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Projected Costs and Returns Associated with the Production of Kentucky Bluegrass

A Study of Economic Feasibility in Indiana and Iowa

This publication is the first of a series of articles aiming to assess the economic feasibility of growing sod. Each publication analyzes the costs and returns associated with specific sod species and compares them with growing Kentucky bluegrass. Publications can help growers understand capital needs, as well as the financial risk and uncertainty of operating a sod farm. Existing firms can also compare their financial performance over time and with other like-firms. New operations seeking to enter the sod industry will have information to assess the viability of such investment.

The initial investment for a turfgrass farm producing 382 acres of Kentucky bluegrass is $3,430,066. Investment includes buildings and office equipment, machinery, and irrigation system acquisition. If the operation yields around 41,130 ft^2 of sod per acre, they can obtain a profit of $5,632 per acre when the average price is $0.26 per ft^2. Labor costs represent 52% of total costs per acre, and the breakeven yield and price of Kentucky bluegrass is 19,468 ft^2, and $0.12/$ft^2$, respectively.

1. Introduction

Turfgrass is a major specialty crop in the US. From its nascent state in the 1960s, the industry had at that time almost 1,000 sod farms in operation with 105,000 acres of production and generating approximately $100 million in sales (Adrian et al., 2004). Data from the 2017 US Census of Agriculture showed that 1,500 sod farms generated $1.2 billion in sales from harvesting approximately 340,000 acres in 2017 (USDA-NASS, 2019). The turfgrass industry's economic impact derives from the environmental, functional, and aesthetic benefits that sod provides to the landscaping sector and the strong demand from residential and commercial property development.

Turfgrasses are grown either from seed or from sod. Sod is harvested by removing a mature turfgrass cover with a minimal amount of soil and then transplanting afterward. Southern states are the leading suppliers of sod in the US, with 220,000 acres harvested in 2017 and almost 65% of the domestic production; this is because warm-season turfgrasses, which are predominant in the southern US, are mostly vegetatively propagated and not available as seeded varieties. In the Midwest, where turfgrass is available to consumers as either sod or seed, the 2017 Census of Agriculture reported that 293 operations harvested 44,633 acres of sod, representing 13% of the domestic production (USDA-NASS, 2019). The other 22% of sod is grown in states in the Northeast and West regions.

Historically, sod production in the Midwest has been dominated by Kentucky bluegrass (Poa pratensis), which includes cultivars that provide high-quality turf when managed with sufficient amounts of fertilizers, water, and pesticides. Although genetic improvements have helped introduce many low-input turfgrasses, such as tall fescue (Schedonorus arundinaceus) and fine fescue (Festuca spp.), Kentucky bluegrass still dominates Midwest turfgrass sod production. Surveys of consumers (Yue et al., 2012; Hugie et al., 2012; Yue et al., 2017) point to an increased market demand for sod with low-input attributes, which could provide new economic opportunities for Midwest producers.

Significant challenges when adopting new turfgrass species have included a lack of economic, agronomic, and market information. There are few studies on the economic impact and costs associated with the production of sod, and most studies have focused on warm-season turfgrass production operations located in southern states (Hinson & Koske, 2006; Adrian et al., 2003; Kaiser & Ernst, 2019; Falconer, 2006). An important first step is to provide information on the potential revenues and expenses associated with producing Kentucky bluegrass as a benchmark which can be used to evaluate the economic feasibility of diversifying sod production.

This publication assesses the economic feasibility of growing Kentucky bluegrass in the Midwest by determining the financial costs and returns associated with one year of production. This publication addresses significant questions, such as: Is Kentucky bluegrass production profitable? What does it take in terms of financial means, to start producing Kentucky bluegrass? How do sod yield and price impact profitability? What is the breakeven price and yield of an average Kentucky bluegrass farm?

Data for this analysis comes from five sod farms, located in Indiana and Iowa; sod growers were interviewed to calculate average capital expenses, labor, variable, and fixed costs. Data was used to develop profitability projections, sensitivity analysis, and breakeven benchmarks based on the three states represented in our sample.

