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PB1649-Commercial Tall Fescue-Kentucky Bluegrass Sod Production

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Commercial Tall Fescue-Kentucky Bluegrass Sod Production in Tennessee

Contents

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Commercial Tall Fescue-Kentucky Bluegrass Sod Production in Tennessee

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Introduction

Many Tennessee farmers, facing narrow profit margins and increasing price risk, are considering new or alternative crop enterprises. New crop enterprises are most successful if they make effective use of existing resources; are adapted to the local environment, soils and climate; and if they serve a market that is well-defined and expanding. Turfgrass sod production is one crop enterprise that may meet these criteria.

A sod production program is founded on agronomic principles. While corn, soybean and wheat production practices often result in increased grain yield, effective sod production results in healthy, dense vegetation free of most troublesome turfgrass pests. Harvested sod is a perishable commodity. Turfgrass plants and accompanying soil must be lifted, loaded, transported and installed in a timely manner.

Turfgrass sod is used to establish lawns, develop sports and recreational facilities, landscape commercial properties and cover highway rights-of-way. It is produced using much of the same equipment commonly found on crop farms, although some specialized equipment is also necessary. Tennessee's climate and many of its soils are very well suited to producing several turfgrass species. In addition, Tennessee's economy and population are growing, providing an expanding market for sod in residential, commercial and public applications.

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Another important consideration is the financial bottom line. Is sod production profitable? This question is best answered by estimating the costs and returns associated with sod production. Production costs depend on production practices and the prices of inputs, while returns depend on sod quality and the market in which it is sold. This publication is intended to serve as an overview of commercial tall fescue-Kentucky bluegrass sod production in Tennessee. It begins with a summary of the turfgrass industry. Next, data sources and production summaries are presented. Water is a very critical element in the sod production process, so irrigation considerations are discussed in detail. The remainder of this publication presents enterprise budgets that estimate the costs and returns for tall fescue-Kentucky bluegrass sod production. Two separate budget analysis are presented — one for a 50-acre enterprise and one for a 150-acre enterprise. It concludes with a review and comparison of the enterprise budget analysis.

New or potential growers will find this publication a helpful source of both production and economic information. Existing growers can use the included budgets to help estimate their own production costs and to identify opportunities to reduce costs.

Industry Overview

According to the 1997 Census of Agriculture[1], 302,930 acres of turfgrass-sod were harvested in the U.S. in 1997, up 39 percent from 1992 and 65 percent from 1987. The most common turfgrasses grown for sod in the U.S. include bermudagrass, centipedegrass, fine fescue, Kentucky bluegrass, ryegrass, St. Augustinegrass, tall fescue and *Zoysia*.

The housing industry is a primary market for sod. Therefore, the greatest demand is often in metropolitan areas. Land development and road construction projects, golf courses, parks, cemeteries, businesses, athletic fields and schools are also primary users. Sod is usually domestically produced and climatic

[1] Source: 1997 Census of Agriculture, Tennessee State and County Data, Vol. 1, Part 42, March 1999.

conditions are similar in both the production and installation areas. Distance from shipping point to landscape site is often less than 180 miles.

Sod is classified into two general categories according to optimum growing temperatures: cool-season (such as Kentucky bluegrass and tall fescue) and warm-season (including bermudagrass and *Zoysia*) turfgrasses. Cool-season turfgrasses grow best in the northern parts of the U.S., as well as in areas with higher elevations and in coastal regions where evening summer temperatures are 50 to 60 degrees Fahrenheit. Warm-season turfgrasses are usually grown in Florida, along the Gulf Coast northwards and throughout the upper South.

Warm-season turfgrasses are often established by vegetative propagation from sprigs or plugs. Cool-season turfgrasses are usually established by direct seeding. Sods established by direct seeding are often blends of two or more varieties or mixtures of two or more species. Varieties and species may respond differently to individual stresses. Blends or mixes are often preferred as success is improved when one or more of the tolerant turfgrasses dominates performance. Blends and mixtures may also offer some advantages in terms of color, strength, durability and adaptation to varying soil and climatic conditions compared to individual varieties.

Generally, cool-season turfgrass seeds germinate best when soil temperatures are cool (e.g., 50 degrees Fahrenheit). Sprigs require higher temperatures for proper root and shoot development. Adequate moisture is an absolute necessity. Growers irrigate and fertilize to insure rapid and quality production, and to protect against stand failure. Sod is mowed to control weeds, remove excess turfgrass growth and improve stand density. Infrequent mowing results in turf that is weak and thin. Sparse, weak sod is difficult to harvest and will be unacceptable to clientele.

Sod is ready for harvest when it has sufficiently matured and provides tensile strength appropriate for handling and transport. The actual length of time from planting to harvest depends on a variety of factors including soil type, moisture, temperature, turfgrass species/varieties, fertilization and other cultural practices. Sod is primarily harvested on demand and is often cut, loaded, delivered and installed on the same day. Fixed costs associated with a sod production operation are substantial. During periods of low prices, many growers provide less turf maintenance. They often hope to sell at higher prices at a later time, rather than harvesting sod at a loss or abandoning production fields.

Interest in commercial sod production in Tennessee has grown steadily during the past 15 years. From 1987 to 1992, sales of sod produced in Tennessee increased from an estimated $1.6 million to $5.4 million. From 1992 to 1997, sales increased to more than $15.5 million. The size and growth of Tennessee's sod industry are summarized in Table 1[2]. It is estimated that approximately one-fourth of the state's overall sod production is tall fescue plus Kentucky bluegrass.

Table 1. Tennessee's Sod Industry

	1997	1992	1987
Number of Farms	41	26	13
Acreage	6516	3304	814
Sales	$15,585,000	$5,424,000	$1,603,000

The short and intermediate outlook for commercial turfgrass sod production in Tennessee appears strong, given current and expected population growth and steady business, industrial and infrastructure construction. Demand for sod has been closely linked to housing starts and industrial development. However, a sod production operation newly established in Tennessee will not be without competition. Florida, Georgia and Alabama are three of the top five sod-producing states in the country. Along with Texas and California, production in the top five states accounts for about 45 percent of the total domestic acreage (Table 2).

While the overall potential for sod sales appears strong in many areas of the state, farmers and agri-entrepreneurs considering a sod-production enterprise should conduct a complete, thorough and balanced

[2] Source: 1997 Census of Agriculture, Tennessee State and County Data, Vol. 1, Part 42, March 1999.

Table 2. Leading Sod States					
Farms		**Acres**		**Total Sales**	
State	**Number**	**State**	**Number**	**State**	**Total Sales**
Florida	166	Florida	65185	Florida	$127,803,000
Texas	156	Texas	27627	California	$124,487,000
Alabama	92	Alabama	17184	Georgia	$52,118,000
Minnesota	90	Georgia	17134	Texas	$51,600,000
Georgia	72	California	13665	Alabama	$37,867,000

analysis. Evaluations should include a comparison of production costs and market potential. An evaluation of the enterprise's profit potential should include a comparison of the price consumers are willing to pay and the projected cost of production.

Source of Data

Presently, no research data or survey results are available for the Tennessee sod production industry on which to base a cost-and-return analysis. Models presented in this publication were obtained from input by industry professionals and personnel in The University of Tennessee Institute of Agriculture with various experiences and expertise in related disciplines.

The cost and return estimates in this publication are not averages, nor are they directly applicable for any particular site, producer or situation. They are, however, representative of inputs, systems and procedures that are considered appropriate for the production of tall fescue-Kentucky bluegrass sod.

The Production Process: (Tall Fescue-Kentucky Bluegrass)

Sod production involves growing a dense stand of adapted turfgrass species/varieties and harvesting plants intact with a thin layer of topsoil. Most sod producers deliver sod to the installation site. Some producers offer custom installation as well.

Evaluation of a commercial turfgrass-sod business should include a complete description of the agronomic production system. The production summary presented in Table 3 provides an abbreviated description of the required activities, along with the necessary equipment and associated products and application rates. The system is organized in chronological order by date of activity. The process is intended to serve as a model for the production of a tall fescue-Kentucky bluegrass sod.

The process was developed with a 50-acre operation in mind. Actual production techniques are dependent on a number of factors, including size of operation, producer experience, disease and insect activity, weed competition, weather, labor availability and specific machinery and equipment.

To establish a commercial turfgrass sod, existing vegetation may be destroyed by herbicide application(s) followed by rotary mowing. An irrigation system must be designed and installed prior to field preparation. Field preparation involves plowing, disking and harrowing. Fertilizer and agricultural limestone are applied and incorporated according to soil test recommendations prior to seeding.

After seeding, a biodegradable netting is installed to improve sod strength and thus reduce the amount of time from planting to harvest. A dedicated mowing regime must also be planned. This likely involves about 20 mowings in the fall and another 30 in the spring. Nitrogen is applied periodically during the fall and spring. Phosphorus and potassium are applied pre-plant and again in March to developing seedlings. Several pesticide treatments (weed control, insect control, fungus control) are applied as needed before harvest.

Harvest is planned from April to July. For a 50-acre operation, the harvest crew consists of one tractor-driver and two stackers. Of these three, one also operates the forklift. Harvesting includes the cutting of sod slabs, stacking slabs on pallets and loading pallets on a trailer. Labor requirements for harvesting are based on capacities of the equipment and the harvest crew. Harvesting efficiencies could be constrained by the capabilities of the distribution system/hauling equipment. For example, one acre of sod can be harvested in a 10-hour period but one semi-truck may only be able to deliver two loads during that time period, which is only about 1/2 acre of sod per day. Activities beyond harvesting and loading pallets on the trailer are considered part of the distribution phase of the enterprise and are therefore not considered in this publication.

