commercially-grown crops in each of the years 1988-93. Ad hoc payments provide an indication of high-loss areas during that period, and may indicate states and counties that would face relatively high risk under a potential FCIC sod policy. These data may also suggest the areas where the demand for a sod crop insurance policy would be relatively high.

Under the 1988-93 legislation, payments were made under the categories of participating program crops, nonparticipating program crops, sugar, tobacco, peanuts, soybeans, sunflowers, nonprogram crops, ornamentals, and at times, aquaculture. Producers without crop insurance--the case for turfgrass sod--were eligible for payments for losses greater than 40 percent of expected production. If a producer had no individual yield data to use in calculating "expected production," county-level or other data were used as a proxy. Payment rates for sod were based on 65 percent of a 5-year average price, dropping the high and low years.

Disaster assistance payments for sod losses totalled about $8.7 million over the 1988-93 period. Payments for sod losses peaked at $5.1 million in 1993, and were about $1.2 million in 1990. There were no payments for sod losses reported in 1988 and 1989. Payments in 1991 and 1992 averaged about $2.4 million.

Ad hoc disaster payments for sod losses were scattered over a geographically broad area. Thirty-one states received payments in at least one of the six years, with ten states, mainly in the South and North Central regions, collecting payments in three of the last four years.

In an ordering of counties, Lincoln County, Missouri ranked first in payments for sod losses, receiving nearly $344,700, all during 1993 as a result of flood damage. The next three counties in the series include: St. Louis County, Missouri ($325,700); Platte County, Missouri ($325,500); and St. Charles County, Missouri ($307,900). Over 130 counties received payments in at least one of the six years, mainly due to droughts and floods. Five of the top-10 counties were located in Missouri, three were in Maryland, and one each were in Florida and Tennessee.

By state, the largest payments were made to Missouri growers ($1.6 million), Maryland growers ($1.3 million), and Tennessee growers ($1.1 million). Other

states that received at least $300,000 in payments include Florida, Iowa, Wisconsin, Minnesota, Texas, and Kansas.

Ad hoc disaster data can be used to indicate which sod-producing areas received large payments relative to their acreage (Table 5). For example, Missouri produced an average of 3,502 acres of sod between 1987-1992, about 1.7 percent of the U.S. total. At the same time, ASCS disaster assistance data indicate that Missouri accounted for 18 percent of U.S. ad hoc disaster payments made for sod between 1988 and 1993. Maryland's and Tennessee's share of disaster payments, at about 15 percent and 12 percent, were also larger than their share of U.S. acreage, at 1.6 percent and 1.0 percent, respectively.

In contrast, Florida, Texas, and Alabama collected a smaller share of ad hoc payments relative to their acreage. Florida accounted for about 25 percent of average U.S. sod acreage over the 1987-1992 period, and collected about 9 percent of U.S. ad hoc payments for that crop between 1988 and 1993. Texas accounted for nearly 10 percent of U.S. sod acreage, and 3.8 percent of ad hoc payments for sod. Alabama accounted for nearly 5 percent of U.S. sod acreage, and collected 2.3 percent of total U.S. ad hoc payments made for sod.

Turfgrass Sod Insurance Implementation Issues

Adverse Selection

Adverse selection is not likely to be a major problem in offering turfgrass insurance. This is because the most serious production perils tend not to be field-specific. Droughts, for example, are a peril cited as a significant reason for losses in several states. Droughts occur over a wide area, and any one specific field is not likely to be more susceptible to losses than any other.

One exception may be losses due to flooding. Sod planted in a flood plain is more likely to experience flooding than that planted at higher elevations.

Setting Reference Prices

FCIC provides reference prices (price elections) for insured crops, which become the basis for assigning values to yield losses. Insured growers elect a price guarantee as the basis for indemnity payments.

An in-field value of the sod crop probably represents the most appropriate reference price for purposes of setting price elections because it would avoid reimbursing growers for non-incurred expenses. In the event of a yield loss, growers generally would not incur harvesting and marketing expenses, which account for an estimated 20 to 50 percent of total production costs.

A second reason for selecting an in-field value is that there are no reported prices available for sod that could be used to develop a market-price based

reference price. The in-field reference price would be best estimated as the cost of production, exclusive of harvesting and marketing expenses.

Estimating Production History

Several factors complicate the estimation of a grower's production history. The first is that when clean-cutting a field of sod, the yield is limited to a maximum of 43,560 square feet per harvested acre. Yields of less than this amount either represent unharvested area or harvesting of low quality sod that is discarded. The grower has some control over the yield of ribbon-cut sod by altering the width of undisturbed ribbons left in the field to establish the next crop.

Another complication in determining yield is the lack of consistency in the growing periods among the various species. Some species reach marketable quality in less than a year, while some require a much longer growing period.

A third complexity is that sod may be stored unharvested in the field for up to three years, until a buyer is available. In addition, during periods of low prices, a grower may decide to keep the field under low maintenance until market conditions improve rather than harvest the field. The availability of buyers--and the prices they are willing to pay--determine the yield of sod during a specific year.