2. Background

The most common turfgrass species grown from sod in the US include bermudagrass (Cynodon spp.), centipedegrass (Eremochloa ophiuroides), fine fescue, Kentucky bluegrass, St. Augustinegrass (Stenotaphrum secundatum), tall fescue, and zoysiagrass (Zoysia spp.) (Rob et al., 2000). Currently, Kentucky bluegrass is the most widespread grass species in commercial and residential landscapes in the Midwest. This type of sod is grown not only because of farmers' familiarity with its production. Kentucky bluegrass develops a dense turfgrass sward, with excellent color, and mows more cleanly than other cultivars, such as tall fescue. Additionally, the extensive rhizome of Kentucky bluegrass produces a solid sod that is vigorous when harvested and established (Casler and Duncan, 2003).

The fact that Kentucky bluegrass requires a higher amount of inputs than other types of turfgrasses has raised environmental concerns, such as potential freshwater contamination from fertilizers, pesticides (Milesi et al., 2005). But when sod growers consider planting other species, they face myriad decisions regarding which species to grow, the cultural practices and investments related to each species, and the impact on farm profitability. This publication focuses on Kentucky bluegrass to set a benchmark on comparing profitability and breakeven ratios for a turfgrass operation in Indiana.

Data from this study was collected using a two-phased approach. Using a semistructured questionnaire, Phase 1 consisted of face-to-face interviews with Indiana sod growers conducted between January and May 2020. Three sod growers provided data on the investments, revenues, and expenses associated with growing sod. Growers also provided information on their general operating practices and a detailed list of machinery used to grow and harvest sod. These interviews helped us develop a web-based survey questionnaire to capture detailed financial information.

Phase 2 consisted of inviting sod growers via email to participate in the web-based survey. Email addresses of growers were obtained from lists provided by turfgrass specialists and producers who expressed their willingness to participate in the study during the 2020 TPI (Turfgrass Producers International) conference in Orlando, Florida. The survey was distributed online via Qualtrics between May and July 2020. Two email reminders were sent in a two week interval. The survey asked participants questions about their operation, machinery owned, variable costs, labor, and fixed costs. The survey excluded delivery and installation costs, as

these services are optional for some operations. A total of three sod farmers from the states of Indiana and Iowa responded to the online survey.

A total of two sod farmers from Indiana and Iowa responded to the online survey. Farms in our sample reported an average of 382 acres of Kentucky bluegrass production. Yield ranged from 39,000 ft^2 to 43,560 ft^2 of harvested sod per acre. The minimum and maximum time for the production cycle is 45 and 55 weeks, respectively, with an average of 52 weeks. The market price used for the analysis was \$0.26/ft^2, obtained through the average selling price from all the sod operators who have participated in the study. Equipment prices were obtained from different sources, including lists of equipment dealers, websites, conferences, trade shows (e.g., 2020 Indiana Green Expo, 2020 TPI conference), and interviews with farmers. Data collected was used to develop SodCalculator, a spreadsheet that serves for data input, analyses, and visualization of the economic feasibility of producing sod.

3. Capital investment

A sod farm, like any other successful small business, should be prepared to invest capital in operating, expanding, and improving its facilities. Capital investment decisions are critical in managing strategic change and sustaining long-term financial performance (Emmanuel et al., 2010). The capital investment in a business represents the initial funds allocated for the acquisition of assets, and also shows the commitment of resources made in the hope of accruing profitability over time (Brower et al., 2001).

Table 1 categorizes three main categories of capital investment in a sod farm: buildings and office equipment, implements and power equipment, and irrigation system.

Buildings and office equipment are investments in assets needed to build facilities that are needed to run the farm. Many sod farms have a storage space, garage for equipment, and sales office. Implements and power equipment represent the machinery needed to operate the farm from seeding through harvesting; this publication provides examples of equipment needed for the establishment and maintenance of sod. Investment in irrigation system involves hiring an irrigation contractor to design, construct, and install an irrigation system, together with the acquisition of different materials, including hard-hose traveling gun systems, pump stations and pumps, and stationary engines, mainline, risers, and valve openers.

Our analysis is based on several assumptions regarding land allocation and depreciation. The land is assumed to be rented at \$215/acre of irrigated cropland in 2018, which comes from reports from the US Department of Agriculture (USDA-NASS, 2018). Land rent price was used to compute an investment of \$82,216 for 382 acres of sod production. We used a straight-line depreciation to spread the cost of investments in assets. The straight-line depreciation assumes that depreciation occurs in equal amounts for each year of the asset's useful life (Alhabeeb, 2012). The useful life of fixed assets was assumed to be 10 years for all equipment, five years for building and office equipment, and 25 years for the irrigation system using a salvage value of 25% of the purchase price over power equipment and implements. The section below provides in detail an explanation of the capital investments in Table 1.

