SOD PRODUCTION

Economics of Tall Fescue Sod Production in the Midwest

Authors:

Sanchez Philocles, Graduate Research Assistant, Department of Horticulture and Landscape Architecture, Purdue University

Ariana Torres, Associate Professor, Department of Horticulture and Landscape Architecture, Department of Agricultural Economics, Purdue University

Eric Watkins, Professor, Department of Horticultural Science, University of Minnesota

Aaron Patton, Professor, Department of Horticulture and Landscape Architecture, Purdue University

Maria Camila Ulloa Gomez, Research Visiting Scholar, Department of Horticulture and Landscape Architecture, Purdue University

Introduction

This publication is the second in a series of articles assessing the economic feasibility of growing sod in the Midwest. (The first publication, "Projected Costs and Returns Associated with the Production of Kentucky Bluegrass," is available at https://www.extension.purdue.edu/extmedia/HO/HO-288-W.pdf.) Using the Purdue Sod Financial Calculator, this article analyzes the costs and returns associated with growing turf-type tall fescue [*Festuca arundinacea* Schreb.; syn. *Schedonorus arundinaceus* (Schreb.) Dumort., nom. cons.]. Turf-type tall fescue has been categorized as a low-input turfgrass with benefits such as lower fertilization and improved drought and shade tolerance, when compared to Kentucky bluegrass. Yet farmers considering switching their acreage to plant tall fescue should understand the financial impact of diversifying their sod operation. This publication can help sod growers understand the capital needs, as well as the financial risk and uncertainty of growing tall fescue. Existing farms can also compare their financial performance over time and with similar farms. Lastly, this publication provides beginner farmers with information to assess the viability of entering the sod industry.

Background of Sod

Production

Sod is an important specialty crop in the U.S., with an annual revenue reported at approximately $1.2 billion in sales in 2017 (USDA-NASS, 2019). According to the 2019 Census of Agriculture, there were 1,465 sod farms operating in the U.S., harvesting collectively 340,000 acres in 2017 (USDA-NASS, 2019). Industry experts expect these numbers to grow due to an increasing demand for sod and the value of residential and non-residential construction. For example, 1.4 million new privately owned housing units were completed in 2021, representing a 4.4 % increase from the previous year (U.S. Department of Commerce, 2021).

Sod production involves growing a solid stand of high-quality turfgrass that provides benefits that are functional, recreational, and aesthetic (Beard, 1980). Functional benefits of turfgrasses include the control of soil, wind, and water; thus, turfgrasses help reduce dust and erosion problems near homes, businesses, and roadsides (Haydu et al., 2006). Recreational benefits involve the use of turfgrasses for sports activities such as golf, baseball, football, and soccer; for example, in 2009, there were about 16,000 golf courses in the U.S. encompassing 1.2 million acres of cultivated turfgrass (Throssell et al., 2009). Lastly, the aesthetic benefits of turfgrass are related to aspects such as beauty, quality of life, mental health, and social harmony. Metropolitan areas and suburban residences benefit from the calm, green, and pleasant environment afforded by healthy lawns. Moreover, studies have shown the inverse relationship between green spaces and several determinants of health, such as lack of physical activity, obesity, and stress (Lee and Maheswaran, 2011; Lachowycz and Jones, 2011).

While turfgrasses provide multiple benefits, their maintenance raises concerns related to the negative effects on the environment. The first concern is related to the excessive use of water for irrigation. To illustrate, there are approximately 50 million acres of maintained turfgrass in the form of residential lawns, athletic fields, golf courses, cemeteries, and parks in the U.S. (Ghimire et al., 2016). This amount of maintained turfgrass demands about 2.3 billion gallons of water per day for irrigation (Maupin et al., 2014). As a result, states like Oklahoma have imposed limits on turfgrass irrigation to reduce water scarcity during droughts and meet water demand for the long term (Boyer et al., 2015).