Table 3. Parameters for a Sample 50-acre Commercial Tall Fescue-Kentucky Bluegrass Sod Production System

Date	Activity	Equipment	Supplies/Rate
Field size and layout	50 acres, 2,178,000 square feet, one relatively flat field, 1,044 feet by 2,088 feet		
Prior to chemical burndown	Harvest/mow/cut existing vegetation	45-horsepower tractor Rotary mower	
Early July	Spray glyphosate (e.g. Roundup Pro®)	45-horsepower tractor 300-gallon, trailer-type, 28-foot boom sprayer	Glyphosate [e.g. 3 qts. Roundup Pro® 4 pounds concentrate/gal/acre]
July	Install irrigation system	Hard-hose traveling gun system, with 1000 feet of 3" diameter P.E. tubing, $25,000. Pump and stationary diesel engine, $10,000. Mainline, risers and valve openers, $7,500 (mainline cost assume that water source is adjacent to field). Water filtration, $500. Total initial cost for irrigation approximately $43,000. 45-horsepower tractor could be used to re-position irrigation system.	
Mid July to mid August	Spray glyphosate (e.g. Roundup Pro®)	45-horsepower tractor 300-gallon, trailer-type, 28-foot boom sprayer	Glyphosate [e.g. 3 qts. Roundup Pro® 4 pounds concentrate/gal/acre]
Prior to plowing	Mow vegetation	45-horsepower tractor Rotary mower	
1 week after 2nd chemical burndown spraying	Plow	45-horsepower tractor 48"-turning plow, 3 - 16 bottom	
After plowing	Heavy disking	Disk, 10 foot 45-horsepower tractor	
After disking	Broadcast fertilizer according to soil test and custom apply ground limestone	45-horsepower tractor Besco®, 2000-pound capacity spreader	If no soil test is available, estimate 400 pounds of 12-24-24 fertilizer per acre. Custom apply 2 tons of agricultural limestone per acre every other year.
After fertilizing and liming	Disking & drag harrow	45-horsepower tractor Drag harrow - 12 foot (homemade with railroad ties) Disk, 10 foot	

Date	Activity	Equipment	Supplies/Rate
Mid-August to mid October	Drill seed	45-horsepower tractor Brillion® seeder with 2 seed boxes, 10 foot, pull-type	385 total pounds of seed per acre - 35 pounds of Kentucky bluegrass - 350 pounds of tall fescue blend improved turfgrasses w/ 3-5 different varieties
Immediately after seeding	Install netting	45-horsepower tractor, netting & wooden stakes	Install biodegradable polypropylene netting. Each roll is 17.25 feet wide and 20,000 feet long. One roll will cover approximately 7.5 acres. Cost = $1,332 per roll. One tractor driver (at an approx. rate of 2 mph) and four field workers will install 1.5 to 2 acres per hour. About 500 (round, 5.5" long, white birch) stakes will be used per acre, installed at an angle. Stakes cost $0.024 each or $12 per acre.
After netting installation (within two days of seeding)	Begin irrigation	45-horsepower tractor Irrigation system	
Prior to mowing	Armyworm and fall armyworm control	45-horsepower tractor 300-gallon, trailer-type, 28-foot boom sprayer	Insecticide (e.g. Sevin 4SL®, 3 ounces per 1000 sq. ft.) 130 ounces of product per acre
Approximately three weeks after seeding	Mow	45-horsepower tractor 15.5-foot, 3-gang, pull-behind, finishing mower	Approximately 22 fall mowings. Mowing to begin three weeks after seeding every four days, on average. Assume use of a 15.5-foot mowing unit at a constant rate of 6 mph. Will mow until mid-December. Start mowing in spring when necessary (early March) every four days until harvest. This mowing system will cover approximately 90 days in the fall and 120 days in the spring for a total of 210 days. Mowing every four days will require 52 mowings.
4 weeks after seedling emergence (approx. 5-6 weeks after seeding)	Broadcast nitrogen fertilizer	45-horsepower tractor Vicon®, 8 cu. ft, broadcast seeder	100 pounds of urea/acre or 125 pounds of ammonium nitrate/acre
After being mowed at least 4 times	Broadleaf weed control	45-horsepower tractor 300-gallon, trailer-type, 28-foot boom sprayer	Broadleaf herbicide (e.g Strike 3® at a rate of 3 pints of product per acre) with surfactant

Date	Activity	Equipment	Supplies/Rate
Early March till harvest — every four days	Mow	45-horsepower tractor 15.5-foot, 3-gang, pull-behind, finishing mower	Approximately 30 spring mowings
March, April & May	Sweep/Vac.	45-horsepower tractor Brouwer®, BV 138, 5 cubic yard capacity, 8-foot sweeper-vac.	Approximately one sweeping per acre during March, April & May after mowing (once per acre over the three month period).
Early March	Broadleaf weed control	45-horsepower tractor 300-gallon, trailer-type, 28-foot boom sprayer	Broadleaf Herbicide (e.g. Strike 3® at a rate of 3 pints of product per acre) with surfactant
Early to mid March	Yellow and purple nutsedge control	45-horsepower tractor 300-gallon, trailer-type, 28-foot boom sprayer	Post-emergence herbicide (Manage 75DF®, 1 ounce of product per acre) with surfactant
Early to mid March	Fertilize	45-horsepower tractor Vicon®, broadcast seeder	100 pounds of urea per acre or 125 pounds of ammonium nitrate per acre
Mid April	Fertilize*	45-horsepower tractor Vicon®, broadcast seeder	75 pounds of urea per acre or 100 pounds of ammonium nitrate per acre on 33 acres
May	Rhizoctinia brown patch control*	45-horsepower tractor 300-gallon, trailer-type, 28-foot boom sprayer	Fungicide treatment (e.g. Daconil Ultrex® 82.5% Chlorothanil® — 15 pounds per acre) on 33 acres
May - June	White grub control*	45-horsepower tractor 300-gallon, trailer-type, 28-foot boom sprayer	Insecticide (e.g. Sevin 4SL®, 130 ounces per acre) on 25 acres
June	Rhizoctinia brown patch control*	45-horsepower tractor 300-gallon, trailer-type, 28-foot boom sprayer	Fungicide treatment (e.g. Bayleton 25 WSP®, 2 ounces of product per 1000 square feet) 87 ounces per acre on 16 acres
Prior to harvest	Roll	45-horsepower tractor Twelve-foot roller	
April - July 1	Harvest[3]	Mechanized, tractor-mounted sod harvester forklift	Sod slabs are stacked on pallets capable of holding 50 square yards of sod. A full tractor-trailer load consists of 18 pallets of sod plus the forklift. The mechanized harvester and three-person harvest crew should be able to "comfortably" harvest about one acre of sod each day. Per-acre harvest labor is assumed at three workers per 10-hour day (30 hours) at $9 per hour ($270 per acre). 50 square yards per pallet, 900 square yards per semi-truckload (450 square yards per gooseneck trailer) 4-1/3 semi-truckloads (8.5 gooseneck trailer loads) to be loaded per day (4,114 sq. yd.) 4,840 sq. yd. available per acre - - assume 85 percent harvestable = 4,114 sq. yd. per acre for sale

* Labor, machinery and application rate requirements have been adjusted for production practices required after harvesting begins in April to reflect the proportion of harvested sod not requiring such practices.

[3] With netting, favorable climate, and appropriate seeding rate, adequate hauling and delivery capabilities and proper mowing, fertilization and irrigation, some tall fescue-Kentucky bluegrass sod may be ready for harvest as early as mid to late November in the year of seeding. Most harvesting is expected to occur from April to July in the year following seeding.

Soils

Deep, fertile, well-drained and level soils are preferred for the production of sod. The coarseness or fineness of the soil also deserves consideration. Soil texture is determined by the relative proportions of sand, silt and clay, as illustrated in Figure 1.[4] A mechanical or particle size analysis may be conducted to determine suitability of soil for sod production. Loam, clay loam and silt loam soils often perform well, holding water and nutrients for plant uptake while providing adequate oxygen for plant growth. Sands often have very limited nutrient- and water-holding capacities. Soils containing large amounts of sand particles uniform in size and round in shape may be unsuitable for sod production. Soils containing too much clay are often poorly drained and prone to compaction.

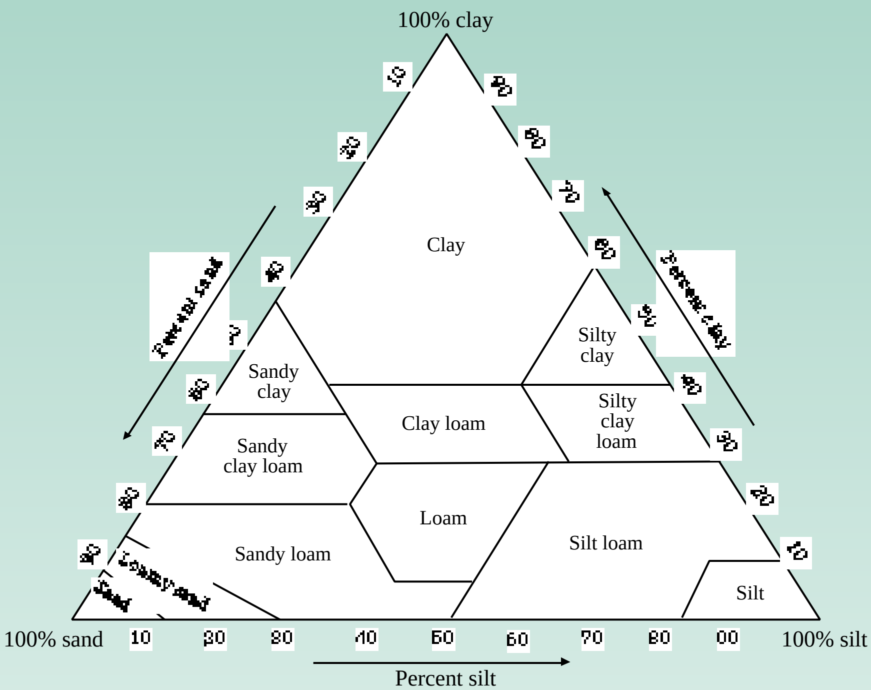

Figure 1. Soil textural triangle identifying classes commonly used to describe soils.