Table 1. Capital investment for an average turfgrass sod farm of 382 acres based on data from sod farms in Indiana and Iowa collected in 2020.

Equipment category	Description	Average purchase price	Useful life (years)	Salvage value	Annual linear depreciation per acre
Building and office equipment	Building and office	**\$11,500**	5		**\$6**
	Land lease (per year)	**\$82,216**	1	**-***	**-***
Implements	Disk	**\$30,000**	10	\$7,500	**\$6**
	Land leveler	**\$15,000**	10	\$13,500	**\$3**
	Moldboard plow	**\$10,000**	10	\$3,750	**\$2**
	Power harrow	**\$30,000**	10	\$7,500	**\$6**
	Roller	**\$3,000**	10	\$ 750	**\$1**
	Rotary mower	**\$134,400**	10	\$33,600	**\$26**
	Rototiller	**\$5,000**	10	\$1,250	**\$1**
	Seeder	**\$18,000**	10	\$4,500	**\$4**
	Soil finisher	**\$5,750**	10	\$ 1,437	**\$1**
	Ripper	**\$30,000**	10	\$7,500	**\$6**
	JD Scraper 1512	**\$10,000**	10	\$2,500	**\$2**
Power equipment	Fertilizer spreader	**\$54000**	10	\$13,500	**\$11**
	Forklift	**\$147,000**	10	\$36,750	**\$29**
	Harvester	**\$550,000**	10	\$137,500	**\$108**
	Sprayer (turfgrass)	**\$21,000**	10	\$5,250	**\$4**
	Tillage tractor	**\$280,000**	10	\$ 70,000	**\$55**
	Tractor (45 HP)	**\$300,000**	10	\$75,000	**\$59**
	Tractor (75 HP)	**\$360,000**	10	\$90,000	**\$71**
	Tractor (125 HP)	**\$450,000**	10	\$112,500	**\$88**
Irrigation system		**\$883,200**	25	\$220,800	**\$69**
Total Investment		**\$3,430,066**			**\$556**

*Land asset is considered to have an infinite useful life, therefore it is not depreciated.

3.1. Seedling preparation

Capital investment for this section includes the purchasing of tillage tractors, used to pull tillage implements such as plows, rollers, and harrow. The average investment is $280,000 for 1-2 tillage tractors (average across 6 farms was 1.4 tillage tractors). Tillage practices are followed by grading activity, which consists of leveling the existing topsoil by a land leveler typically used to level the ground. Farmers reported using one land leveler priced on average at $15,000.

Power tractors are essential for a sod farm operation. Power tractors are usually coupled with other implements in order to carry out turfgrass cultural practices. Farmers reported using power tractors ranging from 45, 75, and 125 horsepower (HP) with an average investment price of $300,000, $360,000, and $450,000, respectively. A typical sod operation also uses power harrows to level and compact soil beds and provide better seed-to-soil contact. Farmers used an average of two power harrows for an average investment of $30,000 for both. Finally, one or two seeders (depending on the operation size) were reported for seeding, with an average purchase price of $18,000 for 1.8 seeders (average number of seeders among five sod farms).

3.2. Cultural practices

Cultural practices reported for sod management include mowing, rolling, fertilization, irrigation, and pest management.

Mowing is the most common and integral cultural practice in sod management (Owen and Lanier, 2013). Mowing provides the desired uniformity and appearance to the turfgrass (Busey & Parker, 1992). Grasses are typically mown to improve the area's appearance, control weed species, and provide a playing surface to different athletic facilities. Sod farmers reported the use of rotary mowers for mowing sod, ranging from one to four mowers, with an average investment of $134,400 for 2.4 rotary mowers (average number of rotary mowers among five sod farms).

After mowing, rolling has been reported as a central cultural practice in sod production. Rolling is performed to smooth the turfgrass surface from the imperfections caused by winter freezing and thawing, moles, earthworms, ants, other insects (Christians et al., 2017). This practice is usually done to ensure good contact between sod and soil. Rolling eliminates air pockets and improves establishment. Farmers surveyed for this study reported the acquisition of one or two rollers with an average investment of $3,000 for 1.5 rollers (average number of rollers among five sod farms).