Other environmental issues of maintained turfgrass are related to the improper application of pesticides and fertilizers. The U.S. Environmental and Protection Agency (EPA) estimated that homeowners and gardeners use 59 million pounds of pesticides by active ingredient weight) per year (Atwood and Paisley-Jones, 2017). Many states have restricted residential lawn care practices to reduce the number of inputs used for turfgrass maintenance. For example, several states, including Minnesota and Wisconsin, have passed legislation restricting turfgrass fertilizer applications containing phosphorous (State of Minnesota, 2010; State of Wisconsin, 2011).

Low-Input Turfgrasses

In response to regulations and concerns regarding turfgrass maintenance inputs, grass breeders and sod producers have developed and made available improved turfgrass cultivars that can help conserve water, decrease the use of fertilizers and pesticides, reduce maintenance costs for households, and improve lawn aesthetics (Van den Berg et al., 2015). Examples of those types of species are low-input turfgrasses such as tall fescue, fine fescue (Festuca spp.), and hard fescue (*Festuca brevipila* Tracey) (Braun et al., 2021). Previous studies (Watkins et al., 2012) found that low-input turfgrasses tend to show excellent persistence and uniformity under low-input environments (i.e., limited water, pesticides, or fertilizers after establishment). However, these species may not reach end-users of turfgrasses due to low supply and lack of consumer awareness (Ghimire et al., 2016).

On one hand, low-input turfgrasses are not widely planted because of the familiarity of growers with widely planted species such as Kentucky bluegrass. On the other hand, there is a limited number of studies available on the economics and marketing of low-input turfgrasses that may affect the demand, and therefore supply. To our knowledge, only one study is available on the cost of production of species such as tall fescue. Rob et al. (2000) used information from industry professionals and personnel from the University of Tennessee to report costs and returns associated with the mixed production of tall fescue and Kentucky bluegrass. They found that it takes about 12 months to produce tall fescue and Kentucky bluegrass, and costs were estimated at $3,206.97 per acre for a sod farm of 50 acres.

Tall Fescue in the U.S.

This study focuses on the economics of producing turf-type tall fescue, which is a type of tall fescue specifically used for turfgrass. Tall fescue is a cool-season perennial turfgrass used for home lawns, recreational surfaces, public lawns, golf course roughs, and athletic fields. Tall fescue is native to Europe. It was introduced into the U.S. during the 1800s (Meyer and Funk, 1989), and is currently one of the top three cool-season grasses produced in the U.S. and Europe due to its tolerance to wear, heat, and drought (Christians et al., 2017). The first turf-type tall fescue cultivars were released in the U.S. during the 1980s. Compared to earlier tall fescues, turf-type tall fescues tend to present a finer texture, increased tiller density, darker color, improved mowing quality, and they also exhibit better disease resistance than Kentucky bluegrass (Meyer and Watkins, 2003).

Researchers have found that tall fescue is one of the species that would be suitable as a sustainable low-input turfgrass (Diesburg et al., 1997; Watkins et al., 2011). Sustainable low-input turfgrasses include species capable of tolerating stresses in temperature, moisture, nutrients, and weed competition. Watkins et al. (2011) established trials for 12 different grass species in the

North Central Region (i.e., IL, IN, IA, MI, MN, MO, ND, OH, SD, and WI) and evaluated uniformity and persistence of turfgrass under mowed and non-mowed conditions. Their results showed that tall fescue, along with hard fescue, sheep fescue, and colonial bentgrass, was among the most notable species to adapt to low-input environments.

Researchers have investigated the consumer preferences toward environmentally friendly landscapes and found a market potential for low-input cultivars. Helfand et al. (2006) found that consumers in the Midwest were likely to adopt more environmentally beneficial landscape designs. Yue et al. (2012) found that consumers were willing to pay an additional $9.70 per 1,000 ft^2 for varieties of turfgrass seed with a low irrigation requirement (less than once a week) instead of high irrigation requirement (3-5 times a week); likewise, consumers were willing to pay a premium of $3.92 per 1,000 ft^2 for turfgrass seed requiring infrequent mowing (once a month) instead of frequent mowing (1-2 times per week).