Irrigation Considerations

The ability to provide supplemental water should be a prime consideration in determining if a site is suitable for sod production. Annual rainfall in Tennessee often averages more than is needed by most crops. However, the timing and amount of natural precipitation rarely correspond with the needs of turfgrasses.

Specifying the components of an irrigation system requires a thorough knowledge of hydraulics — which is beyond the scope of this section. Rather this section introduces the reader to the concepts that the irrigation designer will use in specifying the needed irrigation equipment.

Quality and Quantity of Available Water

To provide sufficient quantities of water for irrigation, the sod production site should be located adjacent to a large surface-water reservoir or over a high-producing aquifer. Portions of West Tennessee are over aquifers that can supply water for a large-scale sod enterprise. Middle and East Tennessee are karst regions. It is unlikely that a well with sufficient water production can be established in these regions, so surface water sources will be needed.

Both the rate of flow and the total volume must be considered when evaluating a potential water source. The flow rate must be adequate to replenish soil moisture before the plant enters dormancy. Sufficient water volume must be available to cover the entire production area. The typical water requirement for sod production is an estimated "1 inch of water per week." This represents a volume of water that

[4]From: H.D. Foth and L.M. Turk. 1951. Fundamentals of Soil Science, 5th ed. John Wiley and Sons, Inc. New York. Pg. 32.

is equivalent to 1 inch of water spread over each acre of the entire production area. As shown in Figure 2, if 50 acres of sod are being produced, a 1-inch application represents 1.4 million gallons of water per week. If irrigation water can only be applied 16 hours per day, five days per week, the demand on the water source would be slightly more than 280 gallons per minute.

Volume
- (Area) (Depth) = Volume
- One inch of water spread over one acre is 1 acre-inch
- One acre-inch is equal to 27,156 gallons
- 50 acre-inches is 1.4 million gallons

Flow
- 16 hours per day, 5 days per week is 4800 minutes
- 1.4 millon gallons in 4800 minutes is 283 gallons per minute

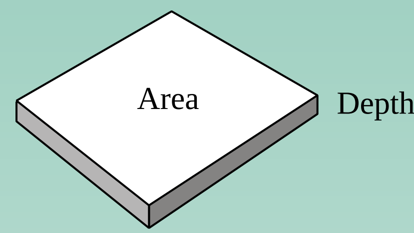

Figure 2. The depth of water applied over an area gives the volume of water required and the flowrate of the pump required to supply this volume in a given amount of time.

Quality

The quality of irrigation water plays a major role in the production of tall fescue-Kentucky bluegrass sod. Determining the suitability of a water source for irrigation often involves submitting a water sample to a laboratory and then interpreting the analysis. Considerations include suspended particulate matter, salinity, toxic ions, bicarbonates and carbonates and pH.

Particulate Matter Sand, silt and clay may be suspended in water, causing excessive wear and premature replacement of irrigation system components. Strainers and centrifugal separators can be installed to limit the amount of abrasive materials entering the irrigation system.

Salinity Problems occur when accumulations of soluble salts in soils exceed tolerance levels of the varieties of tall fescue and Kentucky bluegrass being produced. Excessive salinity often results in nutritional imbalances within these turfgrasses. Plants may wilt and die, because roots cannot absorb water. Salinity can be expressed in terms of electrical conductivity or as parts per million (ppm) of total dissolved solids.

Total Dissolved Solids A measurement of the total dissolved solids (TDS) is the mass of minerals that are dissolved in the water. This measurement is generally given in parts per million (ppm) or as milligrams per liter (mg/L). In dilute solutions, ppm and mg/L of dissolved solids are numerically equivalent.

Electrical Conductivity Electrical conductivity (ECw) is a measurement of the ease by which electricity will pass through the sample of water. Inference can then be made about the total concentration of ions in the water. The units for electrical conductivity of water extracted from a soil sample (ECe) are millimhos per centimeter (mmhos/cm) or deciSiemens per meter (dS/m) [1 mmhos/cm is equal to 1 dS/m]. Because of the lower concentration of soluble salts in irrigation water, electrical conductivity is usually given in micromhos per cm (µmhos/cm), which is one thousandth of a mmhos/cm. Water with a salinity level above 2,250 µmhos/cm is not generally suitable for irrigation under ordinary conditions.

Soil Salt Level Very few turfgrasses can survive a soil salt level (ECe) above 16 dS/m (Table 4). For example, a saturated soil extract of less than 4 is preferred for the production of Kentucky bluegrass sod; and 4 to 8, for the production of tall fescue sod.

Table 4. Approximate Salinity Tolerance of Selected Turfgrasses				
Turfgrass	***Electrical conductivity (ECe) of saturated soil extract (dS/m)***			
	<4	4 - 8	8 - 16	>16
Cool-season	Kentucky bluegrass Colonial bentgrass Red fescue Rough bluegrass	Chewings fescue Perennial ryegrass Tall fescue	Creeping bentgrass	Alkaligrass
Warm-season	Centipedegrass		Bermudagrass *Zoysia*	Seashore Paspalum

Toxic Ions

Although a soluble salts determination (ECw) provides information regarding the total quantity of ions in solution, it does not identify the ions that are major contributors. Excessive chlorides and sulfates can cause yellowing leaf tips or total kill of aerial shoots.

Boron: Boron may reach a toxic level in plant tissue if the concentration in irrigation water exceeds one to two ppm. Toxicity symptoms may first appear as leaf tip necrosis. Leaf tips yellow, then wither and die where the greatest amounts of boron accumulate.

Bicarbonates, Carbonates and pH: The presence of bicarbonates in the irrigation water may raise the soil pH [a numerical measure of the acidity or hydrogen ion activity of the soil (pH = 7 neutral; pH < 7 = acid; and pH > 7 = alkaline)]. A slightly acid soil pH (e.g. 6.0 to 7.0) is preferred for the production of tall fescue-Kentucky bluegrass sod. Calcium and magnesium often combine with bicarbonate in dry soils, forming calcium and magnesium carbonates. Carbonates are not easily leached below the turfgrass root zone and may accumulate with each irrigation, elevating the soil pH. Essential nutrients including copper, iron, manganese and zinc may become unavailable for uptake by plants at high soil pH levels.

Sodium: Sodium is not an essential mineral for turfgrass growth and survival. However, the presence of sodium in irrigation water is of concern to turfgrass-sodproducers because the application of large quantities of water containing high levels of sodium may eventually result in toxic levels of sodium in plant tissue. Water infiltration and percolation rates of soils are often reduced as soil colloids deteriorate with increasing sodium (e.g., sodium carbonate can seriously reduce the permeability of soils high in clay content). The Sodium Adsorption Ratio (SAR) is used to classify water based primarily on the effect of exchangeable sodium on the structure of the soil. SAR is calculated as follows:

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

where Na^+ = sodium ion concentration in milliequivalants per liter (meq/l); Ca^{++} = calcium ion concentration (meq/l); and Mg^{++} = magnesium ion concentration (meq/l). Irrigation water with a SAR greater than nine may seriously reduce water permeability when applied repeatedly to fine-textured soils. Permeability problems associated with high SAR irrigation water are usually much less severe on tall fescue and Kentucky bluegrass plants growing in sandy soils.

Quantity

Irrigation design is based on the water needs of turfgrass and the ability of the soil to meet those needs. Texture and structure govern the amount of water that is available to the plant. Information about the moisture-holding capacity of soils in Tennessee can be found in soil survey manuals for each county. These manuals can be accessed at your local county Extension office. Each soil type has been assigned an Available Water-Holding Capacity (AWHC). Under ideal agronomic conditions, the AWHC is the amount of water (inches) held per inch of soil. Any application of water that exceeds the total AWHC is lost to deep percolation. If the moisture content of the soil is depleted beyond 50 percent of AWHC, turfgrasses will be stressed for water.

Plant water-use often varies throughout the growing season. This variability is a function of the weather and of the plant growth stage. In sod production, the need for water is not limited to evapotranspiration (water lost via evaporation from soil and plant surfaces and water transpired by plants). During establishment, water is needed to initiate and sustain germination. Water may also be applied just before harvest to ease cutting the sod and to insure the survivability of the sod during transport.

Water Requirements for Cool-Season Turfgrasses in Tennessee

From the standpoint of adequate water availability, cool-season turfgrasses are well suited for production in Tennessee. During the fall, winter and spring months, precipitation is generally greater than evapotranspiration. However, the capability to provide supplemental water is required to assure that the timing of the water application matches the timing of the production cycle.

The average annual precipitation for Tennessee is about 50 inches. Using rainfall data collected over a period of 30 years, Safley and Parks (1974) found that this average changes with geographic locations.[5]

- The Mississippi bottomland precipitation ranges from 48 inches in the northwest to 55 inches in the southeastern area.
- Middle Tennessee precipitation ranges from 45 inches in the northern region to about 55 inches in the south.
- In East Tennessee, average precipitation ranges from 42 inches in the northern portion of the Ridge and Valley Province to more than 50 inches in the southern region, and 60 inches on the southern Cumberland Plateau.
- Average annual evapotranspiration ranges from 26 inches on the Cumberland Plateau to 34 inches along the Mississippi River. Evapotranspiration tends to be higher in the southern tier counties.