Other cultural practices include using equipment such as fertilizer spreaders, sprayers, disks, moldboard plows, rippers, rototillers, and scraper tractors.

3.3. Irrigation system

Water irrigation is a major input for maintaining high-quality sod due to its influence on the capacity to achieve high yields (Breuninger et al., 2013). This is especially true for Kentucky bluegrass, which requires irrigation to prevent wilt and sustain foliar density. Farmers may use models to determine the amount of water required to maintain a healthy sod, based upon evaporation and transpiration rates (Christians et al., 2017).

The installation of an irrigation system requires different irrigation contractors. The irrigation design industry plans irrigation systems that are specific to individual sites and applications. In contrast, the irrigation equipment industry develops and manufactures the components and accessories needed, meaning establishing the essential components, including sprinkler heads, valves, automatic controllers, pumps (Breuninger et al., 2013). Although different irrigation systems are available for farmers to choose from, the choice of a system depends on capital, labor, and logistics availability. Data collected from farmers showed that the installation price for a pivot irrigation system ranged from $800,000 to $1,600,000 per farm, with an average installation valued at $883,200 with 25 years of useful life.

4. Turfgrass budget

The following section presents the average variable costs, labor costs, and fixed costs from the five sod farms surveyed.

4.1. Variable costs

Variable costs depend on diverse factors such as weather conditions, the technology used, and species of sod grown. Variable costs typically include seed, chemicals (insecticide, herbicide, fungicide, and fertilizer), fuel, repairs, and irrigation. Other studies have included additional expenses such as land preparation, planting, and equipment operating costs (Ho et al., 2011). Table 2 presents information on the average variable costs for Kentucky bluegrass sod production.

The average production cycle was estimated at 12 months, ranging from 10 to 14 months. The average variable cost was estimated at $1,251 per acre, which included average expenses related to seed ($333), liming materials ($16), pesticides ($124), fertilizers ($127), fuel ($131), repair cost ($25), oil and filter ($62), and pallets

($433). Depending on the severity of weeds and insects invading the cultivar area, pesticides (herbicides, insecticides, and fungicides) costs will vary from one operation to another.

Pallets are used to pile sod harvested; they accounted for 35% of variable costs. While all the operations reuse pallets for future harvests, our analysis assumed that farmers purchased pallets for every production cycle (year). Farmers expecting to reuse pallets should account for this calculation. Fuel, oil, and filter were reported as a single category and accounted for the total expense used to maintain all the farm machinery. Drawing from Rob et al. (2000), who estimated the cost of production of Kentucky bluegrass in Tennessee, we calculated maintenance costs for irrigation and non-irrigation equipment at 2% purchase price per year.

Table 2. Average variable costs per acre per year for a turfgrass sod farm.

Item		Average cost per acre ($)
Seed		$333
Liming		$16
Pesticides		$124
Fertilizers		$127
Fuel		$131
Maintenance and repair cost	Irrigation equipment	$5
	Non-irrigation equipment	$20
Oil and Filter		$62
Pallets		$433
Total variable costs		**$1,251**

44.2. Labor costs

As in any agricultural operation, labor is a critical input for sod farms. Labor tends to account for a high portion of farm expenses, and it is required to perform critical activities. Labor needs during the harvesting process require between three to four workers, depending on the operation. A typical harvesting process includes an employee driving the harvester, two employees placing the sod being harvested on pallets, and an additional employee driving the forklift to pick up the pallets.

Sod farms reported hiring four types of workers: full-time, H2A, machine operators, and part-time workers. H2A workers refer to guest workers who come to the US to work on temporary visas. Machine operators can be considered essential types of laborers in a sod farm because of the intense use of equipment for daily farm operations. Many of the interviewed farmers preferred to hire machine operators who have repair and maintenance skills, allowing them to reduce costs associated with outsourced services. Table 3 illustrates the total labor costs accounted for $1,017,938 per year, which was calculated from hiring an average of twenty employees in a typical sod farm. While some farmers reported total costs depending on the number of working hours multiplied by the respective wage, others reported having a specific budget for different activities, which allows them to hire the number of workers accordingly. Payroll taxes were not included in the total labor costs calculations, however; they represent indirect labor costs, and can fit into fixed overhead costs where we cover insurance and employee benefits.