While we expect demand for low-input turfgrasses to increase as consumers become more environmentally conscious, the capital-intensive nature of sod production can deter growers from making changes to their production system. Thus, it is important for sod growers to understand the financial implications associated with growing tall fescue. This study explores the startup costs, including equipment, variable and fixed costs, and labor costs associated with growing tall fescue. We also shed light on the profitability of growing tall fescue and the sensitivity analysis of profits to changes in production costs, and breakeven analyses on prices and yield. Tall fescue growers can use this enterprise budget to estimate the net profits and assess if the potential profitability meets their goals.

Data and methodology

We collected data from five tall fescue growers interviewed in summer 2021. Collected information was used to calculate average costs for a sod operation. The average production cycle reported by tall fescue growers in our study was 44 weeks. For more details on data collection, please see our previous publication, "Projected Costs and Returns Associated with the Production of Kentucky Bluegrass" (HO-288-W) at https://www.extension.purdue.edu/extmedia/HO/HO-288-W.pdf.

Cost and returns

Capital investment

Capital investment includes the purchase of necessary equipment for the operation of a sod farm. In our analysis, land was assumed to be rented at the average rent cropland rate in the U.S. in 2020, which was estimated at $139 per acre (USDA-NASS, 2020). Farm size in the data collected differs considerably, with operations growing between 5 to 900 acres of tall fescue. To address the heterogeneity of tall fescue acreage size in our data, ranging from 5 to 900 acres, we weighted capital investment to the average tall fescue operation at 211 acres. In other words, prices of capital equipment were prorated to the average-size tall fescue operation, and do not necessarily represent the purchase price for operations of different sizes. The total capital investment for a farm growing 211 acres of tall fescue was $2,320,013. Table 1 shows the purchase price of each equipment and their respective yearly depreciation per acre.

When comparing equipment needs for Kentucky bluegrass production from our previous study (Philocles et al., 2021), and equipment needs for tall fescue production, only one significant difference arose: the use of a netting machine (see Table 1). Tall fescue sod does not hold together as well as Kentucky bluegrass sod (Braun et al., 2021), so netting is needed to ensure that the product holds together from harvest to installation. A netting machine is a field net installer used for turf roll netting. This machine eliminates the labor needs for stacking and installation of netting on the field. The average cost for a netting machine was $13,663, and farmers use one to two for their farms.

Other capital investments included the purchase of fertilizer spreaders, which are used to apply fertilizers more quickly to large turf areas. The investment cost on fertilizer spreaders for the average tall fescue farm was $19,945, with most operations using between one and two fertilizer spreaders. In addition, sprayers are used to apply liquid or dry products individually or simultaneously; farmers used from one to three sprayers for an investment cost of $63,998 for the average tall fescue farm.

Sod growers were asked to provide an estimated value of all the buildings on their farms. The cost of buildings was $188,076 for the average tall fescue farm, and it includes facilities, garage, sales office, office equipment, and storage space. We used a straight-line depreciation to spread the costs of capital investment by irrigation and non-irrigation equipment. This method consists of spreading the initial cost (minus the salvage value) of the equipment over their useful life, which ranges from 5 to 25 years of expected ownership, depending on the type of asset. We used a salvage value of 25% of the purchase price, which is the expected value at the end of the equipment's useful life (Johnson, 2020).

Table 1. Capital investment for an average tall fescue operation (211 acres).