For Kentucky bluegrass and tall fescue production in Tennessee, August, September, May and June are the months that will require the most irrigation. After seeding in August and/or September, it is critical to maintain adequate soil moisture for germination and turfgrass growth. Typically one-half inch of water is needed every three or four days. The seedlings have extremely shallow roots and the top layer of soil dries out very quickly. More frequent irrigation may be necessary if dry, windy conditions prevail.

As the seedlings develop and roots extend deeper into the soil, the moisture-holding capability of the soil can be used to store water. During periods of active growth, plants need about 1 inch of water per week. For most Tennessee soils, 1 inch of water will wet 4 to 5 inches of soil — which is about the same depth as the sod’s root system. Water applications greater than 1 inch will wet the soil deeper than the root system. This water will not be available to the plants. As a consequence, a 2-inch rain does not necessarily supply the turfgrasses with two weeks’ worth of water. Just before harvest, approximately 1/10 of an inch of extra water may be applied to ease sod cutting and to improve the survivability of the sod in transport.

[5]Safley, J. M. and W. L. Parks. 1974. Agricultural Drouth Probabilities in Tennessee, Bulletin 533, The University of Tennessee Agricultural Experiment Station, August.

Application Equipment and Methods

Sprinkler irrigation is a very successful water distribution method for sod production. A wide variety of sprinkler irrigation equipment has been used for sod production in Tennessee. The selection of sprinkler irrigation equipment must be based on the needs of the individual production situation. A comparison of irrigation systems commonly used in Tennessee is presented in Table 5.

Table 5. Styles of Sprinkler Irrigation Used for Sod Production in Tennessee

	Relative Comparisons		
	Application Uniformity	***Cost***	***Labor Requirements***
Wheel Roll	Excellent uniformity, some rutting from wheels, must be rectangular field, water supply must move with system	Relatively high equipment cost, some resale value	Labor required to move system forward
Hand-Move Pipe	Excellent uniformity, can work in odd shaped fields, water supply must move with pipe	Relatively low equipment cost, some resale value	Very high labor
Solid Set	Excellent uniformity, can be designed to work in any shaped field, water source does not have to move, risers are a nuisance to navigate around	Very high initial cost, virtually no resale value	Virtually no labor
Center Pivot	Excellent uniformity, can only work in large fields, water source does not have to move	High initial cost, some resale value	Virtually no labor
Cable-Tow Traveling Gun	Capable of excellent uniformity, can work in any shaped field, uses cable to pull gun cart and water supply line follows cart —heavy supply line could damage sod, requires high pressure system	Medium initial cost, some resale value	Labor needed to reposition gun at end-of-pull
Hard-Hose-Reel Traveling Gun	Capable of excellent uniformity, can work in any shaped field, uses supply hose to pull cart —much narrower line-of-damage to sod, requires high pressure system,	High initial cost, good resale value	Labor needed to reposition gun at end-of-pull

Pump Station

Pump stations can be powered by electricity, diesel, gasoline, propane or natural gas. When selecting an energy source, the producer should consider availability, cost and user-friendliness. Electricity is the most efficient energy source. Many electric companies will not permit a 10-horsepower or larger electric motor to be operated with single-phase electricity. Unfortunately, most irrigation pumps are substantially larger than 10 horsepower and three-phase power is generally not available in rural areas. Most pump stations in Tennessee are petroleum-powered, with diesel units being the most common. Engines tend to be more user-friendly because most production farms employ mechanics to service their petroleum-powered equipment. When electrical systems fail, the service of an off-farm contractor has to be purchased.

The decision whether to purchase a stationary engine or use a power-take-off (pto) depends on several factors. If a farm already has a reliable tractor, with sufficient power that can be dedicated to the irrigation system, then a pto system is a good choice. A stationary engine is less expensive than a new tractor; however, there is very little use for a stationary engine other than to perform the single task of pumping water.

Pumps

A pump must provide the required flow at the pressure needed to deliver the water to the application devices (e.g., sprinkler heads). Every pump is rated for efficiency. This efficiency is the ratio of the power imparted to the water compared to the actual power needed to drive the pump. It is desirable to find a pump with the highest possible efficiency capable of providing the required flow and pressure. Pump efficiency is the primary variable in determining the energy-cost of pumping water. As the pump efficiency increases, the long-term cost of moving water decreases.

Suction lift is another important consideration. Pumps can push water through great changes in elevation; however, water can only be lifted about 20 feet. The ability of a pump to lift water is given by its Net Positive Suction Head Required (NPSHr) rating. NPSHr must be less than the Net Positive Suction Head Available (NPSHa) which is calculated from the conditions at the site. NPSHr is often an issue when it is desired to place the pump on a river bank 20 or more feet above the water surface. Pumps with submerged impellers (such as vertical turbine pumps) are required when the NPSHa is smaller than the NPSHr.

Pumps and power supplies are usually purchased as a package. If the pump and power supply are separate, then the specifications must insure that the pump is compatible with the power supply. A few of the details include the rotational speed and direction of the impeller and the alignment of the mounting brackets.

Mainlines

The mainline is the pipe that carries the entire flow from the pump to distribution equipment. Mainlines are usually buried to protect them from damage by field machinery. The mainline must be designed to supply water as the distribution system moves across the field. For many systems (e.g., wheel lines, hand move and traveling gun) this is accomplished by installing a series of risers along the path of the distribution equipment. A flexible line connects the equipment to the riser. For center-pivot and solid-set systems, the mainline is connected directly to the distribution line(s).

The selection of pipe material and diameter depends on the flow rate, pressure and whether it will be buried. PVC is typically used for buried installations and aluminum is generally used when the pipe is on the surface and must be moved. Pipe left on the surface has the advantage of some salvage value; buried pipe has the advantage of being freeze-proof.

Irrigation Uniformity

All sprinklers are rated according to their output and wetted diameter at different water pressures. Spacing between sprinklers must provide some wetted-overlap as demonstrated in figure 3. The amount of water applied to the soil decreases as the distance from the head increases. Most sprinkler manufacturers specify an overlap percentage to get the most uniform application of water.

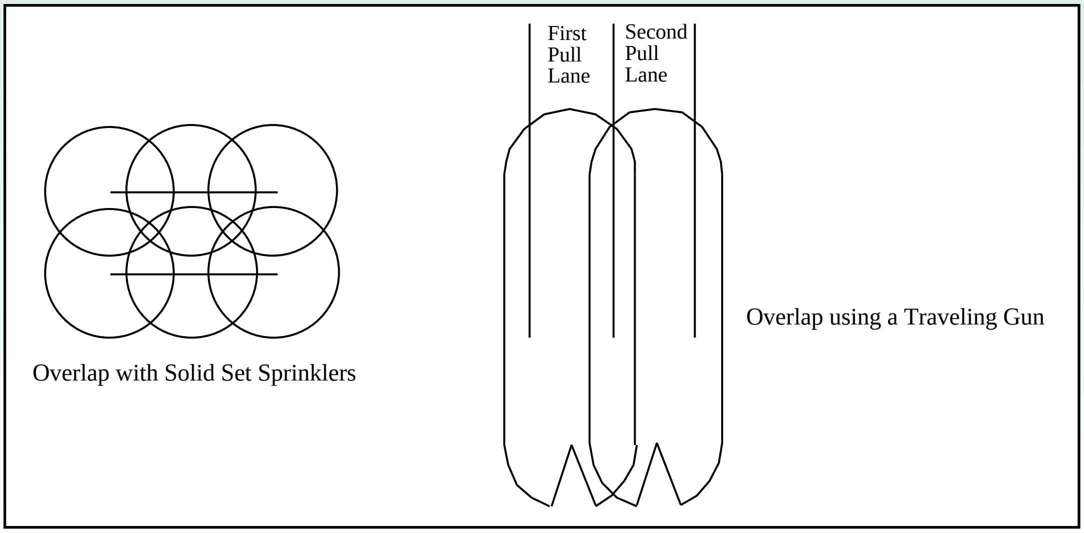

Figure 3. Examples of overlapping sprinkler patterns.

Using a Hard-Hose Traveling Gun System to Irrigate Sod

Currently, hard-hose traveling guns are the most common method of irrigating sod in Tennessee. They are very adaptable to the irregular shapes of many Tennessee fields. This section will focus on the selection and operation of a hard-hose traveling gun system.

Most travelers apply water through a single sprinkler (often referred to as a big gun). The wetted diameters of big guns range between 200 and 400 feet with discharges between 50 and 1200 gallons per minute. On a hard-hose system, the big gun is mounted on a gun cart and is attached to a long, polyethylene hose. This hose is wound on a large-diameter reel. The irrigation process begins by pulling the cart and hose away from the reel. As water is discharged from the big gun, the reel slowly retrieves the hose and irrigates the strip of land along the hose. Most hard-hose units are mounted on turntables. The turntable allows the hose to be retrieved from one direction and the reel is rotated 180 degrees to perform a pull in the opposite direction.

Determining the Capability of a Traveling Gun

As shown in Table 3, a 50-acre field 1,044 feet wide by 2,088 feet long is under consideration for sod production. The soil is assumed to be medium-textured and well-drained. In a rectangular field, traveling guns should work parallel to the long side to reduce the number of 'setups.' If the reel and water supply are placed along a line that bisects the long sides of the field, the hose will need to be long enough to reach the far ends of the field. In this example, the hose needs to be at least 1,000 feet long.

Irrigation systems are designed to satisfy the needs of the sod without exceeding the infiltration capacity of the soil. The infiltration capacity is the rate that water can enter the soil. Soil surveys are a good source of infiltration information. Some general guidelines for infiltration rates are presented in Table 6. When the application rate exceeds the infiltration rate of the soil, water will pool on the surface and possibly run off. For this example, an application rate of one-half inch per hour is used.