Estimating "Appraised Production"

In general, estimating appraised production (harvestable, but unharvested yield) is not likely to be an issue in insuring turfgrass sod. In most cases of damage, such as that due to drought, flooding, or frost, loss to a sod crop will cover the entire field, or at least contiguous areas within the field. In the case of partial damage to sod, the undamaged areas of the field are likely to yield normally when harvested.

Market Prices and Moral Hazard

Moral hazard due to low market prices is less likely an issue in offering crop insurance for turfgrass sod than for perishable commodities, such as fresh market fruits and vegetables. This is because sod can be kept unharvested in the field for a long period of time. With many fresh fruits and vegetables, growers must find a buyer offering an acceptable price during the short period of time when their commodity is ready to sell. Growers may lose their entire investment if such a buyer is not found. Such a situation makes an insurance indemnity due to a crop loss an attractive option and creates an incentive for moral hazard.

Because turfgrass growers can keep their sod unharvested for a long period of time (several years), they are under much less time pressure to harvest on a specific date. Sod producers, consequently, are less likely than perishable-commodity producers to encounter situations where collecting an insurance indemnity becomes a more profitable option than maintaining the crop until a

buyer is found. For this reason, moral hazard is not likely to be an issue in offering turfgrass insurance.

Availability of Individual Yield Data

Individual grower yield data do not appear to be readily available. However, certain states have information that may be useful in the process of obtaining and assessing any individual yield data that is obtained. For example, the Alabama Department of Agriculture and Industries maintains a list of registered sod producers in the state. Their current list of sod producers also indicates planted acreage by grass species.

Auburn University, in cooperation with other institutions, conducted a survey of commercial turfgrass sod producers in Alabama during 1988. The survey elicited data on the species produced, the size of operations, demographic characteristics, and the market outlets used by growers. Detailed information were also collected on production, harvesting, and marketing practices in 1987. The resulting data were compared with a similar survey conducted in 1979. Although yields are not reported for individual growers, county data on the number of growers, acreage, and unit prices for each grass species may aid in computing a historical yield series for individual growers.

Relevant data are also available from Florida. The University of Florida has conducted three surveys profiling Florida's turfgrass sod industry, for the years 1963, 1974, and 1987. An economic comparison of the industry was conducted using data from these three surveys, and was reported in a 1992 publication, "An Economic and Agronomic Profile of Florida's Turfgrass Sod Industry" (Haydu and Cisar). The report includes data on acres planted and harvested by species and by farm size. Another recent economic report was published in December 1994, "Contribution of the Turfgrass Industry to Florida's Economy, 1991/92: A Value Added Approach" (Hodges, et. al.). This report includes data on the cut sod industry's total sales by species, total acreage by species, and unit prices.

Another source is the American Sod Producers' Association Membership Profile Survey, conducted by the Turfgrass Producers' International. Profile survey information is available for 1984, 1988, and 1993

Demand for Insurance

Our assessment is that, although there would be moderate interest among turfgrass producers in buying crop insurance for sod, participation is likely to be lower than for most crops. One reason for lower interest among sod growers is that most sod is produced with the benefit of irrigation. Although drought was listed as a serious production peril is some areas, widespread use of irrigation provides a large measure of protection in most years. Losses from erosion damage and flooding were also cited as occasional production perils. The acreage subject to losses from flooding, however, is likely to be quite small.

On a regional basis, we judge that participation in a sod insurance program would be greatest in the North Central states. The basis for this judgement is the large amount of ad hoc disaster assistance payments for sod reported for this region over the 1988-93 period. Most of the losses were caused by drought and floods. In addition, the largest amount of non-irrigated sod is located in the North Central region. The North Central states accounted for nearly one-quarter of U.S. sod acreage between 1988 and 1993, but collected nearly 39 percent of all disaster assistance paid for sod losses. Disaster assistance payments accounted for 4 percent of the value of sod production in the North Central states, compared with 2 percent nationally.

There is likely to be a moderate amount of interest in crop insurance for sod in the southern states, partly because the South is where the largest amount of sod is grown. Florida accounted for nearly half of the sod grown in the South between 1987 and 1992 and an estimated 25 percent of Florida's acreage is without irrigation and subject, therefore, to drought losses. Some of the largest disaster payments in the South, however, were paid to sod growers in Maryland and Tennessee. These states are in the transition zone, where grass climates overlap and sod producers face more weather uncertainties than those further south or north. Warm weather grasses may be killed by extremely cold winters in this transition area, while extremely hot summers may kill cold-loving grasses.

Interest in crop insurance for sod is likely to be minimal in the western states. Except for California, and to a lesser extent Colorado, the western states reported relatively small acreages of sod. Further, virtually all sod grown in the western states is on irrigated land, which minimizes drought as a production peril. Although the western states accounted for about 12 percent of the U.S. sod acreage between 1987 and 1992, they received only 0.6 percent of U.S. sod disaster payments.

The small amount of acreage in the Northeast limits the potential demand for insurance in these states.