Equipment category	Description	Investment cost for average tall fescue operation	Salvage value	Annual linear depreciation per acre
Building and office equipment	Building and office	$188.076	-*	**$27.78**
Implements	Land lease	$29,301	-*	**-****
	Chisel plow	$7,905	$5,000	**$2.55**
	Disk	$17,131	$7,639	**$3.89**
	Field cultivator	$11,594	$4,500	**$2.29**
	Land leveler	$11,697	$5,156	**$2.63**
	Moldboard plow	$5,088	$2,167	**$1.10**
	Netting machine	$13,663	$4,583	**$2.34**
	Power harrow	$12,688	$7,500	**$3.82**
	Ripper	$28,999	$12,000	**$6.12**
	Roller	$8,851	$2,667	**$1.36**
	Rotary mower	$79,093	$46,800	**$23.86**
	Seeder	$15,054	$6,667	**$3.40**
	Soil finisher	$22,766	$7,196	**$3.67**
Power equipment	Fertilizer spreader	$19,945	$10,025	**$5.11**
	Forklift	$142,684	$86,063	**$43.87**
	Harvester	$662,781	$267,000	**$136.11**
	Sprayer	$63,998	$26,667	**$13.59**
	Tillage tractor	$332,695	$132,000	**$67.29**
	Tractor (45 HP)	$111,346	$75,500	**$38.49**
	Tractor (75 HP)	$116,688	$105,000	**$53.53**
	Tractor (125 HP)	$207,544	$149,063	**$75.99**
Irrigation system installation		$210,424	$104,375	**$53.21**
Total Investment		**$2,320,013**		**$572.00**

** The analysis does not include salvage value for buildings or land.*

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

Variable costs

Table 2 shows that the total variable cost for an average tall fescue operation was $2,456/acre. Variable costs for tall fescue production included expenses on seed, pesticides (i.e., insecticides, herbicides, and fungicides), fertilizers, fuel, repair and maintenance costs, pallets, oil and filter, sod netting, and wooden stakes. While maintenance activities for tall fescue were similar to those of Kentucky bluegrass, switching production to tall fescue resulted in a few differences regarding variable costs: the use of seed mixture, netting rolls, and wooden stakes.

A seed mixture is a combination of two or more species to take advantage of the different attributes offered by the species (Turgeon, 2008). Seed mixtures can help sod farmers growing tall fescue to increase root growth and maintain turfgrass density (Christians et., 2017).

Table 2. Average variable costs per acre for an average tall fescue sod farm (211 acres).

Item		Average Variable Costs
Seed		$601
Liming		$22
Pesticides		$319
Fertilizers		$236
Fuel		$82
Oil and Filter		$38
Pallets		$687
Sod Net Rolls		$281
Wooden Stakes		$81
Maintenance and repair cost*	Irrigation equipment	$66
	Non-irrigation equipment	$41
Total variable costs**		**$2,456**

** Maintenance cost for irrigation and non-irrigation equipment was calculated at 2% of the purchase price per year.*
*** Number from this table were imported from Microsoft Excel; calculation may not be exact due to decimal points.*

Most farmers mix tall fescue with Kentucky bluegrass to be able to hold the sod together. The ratio of tall fescue and Kentucky bluegrass may vary depending on the operation and the availability of mixtures in the area, yet common examples of mixtures ratio from our data include 95-5, 97-3, 90-10 (tall fescue-Kentucky bluegrass by weight). An average tall fescue operation reported spending $601/acre on seeds mixtures, representing 24% of total variable costs per acre.

Popular among sod growers, sod netting is used to speed up the production of species such as tall fescue (Christians et al., 2017). Data collected from our study suggested that with sod netting, farmers may be able to harvest tall fescue faster than traditional Kentucky bluegrass. This result is consistent with Carrow et al. (1981), who reported tall fescue sod can be produced in considerably less time with sod netting in the state of Georgia (fall-seeded in 9 months and spring-seeded in 4.5 months). The netting roll covers between 8 to 11 acres and cost on average $281 per acre. In addition, sod farmers using netting rolls tend to use wooden stakes to keep the netting in place. On average, farmers pay $81/acre for wooden stakes. Both materials related to the sod netting accounted for 15% of the total variable cost per production cycle (i.e., 44 weeks).