Table 6. Application Rates on Various Types of Soils.

Heavy-textured soils	0.10 to 0.50 inch per hour
Medium-textured soils	0.25 to 0.50 inch per hour
Light sandy soils	0.50 to 0.75 inch per hour

Big guns are rated by their wetted-diameter and flowrate. Once the application rate has been established, a gun can be selected to maximize the area covered without exceeding the infiltration rate of the soil. Using one-half inch per hour as the application rate, a big gun with a flow rate of 225 gallons per minute (gpm) and a wetted diameter of 325 feet (at a pressure of 60 pounds per square inch [psi] at the gun) is a good match.

To assure uniformity of water application, the wetted-diameter of adjacent pulls must be overlapped. The amount of overlap depends on the nozzle and on the wind conditions. Most big gun manufacturers recommend an overlap of 70 percent (effective diameter/wetted diameter), resulting in an effective diameter of 227 feet. However, the field in this example can be divided into five equal strips of 209 feet (1,045 feet wide divided by 5 equals 209 feet). Using 209 feet as the effective diameter produces a better overlap and gives equal lane spacing across the field (see Figure 4). If the length of the hose is 1000 feet, and the effective diameter is 209 feet, the area covered per pull is 4.8 acres.

$$\frac{(209 \text{ feet} \times 1000 \text{ feet})}{43{,}560 \ \frac{\text{feet}^2}{\text{acre}}} = 4.8 \text{ acres}$$

With a traveling gun system the application time begins when the leading edge of the effective diameter passes a certain point and continues until the trailing edge reaches that same point. For example, if the application rate is one-half inch per hour and the total depth applied is 1 inch, then the application time is two hours. Therefore the travel velocity of the gun is set to cover the 209 feet in 120 minutes or 1.74 feet per minute. Using a 1000-foot hose, the time required to apply 1 inch of water per pull would be 575 minutes, or 9.6 hours. Assuming it took 30 minutes to reposition the reel for the next pull, about 7.7 acres could be irrigated per 16-hour day. In other words, it would take seven 16 hour days to apply 1 inch of water over 50 acres, matching the desired peak application rate of 1 inch per week.

During germination, it is desirable to maintain soil moisture near the turfgrass seeds. By increasing the travel speed of the big gun to 3.5 feet per minute, one-half inch will be applied and the 50 acres can be covered in approximately four and one-half 16-hour days.

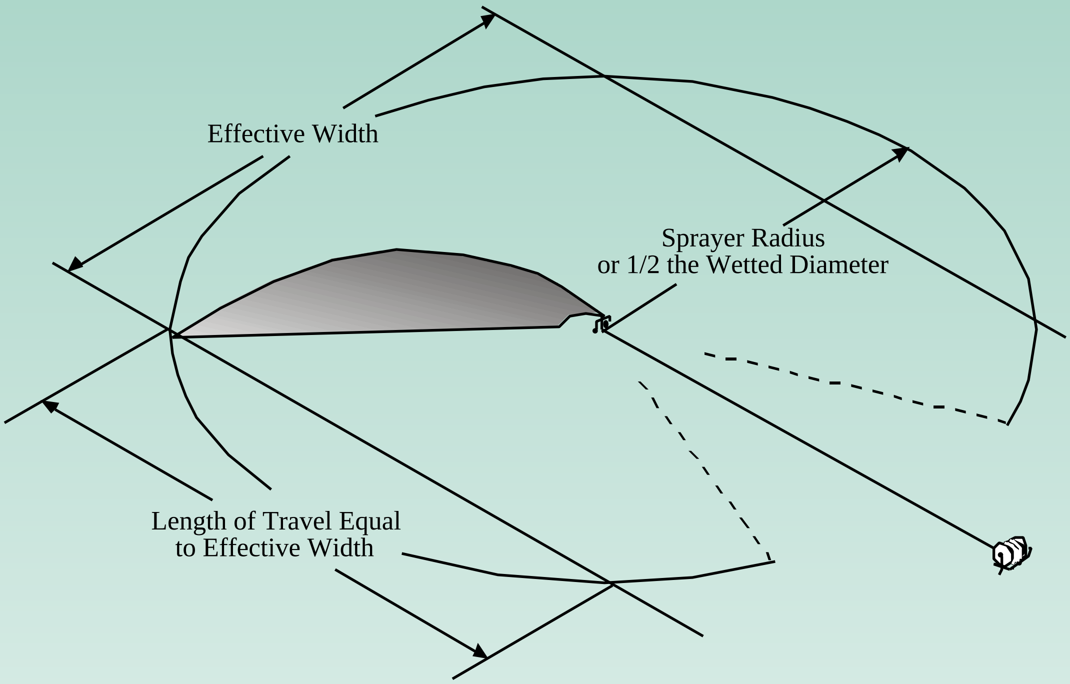

Figure 4. The lane spacing between pulls is based on the effective width of water application.

Hydraulic Delivery System

The traveling gun used in this study requires a water-delivery system that can supply 225 gpm and provide 60 psi at the gun. A typical layout would include a pump and a mainline. The mainline would have risers near each location where the reel would be placed. A flexible hose is used to connect the riser to the reel. Many different types of pipe material are available. Gasket-jointed PVC is usually used when pipe is buried. The risers are tees in the line and have valves that control the flow to the attached hose. For this example, 4-inch diameter Class 200 PVC would serve as the mainline if the distance from the pump to the reel did not exceed 1,500 feet.

As water is delivered to the gun, the pressure changes due to friction in the pipe and to elevation changes. Reductions in pressure must be accounted for in the design of the hydraulic system and in the selection of an appropriate pump. A reel with a hose length of 1,000 feet and a flowrate of 225 gpm should have a minimum hose diameter of 3 inches. At 225 gpm, 47 psi of pressure will be lost in the 3-inch tubing. For this application, 60 psi is needed at the big gun. Given additional pressure losses due to connections and fittings, at least 115 pounds of pressure must be available at the riser while the water is flowing. Additional pressure will be required to overcome any elevation changes from the pump to the nozzle, and frictions losses in the mainline. For this application, the pump must produce 225 gpm against a pressure head of 130 psi. The design of the hydraulic system and the selection of the pump must be performed by a person who is trained in hydraulics.

Economic Evaluation: Tall Fescue-Kentucky Bluegrass Sod, 50-Acre

As with any enterprise, the costs and returns of sod production must be carefully evaluated. The economic evaluation presented in this section is intended to estimate the economic potential of producing and marketing 50 acres of tall fescue-Kentucky bluegrass sod in Tennessee. To evaluate the economic potential of a sod enterprise, specific production/operating information must be known and costs allocated accordingly. To this end, a variety of basic assumptions must be made to define a certain set of parameters and associated costs. The basic production parameters for the economic analysis of a 50-acre enterprise were presented in Table 3 on pages 6-8.

Establishing a commercial sod enterprise requires substantial capital investments. Capital investments are the long-term assets of the business essential to the production process, including land, equipment, machinery and facilities. The various capital requirements for a 50-acre sod operation are listed in Table 7, along with a brief description and an estimated price if purchased new.

The estimated hours of use per acre are listed for each equipment item, along with an estimate for annual per-acre depreciation and repair costs. Except for the irrigation system, a five-year average is used for depreciation and repair costs. A straight-line, 10-year depreciation schedule with no salvage value is assumed for the irrigation system. All equipment is assumed to be purchased new. Approximately $227,500 in start-up investment will be needed for a 50-acre sod operation on an existing farm. Annual depreciation and repair costs are estimated at $208.52 and $81.26 per acre, respectively.

Labor and equipment expenses are often thought of as limiting factors for some sod operations. Table 8 presents the per-acre labor and equipment requirements for the 50-acre operation. These estimates are based on recommended production practices. Equipment requirements are estimated in minutes per activity based on equipment size, speed of operation and efficiency of operation. Labor requirements include a 25 percent addition to the equipment usage to account for time spent locating, moving and adjusting machinery prior to use. Additional labor is included for the installation of netting and additional equipment usage is included for the operation of the irrigation system.

According to the information in Table 8, approximately 47 labor hours will be needed per acre — or about 2,350 hours per year for a 50-acre operation. Labor and machinery requirements have been adjusted for production practices required after harvesting begins in April to reflect the proportion of harvested sod not requiring such practices. That is, labor and machinery associated with fertilizer, fungus control and insect control applications that are made after harvest begins in April are only allocated for those acres that have not yet been harvested. The labor estimates in Table 8 do not include any supervisory, managerial, shop, marketing or clerical expenses.