Defining "Areas" for the Non-Insured Assistance Program

The non-insured assistance program (NAP) of 1994 Crop Insurance Reform covers crops that are not currently insured by FCIC--including turfgrass sod--until the development of an insurance policy. Under NAP, an "area" must incur at least a 35-percent yield loss in order to trigger assistance payments. The definition of "areas" for purposes of calculating "area average yield" may determine whether or not growers with a qualifying yield loss (50 percent or greater of the individual average) are eligible for NAP payments.

Defining areas along county lines, or perhaps by climatic regions or zones, would provide a more equitable method for triggering NAP payments than would defining areas by state lines. Zones vary by climatic characteristics, which help in turfgrass selection and management--all of which are essential to the quality of sod production.

In the minor sod states, area yields may need to be defined along state lines or at least a greater level of aggregation than county lines. In some minor producing counties there are few growers, and one larger grower's yield may effectively determine the county average.

References

1993 ASPA Membership Profile Survey. ASPA Turf News. November/December 1993.

American Sod Producers Association. *Self-Scoring Method: How to Establish A Lawn*. Brochure.

Beard, J. B. "Turfgrass Selection: Greater Choice--Greater Challenge." *TurfNews*. Special issue.

Cockerham, Stephen T. *Turfgrass Sod Production*. Cooperative Extension Service. Division of Agriculture and Natural Resources. University of California. Publication 21451. 1988.

Dingerson, C. Consolidated Farm Service Agency (CFSA) County Office. Adams County, Illinois. Personal Communication. January 1995.

Duble, Richard L. *Commercial Sod Production in Texas*. Texas Agricultural Extension Service. Texas A&M University.

Duble, Richard L. Turfgrass Specialist. Texas Agricultural Extension Service. Texas A&M University. Personal Communication. January 1995.

Fender, D. H. Executive Director. Turfgrass Producers International. The Turf Resource Center. Personal Communication. January 1995.

Gibeault, V. A. Turfgrass Specialist. Cooperative Extension Service. University of California. Personal Communication. December 1995.

Haydu, John J. and John L. Cisar. *An Economic and Agronomic Profile of Florida's Turfgrass Sod Industry*. University of Florida. Food and Resource Economics Department. Florida Agricultural Extension Stations. Economics Report ER92-1. March 1992.

Hodges, A. W., J. J. Haydu, P. J. van Blokland, and A. P. Bell. *Contribution of the Turfgrass Industry to Florida's Economy, 1991/92: A Value Added Approach*. University of Florida. Food and Resource Economics Department and Florida Agricultural Experiment Station. Economics Report ER 94-1. December 1994.

Hogdal, John. Minnesota Sod Grower. Personal Communication. January 1995.

Iowa State University. Cooperative Extension Service. Sod Production. *Alternative Ag Enterprises from Iowa State University Extension*. Pm-1295b. September 1987.

Jensen, B. CFSA County Office. Steele County, Minnesota. Personal Communication. January 1995.

Klint, K. Executive Director. Minnesota Turf Association. Personal Communication. December 1994.

Murphy, J. A. Turfgrass Management Extension Specialist. New Jersey Cooperative Extension Service. Rutgers University. Personal Communication. January 1995.

Peacock, C. H. *Sod Production and Management*. Proceedings, Virginia Turfgrass-Landscape Conference. Blacksburg, Virginia. Virginia Cooperative Extension Service. December 1990. Pages 81-83.

Peterson, B. Turfgrass Specialist. Southern Experiment Station. University of Minnesota. Personal Communication. December 1994.

Quinn, A. CFSA County Office. Matagorda County, Texas. Personal Communication. January 1995.

Roberts, J. CFSA County Office. Union County, Florida. Personal Communication. January 1995.

Rogers, Walt. "Turf's Role in Today's Multi-use Landscape Designs." *Journal of Environmental Turfgrass*. Vol. III, No. 1. Spring 1991. Page 6.

Smith, M. *The Ortho Problem Solver*. Ortho Information Services. San Ramon, California. Third Edition. 1989.

Turner, T. B. Turfgrass Management Professor. Department of Agronomy. University of Maryland. December 1994.

U.S. Department of Agriculture. Agricultural Stabilization and Conservation Service. Disaster Assistance Data Files, 1988-93. Compiled by the General Accounting Office.

U.S. Department of Agriculture. Maryland Department of Agriculture. *Maryland Turfgrass Survey 1987*. Marketing Service Section. July 1987.

U.S. Department of Commerce. *Census of Agriculture, 1987*. (Including special runs requested by USDA, ERS.)

U.S. Department of Commerce. *Census of Agriculture, 1992*. Various State reports.

Voigt, T. B. Turfgrass Specialist. Department of Horticulture. University of Illinois. Personal Communication. December 1994.

Ward, C. Y. Turf Specialist. Extension Division. Auburn University. Personal Communication. January 1995.

Watschke, Thomas L. "Turfgrasses Can Safely Clean Our Water Supplies." *TurfNews*. Special issue. Page 18.

White, Robert W., J.L. Adrian, and R. Dickens. *Alabama's Turfgrass-Sod Industry*. Alabama Agricultural Experiment Station. Auburn University. Bulletin 610. March 1991.

Wilkinson, H.T. *The Sod Process: An Overview*. Unpublished Report. October 1988.