Additional variable costs per acre for an average tall fescue operation included liming materials ($22/acre), pesticides ($319/acre), fertilizers ($236/acre), fuel ($82/acre), maintenance and repair ($107/acre), oil and filter ($38/acre), and pallets ($687/acre).

Labor costs

Sod farmers surveyed in this study reported having four types of workers: full-time, H2A, equipment operators, and part-time employees. While machine operators can be considered full-time workers, they tend to receive higher salary than other full-time workers, and thus were placed in a different category. The average tall fescue operation hired 20 employees. Table 3 presents labor costs for a production cycle, which accounted for $743,839. Payroll taxes were not included in labor costs.

Table 3. Labor costs per production cycle for an average tall fescue operation (211 acres).

Type of workers	Average labor costs ($)
Full-time	$367,809
H2A	$137,919
Equipment operators	$209,384
Part-time	$28,728
Total labor costs	**$743,839**

Fixed and Overhead Costs

Fixed costs for an average tall fescue operation included communication and advertising, insurance, interest on loans, property taxes, employee benefits, and depreciation of capital investment. Table 4 provides the amount of fixed cost calculated at $293,195. Fixed and overhead costs were adjusted to the length of the production cycle of tall fescue (i.e., 44 weeks). Table 4 shows that depreciation of irrigation and non-irrigation equipment represents more than 40% of the total average fixed costs ($5,681 and $119,501, respectively), followed by insurance ($51,250) and property taxes costs ($48,504).

Table 4. Fixed costs of an average tall fescue operation (211 acres).

Item	Average
Non-irrigation equipment (depreciation)	$119,501
Irrigation equipment (depreciation)	$5,681
Communication, advertising	$12,067
Insurance	$51,250
Interest on loan	$38,875
Property taxes	$48,504
Employee benefits	$17,3167
Total fixed costs	**$293,195**

Analyses

Costs and revenues data were used to calculate profitability projections, cost structure, sensitivity analysis, and breakeven benchmarks. The sections below illustrate the financial analyses.

Profitability projections

Table 5 shows the profitability projection for an average tall fescue operation. The projection computes the tall fescue profitability after deducting variable, labor, and fixed costs. The average operation generated $2,419,984 in sales per production cycle. Total costs accounted for $1,554,748, with almost half of them due to total labor costs ($743,839), followed by total variable costs ($517,714), and total fixed costs ($293,195). In other words, the average tall fescue operation generated a profit of $865,236 per production cycle. Table 5 also reports the per acre values for the average tall fescue operation. Farmers collected a revenue of $11,480 per acre and $7,375 in total costs, including variable ($2,456/acre), labor ($3,529/acre), and fixed costs ($1,391/acre), resulting in a net profit of $4,105 per acre.

Table 5. Profitability projections of an average tall fescue operation (211 acres).

Item	Values for 1 acre	Average farm (211 acres)
Gross revenue	**$11,480**	**$2,419,984**
Total costs	**$7,375**	**$1,554,748**
Total variable costs	$2,456	$517,714
Total labor costs	$3,529	$743,839
Total fixed costs	$1,391	$293,195
Profit (Loss)	**$4,105**	**$865,236**

** Number from this table were imported from Microsoft Excel; calculation may not be exact due to decimal points.*

Cost structure

Figure 1 (see page 7) shows the cost structure distribution for an average tall fescue operation. The figure illustrates that total labor costs represented 48% of total costs, followed by total variable costs (33%), and total fixed costs (19%). The idea of identifying the cost structure is to understand the distribution of variable, labor, and fixed costs effectively. The cost structure allows farmers to untangle different aspects of production costs and make proper strategic business decisions. Farmers may use cost structure to help set pricing and identify areas where expenses can be reduced, which in turn can help them get insights on how to improve profitability and cut costs by making corrective decisions.