Table 7. Capital Requirements: Tall Fescue-Kentucky Bluegrass, 50-Acre System					
			Per-acre Estimates		
Equipment Listing	**Description**	**New Price ($)**	**Estimated Hours of Use**	**Five-Year Average Depreciation Cost ($)**	**Five-Year Average Repair Cost ($)**
Tractor	45-horsepower, 4 wd	25,000.00	11.69	12.90	6.20
Sprayer	300-gallon, 3-point hitch with 28-foot boom	3,000.00	0.48	3.76	0.65
Turning plow	48", 3-16 bottom	3,500.00	0.53	1.40	0.25
Disk	10 foot	6,300.00	0.33	5.60	0.10
Fertilizer spreader	Besco®, 2000-pound capacity, 3 point-hitch	2,500.00	0.40	1.24	0.36
Seeder	Brillion®, with 2 seed boxes, 10 foot, pull type	13,300.00	0.165	4.94	0.055
Scotch harrow	12 foot	1,200.00	0.165	1.07	0.050
Roller	12-foot drum with cement	1,000.00	0.138	0.98	0.040
Mower	Progressive® Mower, 15,5-foot, 3 gang, finishing mower	11,500.00	5.55	5.56	39.30
Harvester	Brouwer®, Model 1560, 16" cut, with options	50,000.00	6.4	52.45	8.96
Sweeper /Vac.	Brouwer®, BV138, 8-foot, 5 cubic-yard capacity	11,700.00	0.9	4.37	0.96
Forklift	Brouwer®, Hitchhiker, 23-horsepower	35,000.00	1	27.00	6.75
Rotary mower	Five-foot, 3-point hitch	2,500.00	0.24	1.25	0.38
Irrigation system	Hard-hose, traveling gun, pump & station, diesel engine, mainline risers	43,000.00	42	86.00	17.20
Shop, office, storage	780 sq. ft. storage, 120 sq. ft. office, @ $20/sq. ft.	18,000.00			
Total		**$227,500.00**		**$208.52**	**$81.26**

Table 8. Labor and Equipment Inputs: Tall Fescue-Kentucky Bluegrass, 50-Acre System				
			Minutes per Acre	
Date	**Activity**	**Power Unit and Equipment**	**Machine**	**Labor**
After harvest (July-Aug.)	Spray Roundup Pro® (two applications)	Tractor and sprayer Tractor and sprayer	4.42 4.42	5.53 5.53
Prior to plowing	Mow	Tractor and rotary mower	14.14	17.68
After mowing vegetation	Plow	Tractor and plow	32.00	40.00
After mowing	Disk	Tractor and disk	9.90	12.38
After disking	Fertilize	Tractor and fertilizer spreader	6.60	8.25
After fertilizing	Disk and drag	Tractor, disk and harrow	9.90	12.38
Mid Aug. to Oct.	Seed	Tractor and seeder	9.90	12.38
After seeding	Install netting	Tractor Additional labor	35.00	43.75 137.00
Within two days of seeding	Begin irrigation	Irrigation system (no labor) Tractor	2112.00 132.00	165.00
Prior to mowing	Insect control	Tractor and sprayer	4.42	5.53
Approximately three weeks post-plant	Mow	Tractor and mower	6.40	8.00
After seedling emergence	Fertilize	Tractor and fertilizer spreader	6.60	8.25
Every four days until mid Dec. (22 mowings)	Mow	Tractor and mower	140.80	176.00
After 4th mowing	Broadleaf weed control	Tractor and sprayer	4.42	5.53
March until harvest (30 mowings)	Mow	Tractor and finishing mower	192.00	240.00
March, April and May	Sweep/Vac.	Tractor and sweeper/vac.	54.00	67.50
March	Broadleaf weed control	Tractor and sprayer	4.42	5.53
March	Nutsedge control	Tractor and sprayer	4.42	5.53
March	Fertilize	Tractor and fertilizer spreader	6.60	8.25
April	Fertilize*	Tractor and fertilizer spreader	4.36	5.45
May	Fungus control*	Tractor and sprayer	2.92	3.65
May - June	Insect control*	Tractor and sprayer	2.21	2.76
June	Fungus control*	Tractor and sprayer	1.46	1.83
Prior to harvest	Roll	Tractor and roller	8.25	10.31
April - July 1	Harvest	Tractor-mounted harvester	380.80	1800.00
TOTAL LABOR MINUTES PER ACRE				**2813.95**
TOTAL LABOR HOURS PER ACRE				**46.90**

* Labor and machinery requirements have been adjusted for production practices required after harvesting begins in April to reflect the proportion of harvested sod not requiring such practices.

A budget of the estimated per-acre expenses for tall fescue-Kentucky bluegrass sod is presented in Table 9. Listed first, the variable expenses are those production expenses directly related to the costs of production. These expenses include seed, fertilizer, chemicals, operation of the irrigation system, pallets, netting and variable expenses for equipment. Repair expenses for the irrigation system are based on a 2 percent allocation of the initial system cost ($43,000), divided by the total acreage (50 acres). Fuel and oil and filter expenses were calculated using the "Machinery Cost Calculator."[6] Equipment repairs and maintenance are based on a five-year average for the first five years of the equipment's use and were also calculated using the "Machinery Cost Calculator." A per-acre pallet cost of $137 is allocated. Whether single-use ($1.70 each for 81 pallets per acre) or multi-use pallets ($6.50 each for four uses) are considered, this is an appropriate estimate for budgeting. As with most agricultural crops, sod enterprises require the expenditure of funds months before the sale of the crop. Therefore, a six-month interest charge on the variable costs is included as a variable expense.

A listing of the fixed costs of production (the expenses that must be paid regardless of the amount of sod produced) is also presented in Table 9. Fixed costs include insurance, taxes, depreciation, interest charges, annual overhead-type expenses (pick-up truck, ATV, communications, managerial and clerical labor, facility maintenance) and land rent. Five-year average costs for depreciation, interest, housing and insurance expenses for equipment were calculated using the "Machinery Cost Calculator." These expenses are based on the assumption of all new equipment. Straight-line depreciation is used on the irrigation equipment and is based on a 10-year useful life, with zero salvage value. Annual overhead cost (pick-up truck, ATV, communications, clerical staff, advertising) is estimated at $500 per acre. Annual overhead items are often used in the production and management of commercial sod, but are often funded by the operation from net returns to management rather than required line-item expenses. The annual overhead cost is estimated from typical expenses incurred by sod operations. The annual overhead costs will vary widely from one farm to another.

Total labor expense includes installing netting, harvesting, irrigation and other labor needs as detailed in Table 8. The labor charge of $9 per hour includes both cash wages as well as payroll overhead expenses and taxes. At an average wage rate of $9 per hour (including taxes and benefits), hired labor costs are estimated at $421 per acre or $21,050 for the entire enterprise.

Total variable, fixed and labor expenses are combined to estimate the total budgeted expenses per acre of $3,206.97. According to the budget, about 55 percent of the budgeted expenses are represented by the variable costs of production — seed, fertilizer, sod netting, chemicals, fuel and repairs. Fixed costs including depreciation, interest, housing and insurance represent approximately 32 percent of the budgeted expenses. Labor costs account for approximately 13 percent of the budgeted expenses.

[6] Cross, Tim L. "Machinery Cost Calculator." AE&RD Info. No. 3, The University of Tennessee Agricultural Extension Service, 1998. The "Machinery Cost Calculator" software can be accessed vie the World Wide Web at: http://web.utk.edu/~ExtAgEco/machine/machine.html.

Table 9. Estimated Expenses per Acre: Tall Fescue-Kentucky Bluegrass, 50-Acre System						
Item	***Description***	***Unit***	***Quantity***	***Price ($)***	***Amount ($/Acre)***	***Your Farm***
Variable Costs:						
Seed	Tall Fescue blend	lb.	350	1.50	525.00	
	Kentucky Bluegrass	lb	35	2.90	101.50	
Fertilizer	12-24-24	lb	400	0.13	51.28	
	Urea*	lb	250	0.30	75.00	
Agricultural lime	Custom applied	ton	1	18.00	18.00	
Netting	Sodnet netting	roll	0.133	1332.00	177.16	
	Wooden stakes	ea	500	0.02	12.00	
Herbicides	Roundup Pro®	qt	6	12.38	74.28	
	Strike 3®	pt	6	2.35	14.10	
	Surfactant	qt	0.2	2.50	0.50	
	Manage 75DF®	oz	1	79.23	79.23	
	Surfactant	qt	0.2	2.50	0.50	
Fungicides	Daconil Ultrex®*	lb	10	8.67	86.70	
	Bayleton 25WSP®*	oz	87	1.99	57.71	
Insecticide	Sevin 4SL®*	oz	195	0.23	44.85	
Irrigation	Repairs	2 percent of per-acre purchase price per year			17.20	
	Fuel (diesel)	gal	114	0.70	79.80	
Pallets	Wooden pallets				137.19	
Non-irrigation Equipment	Fuel				61.06	
	Oil and filter				9.11	
	Repairs and maintenance				64.02	
Sub-total					1686.19	
Operating capital	6 months	acre	1870.64	0.09	75.88	
Total Variable Costs					**1762.06**	

* Application rates have been adjusted for production practices required after harvesting begins in April to reflect the proportion of harvested sod not requiring such practices.

Table 9. (continued) Estimated Expenses per Acre: Tall Fescue-Kentucky Bluegrass, 50-Acre System						
Item	***Description***	***Unit***	***Quantity***	***Price ($)***	***Amount ($/Acre)***	***Your Farm***
Fixed Costs:						
Non-irrigation equipment	Depreciation				130.82	
	Interest				150.58	
	Housing and insurance				8.21	
Land	Per-acre opportunity cost				100.00	
Irrigation	Straight-line depreciation ($43,000 for 10 years over 50 acres)				86.00	
	Interest (annualized interest for 10 years at 9 percent)				48.01	
Annual overhead	Pick-up truck, ATV, communications, clerical staff, advertising				500.00	
Total Fixed Costs					**1,023.62**	
Labor Costs:						
Production	Install netting & field work	hours	14.06	9.00	126.54	
Harvesting	Harvest	hours	30.00	9.00	270.00	
Irrigation	Irrigate	hours	2.75	9.00	24.75	
Total Labor Costs					**421.29**	
Total Budgeted Expenses (per acre)					**3,206.97**	
Total Budgeted Expenses (per square yard)					**0.78**	

Economic Evaluation: Tall Fescue-Kentucky Bluegrass Sod, 150-Acre

The basic parameters for the economic analysis of the 150-acre operation are given in Table 10. The same general production specifications for the 50-acre enterprise presented in Table 3 are applied to the 150-acre analysis. The equipment complement assumed in the 50-acre operation is the basis for the 150-acre operation, with additional equipment purchased as necessary.