Table 3. Average labor costs per year for a turfgrass sod farm of 382 acres.

Type of workers	Average labor costs ($)
Full-time workers	$415,430
H2A workers	$211,530
Machine operators	$365,813
Part-time workers	$25,165
Total labor costs	**$1,017,938**

*Payroll taxes are not included in the labor costs calculation.

4.3. Fixed costs

Fixed costs are costs that must be paid regardless of the amount of sod harvested and sold. Fixed costs included expenses related to depreciation and overhead costs (advertising, employee benefits, insurance, interest, and taxes). Table 4 provides a list of categories of fixed costs reported by sod operators, averaging $438,984 per year. Annual depreciation was included as a way to recover the purchase price of the assets acquired for the farm operations.

Table 4. Average fixed costs for a turfgrass sod farm of 382 acres.

Item	Average fixed costs ($)
Depreciation for power equipment and implements	$204,502
Communication, advertising	$9,189
Employee benefits	$33,736
Housing and insurance	$12,500
Interest on loan	$127,500
Property taxes	$51,558
Total overhead costs	**$438,984**

5. Analyses

Costs and revenues data were used to calculate profitability projections, cost structure, sensitivity analysis, and breakeven benchmarks.

5.1. Profitability projections

The profitability projection in Table 5 presents annual revenues, costs, and net profit per acre for an average farm (382 acres). A typical farmer generates $10,694 in sales and $5,062 in total costs, resulting in a net profit of $5,632 per acre. An average farm of 382 acres would generate a net profit of $2,153,674.

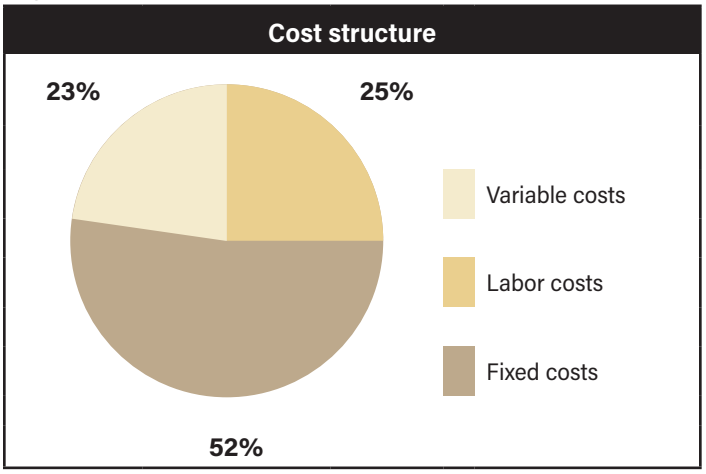
Table 5. Profitability projections.

Item	Values for 1 acre	Average farm (382 acres)
Gross revenue	**$10,694**	**$4,089,309**
Total costs	**$5,062**	**$1,935,635**
Variable costs	$1,252	$478,712
Labor costs	$2,662	$1,017,938
Fixed costs	$1,148	$438,984
Net profit (Loss)	**$5,632**	**$2,153,674**

5.2. Cost structure

The cost structure analysis helps farmers get a peripheral view of the distribution of each cost category. Labor costs accounted for half of the total costs per acre (52%). Other costs reported were variable costs (25%) and fixed costs (23%). This analysis can be used to project how changes in investments (i.e., automated harvester) can impact cost structure.

Figure 1. Cost structure of a sod farm.



5.3. Sensitivity analysis

A sensitivity analysis presents a "what-if" approach that measures how the net profit in a decision model will be affected by changes in price and yield. For example, the average selling price of sod is reported at $0.26/ft^2, and the average yield reported is 41,130 ft^2/acre. Therefore, if both conditions met, the net profit would be $5,632 per acre. Whereas, if yield drops by 2% and sod price drops by 20%, the net profit will decrease to $3,322 per acre. Alternatively, if only price increases by 10%, the net profit would increase to $6,701 per acre