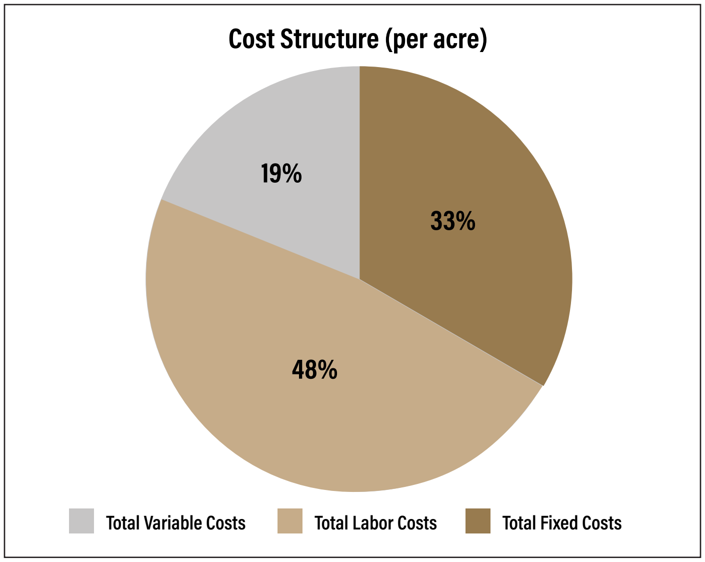
Sensitivity analysis

Sensitivity analysis provides information on how sensitive net profit can be to changes in prices and yield. Data obtained from tall fescue growers shows that the average selling price of sod was $0.29 per ft^2, with an average yield of 40,000 ft^2 per acre. When both conditions are met, net profit results in $4,105 per acre for the average tall fescue operation. Table 6 (see page 7) shows that a 2% increase in yield (from 40,000 to 40,800 ft^2 per acre), while holding the average price at $0.29 per ft^2, generates a new net profit of $4,334 per acre. Yield increases may be due to factors such as improved farming practices, efficient application of fertilizers, and the use of precision farming technologies.

Breakeven analysis

The breakeven analysis includes both breakeven yield and breakeven price analyses. The breakeven yield analysis illustrates the minimum amount of sod that needs to be sold to cover total costs. Breakeven yield analysis provides farmers with a production target

Figure 1. Cost structure of an average tall fescue operation.



(in square footage) that they must meet to cover all the production costs in a given production cycle. Breakeven yield can help farmers analyze alternative production options and decide if a given crop is a good choice given the growing conditions.

Table 7 shows that the breakeven yield for the average operation was 25,698 ft^2/acre, at the average selling price (\$0.29 per ft^2; \$2.61 per yd^2) and yield (40,000 ft^2 per acre). In other words, the average sod grower should sell at least 25,698 ft^2 per acre to cover total production costs. Table 7 also incorporates sensitivity analysis to illustrate how changes in price and total costs can impact breakeven yield. For example, if sod price increases by 20% (from \$0.29 to \$0.34 per ft^2) and total costs remain constant (at \$7,375 per acre), the new breakeven yield would be 21,415 ft^2/acre. Price increases may be due to high consumer demand, government subsidies, or an unexpected pandemic.

Table 6. Sensitivity analysis for an average tall fescue operation.

			Price ($/ft²)				
			-20%	**-10%**	**Average**	**10%**	**20%**
			\$0.23	**\$0.26**	**\$0.29**	**\$0.32**	**\$0.34**
Yield (ft²/acre)	**-4%**	**38,400**	\$1,441	\$2,543	\$3,645	\$4,747	\$5,849
	-2%	**39,200**	\$1,625	\$2,750	\$3,875	\$5,000	\$6,125
	Average	**40,000**	\$1,809	\$2,957	**\$4,105**	\$5,253	\$6,401
	2%	**40,800**	\$1,992	\$3,163	\$4,334	\$5,505	\$6,676
	4%	**41,600**	\$2,176	\$3,370	\$4,564	\$5,758	\$6,952

** Numbers in this table are profits per acre.*

Table 7. Breakeven yield analysis for an average tall fescue operation.