The capital requirements for the 150-acre system are presented in Table 11. Total initial investment (at new equipment prices for all equipment) is $404,000 with an average depreciation of $179.93 and average repair cost of $54.54 per acre. The total initial investment of $404,000 is 77.6 percent greater than the initial investment for a 50-acre operation, but 40.8 percent less than the per-acre investment required for the smaller operation.

Table 10. Basic Parameters for the 150-Acre Operation

Field size	150 Acres
Field layout	Three 50-acre fields Each field relatively flat Approximately 2,178,000 square feet (1,044 feet by 2,088 feet)
Irrigation	Three hard-hose traveling gun systems, with 1000 feet of 3" diameter P.E. tubing - $75,000. Pump and stationary engine - $15,000. Mainline, risers, and valve openers - $12,300 (mainline cost assumes that water source is adjacent to field). Water filtration - $1,000. Total initial cost for irrigation approximately $103,000.
Mowing schedule	45-horsepower tractor and 15.5 foot mower will be dedicated to 50 acres and a 60-horsepower tractor and 21.5 foot mower will be dedicated to 100 acres for 22 fall mowings and 30 spring mowings.

The labor and equipment requirements are presented in Table 12. Overall, the per-acre labor requirements decrease from the 50-acre system to the 150-acre system due to the efficiencies of larger equipment.

A detailed budget of the per-acre expenses is presented in Table 13. Variable expenses per acre are slightly lower than the 50-acre system at $1,738.01. However, variable expenses for the larger system represent a larger portion of the total per-acre expenses (61 percent) than in the smaller system. The total fixed costs per acre of $576.16 are considerably lower for the larger operation, while per-acre labor costs are only slightly lower. Overall, the total budgeted expenses per acre for the 150-acre system are $487.06 ($0.12 per square yard) lower than the 50-acre system.

Table 11. Capital Requirements: Tall Fescue-Kentucky Bluegrass, 150-Acre System

		Per-acre Estimates			
Equipment Listing	***Description***	***New Price ($)***	***Annual Hours of Use***	***Five-Year Average Depreciation Cost ($)***	***Five-Year Average Repair Cost($)***
Tractor	45-horsepower, 4 wheel drive	25,000	5.44	6.01	2.89
Tractor	60-horsepower, 4 wheel drive	30,000	5.15	5.91	4.10
Sprayer	300-gallon, 3 point-hitch with 28-foot boom	3,000	0.55	4.31	0.74
Turning plow	48", 3-16 bottom	3,500	0.48	1.35	0.24
Disk	10 foot	6,300	0.33	5.60	0.10
Fertilizer spreader	Besco® 2000-pound capacity, 3-point hitch	2,500	0.4	1.24	0.36
Seeder	Brillion®, with 2 seed boxes, 10 foot, pull type	13,300	0.165	4.94	0.06
Scotch harrow	12 foot	1,200	0.165	1.07	0.05
Roller	12-foot drum with cement	1,000	0.069	0.49	0.02
Roller	12-foot drum with cement	1,000	0.069	0.49	0.02
Mower	Progressive® Mower, 15,5-foot, 3-gang finishing	11,500	1.83	1.73	12.91
Mower	Mathis® Mower, 21.5-foot, 3-gang finishing	17,900	2.76	2.85	3.85
Harvester	Brouwer®, Model 1560, 16" cut, with options	50,000	3.17	21.88	3.74
Harvester	Brouwer®, Model 1560, 16" cut, with options	50,000	3.17	21.88	3.74
Sweeper/vac.	Brouwer®, BV138, 8-foot, 5 cubic-yard capacity	11,700	1.81	3.93	.86
Forklift	Brouwer®, Hitchhiker, 23-horsepower	35,000	1	27.00	6.75
Rotary mower	Five-foot, 3-point hitch	2,500	0.24	1.25	0.38
Irrigation system	Hard-hose, traveling guns, pump & stationary diesel engine, mainline risers	103,000	42	68.00	13.73
Shop, office, storage	780 sq. ft. storage, 120 sq. ft. office @ $20/sq ft	35,600			
Total		**$404,000**		**$179.93**	**$54.54**

Table 12. Labor and Equipment Inputs: Tall Fescue-Kentucky Bluegrass, 150-Acre System

			Minutes per acre	
Date	***Activity***	***Power Unit and Equipment***	***Machine***	***Labor***
After harvest (July-Aug.)	Spray Roundup Pro® (two applications)	45-horsepower tractor and sprayer 45-horsepower tractor and sprayer	4.42 4.42	5.53 5.53
Prior to plowing	Mow	45-horsepower tractor and rotary mower	14.14	17.68
After mowing vegetation	Plow	60-horsepower tractor and plow	28.80	36.00
After mowing	Disk	60-horsepower tractor and disk	9.90	12.38
After disking	Fertilize	45-horsepower tractor and fertilizer spreader	6.60	8.25
After fertilizing	Disk and drag	60-horsepower tractor, disk and harrow	9.90	12.38
Mid Aug. to Oct.	Seed	45-horsepower tractor and seeder	9.90	12.38
After seeding	Install netting	60-horsepower tractor Additional labor	35.00	43.75 137.00
Within two days of seeding	Begin irrigation	Irrigation system (no labor) 45-horsepower tractor	2,112.00 132.00	165.00
Prior to mowing	Insect control	45-horsepower tractor and sprayer	4.42	5.53
Approximately three weeks post plant	Mow	45-horsepower tractor and mower	6.40	8.00
After seedling emergence	Fertilize	45-horsepower tractor and fertilizer spreader	6.60	8.25
Every four days until mid Dec. (22 mowings)	Mow	1/3 of acres mowed with 45-horsepower tractor and Brouwer® mower 2/3 of acres mowed with 60-horsepower tractor and Mathis mower	46.46 71.10	58.08 88.87
After 4th mowing	Broadleaf weed control	45-horsepower tractor and sprayer	4.42	5.53
March until harvest (30 mowings)	Mow Mow	1/3 of acres mowed with 45-horsepower tractor and Brouwer® mower 2/3 of acres mowed with 60-horsepower tractor and Mathis® mower	63.36 94.25	79.20 117.81
March, April and May	Sweep/Vac.	60-horsepower tractor and sweeper/vac.	48.60	60.75
March	Broadleaf weed control	45-horsepower tractor and sprayer	4.42	5.53
March	Nutsedge control	45-horsepower tractor and sprayer	4.42	5.53
March	Fertilize	45-horsepower tractor and fertilizer spreader	6.60	8.25
April	Fertilize*	45-horsepower tractor and fertilizer spreader	4.36	5.45
May	Fungus control*	60-horsepower tractor and sprayer	2.92	3.65
May - June	Insect control*	45-horsepower tractor and sprayer	2.21	2.76
June	Fungus control*	45-horsepower tractor and sprayer	1.46	1.83
Prior to harvest	Roll Roll	45-horsepower tractor and roller 60-horsepower tractor and roller	4.13 4.13	5.16 5.16
April - July 1	Harvest	Tractor-mounted harvester	380.80	1,800.00
Total Labor Minutes per Acre				**2,731.16**
Total Labor Hours per Acre				**45.52**

* Labor and machinery requirements have been adjusted for production practices required after harvesting begins in April to reflect the proportion of harvested sod not requiring such practices.

Table 13. Estimated Expenses Per Acre: Tall Fescue-Kentucky Bluegrass, 150-Acre System						
Item	***Description***	***Unit***	***Quantity***	***Price ($)***	***Amount ($/acre)***	***Your Farm***
Variable Costs:						
Seed	Tall Fescue blend	lb	350	1.50	525.00	
	Ky. Bluegrass	lb	35	2.90	101.50	
Fertilizer	12-24-24	lb	400	0.13	51.28	
	Urea*	lb	250	0.30	75.00	
Agricultural lime	Custom-applied	ton	1	18.00	18.00	
Netting	Sodnet netting	roll	0.133	1,332.00	177.16	
	Wooden stakes	ea	500	0.02	12.00	
Herbicides	Roundup Pro®	qt	6	12.38	74.28	
	Strike 3	pt	6	2.35	14.10	
	Surfactant	qt	0.2	2.50	0.50	
	Manage 75DF®	oz	1	79.23	79.23	
	Surfactant	qt	0.2	2.50	0.50	
Fungicides	Daconil Ultrex®*	lb	10	8.67	86.70	
	Bayleton 25WSP®*	oz	87	1.99	57.71	
Insecticides	Sevin 4SL®*	oz	195	0.23	44.85	
Irrigation	Repairs	2% of per-acre purchase price /year			13.73	
	Fuel (diesel)	gal	114	0.70	79.80	
Pallets	Wooden pallets				137.19	
Non-irrigation Equipment	Fuel				63.47	
	Oil and filter				10.36	
	Repairs and maintenance				40.81	
Sub-total					1,663.17	

* Application rates have been adjusted for production practices required after harvesting begins in April to reflect the proportion of harvested sod not requiring such practices.