Table 6. Sensitivity analysis

			Price ($/ft^2)				
			-20%	-10%	Average price	10%	20%
			$0.21	$0.23	$0.26	$0.29	$0.31
Yield (ft^2/ acre)	-4%	39,485	$3,151	$4,178	$5,204	$6,231	$7,257
	-2%	40,307	$3,322	$4,370	$5,418	$6,466	$7,514
	average yield	41,130	$3,493	$4,563	**$5,632**	$6,701	$7,771
	2%	41,953	$3,664	$4,755	$5,846	$6,937	$8,027
	4%	42,775	$3,835	$4,948	$6,060	$7,172	$8,284

5.4. Breakeven analysis

Enterprise budgets are useful for performing breakeven analysis on prices and yields. Breakeven yield analysis shows that to cover all the costs from an average operation, a sod farmer has to sell at least 19,468 ft^2 of sod at $0.26 per ft^2. Table 7 shows that decreasing the selling price by 10% (at $0.23) can result in a new breakeven yield of 21,632 ft^2 of sod. Lower prices may be a result of oversupply, supply chain disruptions, or an unexpected pandemic. In other words, a sod operation should at least sell 21,632 ft^2 of sod if Kentucky bluegrass prices lower from 0.26 to 0.23 per ft^2.

Table 7. Breakeven yield.

			Price ($/ft^2)				
			-20%	-10%	average	10%	20%
			$0.21	$0.23	$0.26	$0.29	$0.31
Total cost ($/acre)	-20%	$4,049	19,468	17,305	15,575	14,159	12,979
	-10%	$4,556	21,902	19,468	17,522	15,929	14,601
	average cost	$5,062	24,336	21,632	**19,468**	17,699	16,224
	10%	$5,568	26,709	23,795	22,415	19,468	17,846
	20%	$6,074	29,203	25,958	23,362	21,238	19,468

Breakeven price analysis (Table 8) showed the breakeven price at $0.12, which represents the minimum price that allows the farm to cover all projected costs. An unproductive year where yield decrease by 4% (39,485 ft^2) and costs per acre increased by 10% (total costs at $5,568), the new breakeven price would be $0.14/ft^2.

Table 8. Breakeven price.

			Sod yield (ft^2/acre)				
			-4%	-2%	average	2%	4%
			39,485	40,307	41,130	41,953	42,775
Total cost ($/acre)	-20%	$4,049	$0.10	$0.10	$0.10	$0.10	$0.09
	-10%	$4,556	$0.12	$0.11	$0.11	$0.11	$0.11
	average cost	$5,062	$0.13	$0.13	**$0.12**	$0.12	$0.12
	10%	$5,568	$0.14	$0.14	$0.14	$0.13	$0.13
	20%	$6,074	$0.15	$0.15	$0.15	$0.14	$0.14

6. Take-home message

An enterprise budget can assist farm-level decision-making. Understanding the crop profitability and how price, cost, and yield can change this bottom line can help sod farmers make economically feasible decisions. Using an enterprise budget for Kentucky bluegrass, this publication provides profitability, cost, sensitivity, and breakeven analysis to farmers growing Kentucky bluegrass in Indiana and Iowa. Data collected provide the economic feasibility of growing Kentucky bluegrass and serves as an economic benchmark for sod growers considering diversifying their crop mix.

Sod farmers can use this publication to evaluate their farm's efficiency, estimate benefits and costs for significant changes in production practices, and invest in new technology. For example, this tool can help sod growers understand the financial impact of investing in an automated harvester in terms of cost and revenues. Turfgrass production is location specific, and farmers should take into consideration differences related to location, markets, and varieties before using our study results. Those differences may impact significantly a sod farm's financial numbers. Future studies can break down costs such as water irrigation costs, administrative and personnel costs, and income taxes.

Our findings show that sod production requires a sizable capital outlay. Initial investment for a turfgrass farm of 382 acres was calculated at $3,430,066. A sod farm typically uses most of the frequent equipment used for other crops; however, highly specialized equipment is needed, such as sod harvesters, rotary mowers, and rollers. Results of this analysis indicate that Kentucky bluegrass is highly profitable, depending on the farm location. As an example of profitability, an operation yielding 41,130 ft^2 of sod per acre can obtain a net profit of $5,632 per acre when the average price is $0.26 per ft^2. Labor costs are the biggest category of costs, representing 52% of total costs per acre. Breakeven yield analysis showed that a farmer needs to harvest at least 19,468 ft^2 to cover production costs, and the breakeven price of Kentucky bluegrass sod is $0.12/$ft^2$.

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