			Price ($/ft²)				
			-20%	**-10%**	**Average**	**10%**	**20%**
			\$0.23	**\$0.26**	**\$0.29**	**\$0.32**	**\$0.34**
Total cost ($/acre)	**-20%**	**\$5,900**	25,698	22,843	20,559	18,690	17,132
	-10%	**\$6,638**	28,911	25,698	23,129	21,026	19,274
	Average	**\$7,375**	32,123	28,554	**25,698**	23,362	21,415
	10%	**\$8,113**	35,335	31,409	28,268	25,698	23,557
	20%	**\$8,851**	38,548	34,265	30,838	28,035	25,698

Table 8 illustrates the breakeven price for an average tall fescue operation. Breakeven price analysis provides farmers with the minimum price (in \$/ft^2) that they must receive to cover all production costs. This analysis can help farmers consider alternative market and buyer options and decide if sod production is a good choice. With the average production cost (at \$7,375 per acre) and yield (at 40,000 ft^2 per acre) from the average sod operation in this analysis, the breakeven price of tall fescue is \$0.18/ft^2 (\$1.62/yd^2). In other words, the average sod operation should sell tall fescue at least at \$0.18/ft^2 to cover all production costs. Following a sensitivity analysis, if total cost per acre decreases by 20% (from \$7,375 to \$5,900) and sod yield remains constant (at 40,000 ft^2 per acre), the new breakeven price would be \$0.15/ft^2 (\$1.35/yd^2). Cost decreases may be due to technological improvements, better use of inputs, and higher productivity.

Table 8. Breakeven price analysis for an average tall fescue operation.

			Yield (ft^2/acre)				
			-4%	**-2%**		**2%**	**4%**
			38,400	**39,200**	**40,000**	**40,800**	**41,600**
Total cost (\$/acre)	**-20%**	**\$5,900**	\$0.15	\$0.15	\$0.15	\$0.14	\$0.14
	-10%	**\$6,638**	\$0.17	\$0.17	\$0.17	\$0.16	\$0.16
	Average	**\$7,375**	\$0.19	\$0.19	**\$0.18**	\$0.18	\$0.18
	10%	**\$8,113**	\$0.21	\$0.21	\$0.20	\$0.20	\$0.20
	20%	**\$8,851**	\$0.23	\$0.23	\$0.22	\$0.22	\$0.21

Take-home message

Enterprise budgets are useful planning tools that help farmers estimate current and projected costs and revenues, and compare investment alternatives before committing resources to a particular cultivar or technology. In this article, we have provided the costs and returns associated with growing tall fescue sod, as well as the financial analysis for an average tall fescue operation of 211 acres. Our results can help farmers make better-informed decisions. Analyses in our study include profitability projections, cost structure, sensitivity analysis, and breakeven price and breakeven yield. The data collected and results obtained show the economic viability of growing tall fescue grass and serve as an economic benchmark for sod growers considering diversifying their crop mix.

Using the Purdue Sod Financial Calculator, our study can help sod growers evaluate the financial efficiency of their farms, including identifying all variable or operating expenses, fixed or property expenses, and opportunity costs in factors such as operating labor, capital, and management. Based on data collected from sod growers, the capital investment for an average tall fescue operation of 211 acres is \$2,320,013. Results also show the average tall fescue operation can generate profits of \$865,236 per production cycle or \$4,105 per acre when yield of sod is 40,000 ft^2 per acre and price is at \$0.29 per ft^2 (\$2.61/yd^2). Labor costs are the highest expenses for an average tall fescue operation, representing 48% of total costs. Breakeven yield analysis shows that the average tall fescue operation needs to harvest at least 25,698 ft^2 of tall fescue to cover production costs, and needs to have a breakeven price of \$0.18 per ft^2 (\$1.62/yd^2). The Purdue Sod Financial Calculator will be available soon at the Purdue HortBusiness website (www.hort.purdue.edu/hortbusiness).

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June 2022