Table 13. (continued) Estimated Expenses Per Acre: Tall Fescue-Kentucky Bluegrass, 150-Acre System						
Item	***Description***	***Unit***	***Quantity***	***Price ($)***	***Amount ($/acre)***	***Your Farm***
Operating Capital	6 months	acre	1848.75	0.09	74.84	
Total Variable Costs					**1,738.01**	
Fixed Costs:						
Non-irrigation equipment	Depreciation				111.93	
	Interest				83.60	
	Housing and insurance				7.30	
Land	Per acre opportunity cost				100.00	
Irrigation	Straight-line depreciation ($103,000 for 10 years over 150 acres)				68.67	
	Interest (annualized interest for 10 years at 9 percent)				38.33	
Annual Overhead	Pick-up truck, ATV, communications, clerical staff, advertising				167.00	
Total Fixed Costs					**576.16**	
Labor Costs:						
Production	Install netting & field work	hours	12.68	9	114.10	
Harvesting	Harvest	hours	30	9	270.00	
Irrigation	Irrigate	hours	2.75	9	24.75	
Total Labor Costs					**408.87**	
Total Budgeted Expenses (per acre)					**2,723.04**	
Total Budgeted Expenses (per square yard)					**0.66**	

Marketing

Once the decision is made to produce sod, the decision is also made to market sod. Marketing turfgrass is different from marketing most traditional agronomic crops. A guaranteed market does not exist for turfgrass sod. Demand fluctuates from year to year and from month to month. Market availability is one of the most important factors of establishing a successful sod operation. Producing a quality sod at a low cost will not insure a profitable operation. Chances of success decrease as the demand for sod decreases. One method of "experiencing" the turfgrass sod market with relatively lower levels of risk involves a gradual production plan. For instance, three to 10 acres may be a good production amount for the first year, followed by 10 to 20 acres in the second year. Cash flow during the first couple of years may be tight, but lower levels of marketing risk could be experienced.

Turfgrass producers generally do not have readily available, well-defined markets. Turfgrass producers will be confronted with several marketing issues, such as identifying buyers, advertising, delivering sod and pricing.

Landscapers and building contractors represent the largest market for turfgrass. Other buyers include homeowners and managers of sports fields and golf courses (Table 14). Obtaining and maintaining market share can be challenging for new sod-producing operations. To reduce risk, a producer may want to secure a buyer for at least part of the crop prior to planting. Providing a quality product increases the chances of repeat business and favorable referrals. Typical sod sales by customer are presented in Table 14.[7]

Table 14. Typical Sod Sales by Customer

Typical Portion of Sales[8]	*Customer*
50	Landscapers and building contractors
15	Homeowners
15	Sports fields
10	Golf courses and cemeteries
7	Garden centers
7	Other sources
4	Sod brokers
2	Government agencies

While price and quality are the primary sales criteria, marketing sod often takes on more service than commodity characteristics. Sales are often dependent on transportation and installation. The costs estimated in previous sections assume sod was produced, harvested and loaded at the production site. Costs for distribution from the production site, unloading and installing are not included. However, distribution is a critical component of a sod business and must not be overlooked. Many sod producers consider themselves to also be in the trucking business because they usually provide delivery of their product to the buyer. Due

[7] Source: Sod Production in the Southern United States, B. McMarty, G. Landry, J. Higgins and L. Miller, Clemson Extension, EC 702, May, 1999.

[8] Total may not sum to 100% due to duplicate responses and rounding.

primarily to the capital investments, smaller operations tend to rely largely on sales of sod directly from the field or deliveries within a fairly small radius (35 to 50 acres or miles), while larger operations primarily deliver to the point of installation within a radius of 150 to 200 miles. To expand their marketing opportunities and provide more flexible distribution arrangements, more and more sod producers include a large flat-bed tractor trailer with a piggyback forklift in their machinery complement. However, some growers contend that trucking can always be arranged and they are not compelled to include trucking as part of their operation but instead rely on contract trucking arrangements when needed.

Regardless of the distribution arrangements, most sod producers must take a different view of marketing their crop from farmers of traditional commodities. Advertising and promotion tactics are commonplace for sod producers. Business cards, brochures, yellow page and trade magazine advertisements, trade shows and direct mailings are some of the marketing tactics utilized by sod producers. Some larger operations actually employ a full-time salesperson to market the crop. Sod operations often spend 1 to 2 percent of gross sales on advertising.

Not only must the grower contend with weather and mowing, irrigation and harvesting schedules, but scheduling deliveries often becomes a challenge. Sod is a perishable crop once harvested. Therefore, harvesting, delivery and installation must be carefully scheduled.

In a 1978-1979 study by the University of Alabama Experiment Station,[9] 80 percent of turfgrass sod producers reported the ability to deliver sod to the purchaser and all of the surveyed growers reported selling some sod directly from the field. Large growers tend to deliver sod to the site of installation as long as the buyer is willing to pay for the transportation service. Most small and medium size operations restrict delivery to a radius of less than 100 miles. Growers providing delivery indicated that 90 percent of their production is delivered. Delivery charges are normally based on one of three methods: per load, per loaded mile or per square yard. Per square yard charges are typically $0.25 or more, while per loaded mile rates range from $1.70 to $2.05.[10] Charges on a per-load basis are often determined as a function of the amount of sod involved and the distance of haul.

The most common payment practices in the sod industry include cash on delivery, extended credit terms and balance due by a specified date. Many sod producers find themselves in the credit and collection business. While most operations receive a majority of payments at delivery, cash flow problems can arise from delayed payments by customers. Good customer relations and effective record-keeping help minimize accounts receivable problems.

Historically, base prices for turfgrass sod have been set by larger operations. Smaller growers tend to use these base prices as a guide for establishing their prices. Prices tend to increase as operator size increases. In 1978-1979, 93 percent of Alabama sod was sold at a wholesale price.[11] Generally, the amount of sod purchased determines whether a wholesale or retail price is charged. Sometimes, an order of 250 square yards or more will generate enough volume to establish a wholesale price. However, only sales to middlemen will qualify for a wholesale price.

Average wholesale prices for tall fescue-Kentucky bluegrass in Tennessee tend to range from $1.15 to $1.25 per square yard, at the production site.[12] Table 15 presents per-acre gross revenue estimates for various per-acre yields and various prices per square yard, based on typical prices and yields in Tennessee.

Estimates of per-acre returns to management, marketing and risk can be calculated by comparing the total budgeted expenses per acre (from Table 9 for the 50-acre system and Table 13 for the 150-acre system) to the gross revenue for appropriate average per-acre yield and price per square yard in Table 15. For example, at an average per acre yield of 4000 square yards and an average sales price of $1.25 per square yard, gross revenue per acre is $5,000. Compared to the total budgeted expenses per acre for the 50-acre system of $3,206.97 and $2,723.04 for the 150-acre system, a net return to management, marketing and risk of $1,793.03 and $2,276.96 is generated by the respective systems. Therefore, the 50-acre system generates a return to management, unpaid capital and unpaid family labor of $89,651.50 while the 150-acre system returns $341,544. Similar return estimates can be made for other combinations of price and yield.

[9] Commercial Turfgrass Production in Alabama, Bulletin 529, August 1981.

[10] Source: Sod Production in the Southern United States, B. McCarty, G. Landry, J. Higgins and L. Miller, Clemson Extension, EC 702, May, 1999.

[11] Commercial Turfgrass Production in Alabama, Bulletin 529, Alabama Agricultural Experiment Station, August 1981.

[12] Based on a random sample of Tennessee commercial sod growers by Dr. Tom Samples, Turfgrass Specialist, The University of Tennessee Agricultural Extension Service, 1999.

Table 15. Gross Revenue Projections with Various Yields and Price per Square Yard					
Per-Acre Yield (square yards)	***Wholesale Price per Square Yard***				
	$1.00	**$1.10**	**$1.20**	**$1.25**	**$1.30**
3800	$3,800	$4,180	$4,560	$4,750	$4,940
4000	$400	$4,400	$4,800	$5,000	$5,200
4114	$4,114	$4,525	$4,937	$5,143	$5,348
4200	$4,200	$4,620	$5,040	$5,250	$5,460
4500	$4,500	$4,950	$5,400	$5,625	$5,850

Conclusions

The market for turfgrass sod in Tennessee appears to be significant and growing. Although sod is produced in several nearby states, hauling distances and costs favor local production, especially near the metropolitan areas. Potential sod growers must be aware that marketing sod is not the same as marketing grain or livestock. No terminal markets or auctions exist for sod, so growers must actively advertise, promote and sell their product. In addition, collection of sale proceeds remains the responsibility of growers.

The production cycle for tall fescue-Kentucky bluegrass sod is approximately 12 months long, with establishment occurring in late summer and harvest taking place primarily during the following spring and summer. Machinery and equipment needed to produce sod is similar to the machinery needed to establish and maintain forages, but specialized equipment is required to harvest and load sod. Labor requirements for sod production are high, totaling almost 50 hours per acre.

Producing high-quality sod and achieving necessary yield levels are only possible with an efficient irrigation system. Sufficient quality and quantity of irrigation water is needed to ensure that sod receives an adequate amount of moisture on a regular basis. The estimated cost of a hard-hose-reel traveling gun system to water a 50-acre field is $43,000, including the pump and engine, mainline, hose, and traveling gun. The investment cost of other machinery and equipment plus shop, storage and office space is $184,500, resulting in a total investment cost of $227,500 for a 50-acre tall fescue-Kentucky bluegrass sod enterprise. This investment total excludes land, trucks and other utility vehicles. Total investment for a 150-acre sod enterprise is estimated at $404,000, lowering the per-acre investment required from $4,550 for a 50-acre enterprise to $2,693 for a 150-acre enterprise.

Sod production costs are estimated at $3,206.97 per acre for a 50-acre sod farm and $2,723.04 for a 150-acre sod farm. If yield is 4,000 square yards per acre, then breakeven prices over budgeted expenses are $0.80 and $0.68 per square yard for a 50-acre and 150-acre farm, respectively. Prices are typically at least $1 per square yard, suggesting that returns from sod will exceed budgeted expenses. No charges have been included in this budget for family labor, management or general farm overhead, so these costs must be paid from the returns above budgeted expenses.

Sod production entails considerable risks and requires high levels of management. Prospective new growers should invest time in learning about producing and marketing sod before establishing a new sod enterprise.

Notes

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