

# Switchgrass and Miscanthus: Economics of Perennial Grasses Grown for Bioenergy

Cellulosic biomass is among the most promising renewable energy sources being researched and considered in Missouri. Two crops, switchgrass and miscanthus, could partially supply the cellulosic material to make the renewable energy. The purpose of this guide is to help Missouri producers understand the financial rewards and risks of the decision to plant one of these grasses. A producer also needs to weigh growing these perennial grasses against the opportunity of growing other crops or using the land as pasture.

## Basic information on the grasses

Both switchgrass and miscanthus are C4 warm-season perennial grasses. They grow in Missouri's climate and soils, offer ecosystem benefits associated with growing a perennial crop, have similar cellular structures and require similar amounts of inputs. When these grasses are grown for bioenergy, management practices and necessary equipment are also quite similar.

Both crops require minimal inputs compared to annual row crops. Suggested fertilizer rates for both miscanthus and switchgrass are similar. Herbicides may be required during establishment years; after that, an established stand should outcompete any weeds. Soil amendments like potassium, phosphorus and lime may be required before planting, depending on field conditions.

Making a sound financial decision will require understanding the differences between the two grasses. Table 1 highlights four important differences that affect the financial outcomes of these two cropping systems.

The yield potential is greater for miscanthus than for switchgrass. Estimates from southern Illinois show miscanthus yields to be about three times that of switchgrass. Research in Missouri has shown miscanthus yields of about twice as much biomass as switchgrass. The estimated yields in Table 1 are based on research plots at the University of Missouri. Yield variance was due to weather conditions. Greater yield per acre translates into greater revenue per acre and potentially more profit.

Table 1. Key differences between switchgrass and miscanthus.

Characteristic	Switchgrass	Miscanthus
Yield potential	Estimated 4–6 tons per acre	Estimated 12–15 tons per acre
Value for other uses	Can be used as a forage crop	Very limited
Life of stand	Average 10–15 years	Stands have lasted up to 25 years
Propagation method	Seeds	Rhizomes

The end-market for cellulosic biomass for bioenergy is not a fully developed market. Therefore, finding a reliable buyer could be problematic. Although switchgrass yields less per acre, it does have some value as a forage grass. Selling switchgrass as forage gives a producer an alternative market if bioenergy flounders or if prices for forages are greater. Miscanthus is a dedicated energy crop and is unlikely to be sold as forage crop.

Differences in propagation affect establishment costs. Switchgrass seed currently costs less on a per acre basis than miscanthus rhizomes. Switchgrass seed can also be planted with standard equipment, whereas miscanthus rhizomes are planted most efficiently with a specialized planter.

Perennial grasses are a multiyear investment in which significant costs occur during the establishment phase. Being able to amortize those costs over more years increases the overall profitability. A stand lasting 10 years is not as profitable as a stand lasting 20 years, everything else equal. Agronomic studies indicate that a stand of switchgrass can last beyond 10 years if properly managed. However, these studies do not state an upper bound. A miscanthus stand planted 25 years ago in Denmark for bioenergy is still productive. However, stands in Japan have lasted only five years when grazed. In determining the time frame for financial planning purposes, 10 years is standard even though it most likely underestimates the longevity and the future revenues.

## Policy landscape

Energy markets are closely tied to policies. Changes in policy at the local, state or national level or through a judicial ruling can result in different prices, management practices and even more significant changes in the overall market. Although local and state regulations and targets

Written by  
**Joseph Dolginow**, Research Specialist, Commercial Agriculture Program  
**Ray Massey**, Extension Professor, Commercial Agriculture Program

exist and are important, two federal programs require in-depth explanation.

The Renewable Fuel Standard (RFS) mandates production levels of different renewable transportation fuels — such as ethanol, cellulosic ethanol, biodiesel and other advanced biofuels — until the year 2022. These fuels are blended with gasoline to power automobiles, airplanes and other transportation vehicles. Each year starting in 2010 and continuing through 2022, RFS mandates increasing amounts of cellulosic ethanol and advanced biofuels.

Despite RFS having been signed into law, there is uncertainty about it. Mandates have been relaxed in past years as production levels of cellulosic ethanol and advanced biofuels have not been met because of technical difficulties, hesitant investors and a lack of infrastructure. In the future, if those mandated production levels are held firm by the Environmental Protection Agency (EPA), the price of any cellulosic material, including biomass from miscanthus or switchgrass, is likely to increase as companies will want to produce cellulosic ethanol, an advanced biofuel. Alternatively, if the cellulosic ethanol mandate is reduced or eliminated, the price of that biomass will likely decrease.

The Biomass Crop Assistance Program (BCAP) was created in the 2008 Farm Bill to help meet the goals of the RFS. This program works with an aggregator and producers to help establish cellulosic-based energy in general and, more specifically, advanced transportation fuels. Under approved BCAPs, producers are reimbursed for 75 percent of establishment costs, receive annual per acre rental payments for the first five years of production, and receive matching payments for biomass delivered to ethanol production facilities.

## Contractual considerations

Because growing biomass for energy production is an emerging economic activity, many of the marketing and production aspects are being decided over time as experience reveals new concerns and opportunities. Depending on the aggregator or end user, emerging activities are often fostered via contractual relationships. The contract specifies the division of responsibilities, rewards and risks. Below are a few current contractual considerations that producers need to understand before growing biomass.

### Length of contract

Switchgrass and miscanthus stands are expected to last for 15 years. Some biomass contracts are for fewer years. This difference means that once the contract expires, a biomass stand may still be productive, but the market diminished. Accommodate this risk by assuming that the life of productive stand is the length of the contract. Shorter contracts will cause the amortized cost of establishment to increase; longer contracts will reduce this cost.

## Ownership of the plants

Switchgrass stands are usually owned by the person planting the seeds. Miscanthus though, because it is a rhizome, may be owned by the one who supplies the rhizome. Understand the contract limitations on what can be done with seed or rhizomes produced on your land and what happens to the rhizomes at the end of the contract. Consider the implications of ownership of plants for eradication when the field is converted out of biomass production.

## Harvest

Biomass harvesting equipment is similar to that used for hay. But the specific dimensions and weights of the bales may be based on storage and transportation issues. Be sure that you own or have access to the proper equipment for harvest.

## Storage and transportation

Biomass is usually harvested once a year but will be used to produce energy throughout the year. Determine where the product will be stored, who has the responsibility for maintaining quality, and who decides when the product will be delivered or taken to be used for energy generation. Also, understand who will pay for the transportation from the field to storage or processing plant.

## Energy premiums and carbon credits

- Energy produced from biomass may generate revenue in addition to the sale of the biomass in the form of green energy premiums or carbon credits. Understand how they will be distributed to the growers, aggregators and energy companies.

## Counterparty risk

Consider what your options are if the company with which you currently contract ceases to do business and the next closest market is some distance from your farm. Identify other uses or markets for the biomass produced.

## Price

Biomass will most likely be priced on a per ton basis. However, some scenarios show it being priced on a per acre basis. Evaluate the price an aggregator or end user is offering based on your estimated costs of production.

## Projected financial returns

Tables 2 and 3 provide estimates of the costs and revenues associated with switchgrass and miscanthus production, respectively. They provide estimates for the first and second years, which are considered establishment years; Years 3 to 5, which have a BCAP payment not available after five years; and Years 6 and beyond (6+), when production is established and no BCAP payments are received.

Table 2. Projected financial returns for growing switchgrass for biomass.

Revenue	Switchgrass Year 1			Switchgrass Year 2			Switchgrass Years 3-5			Switchgrass Years 6+		
	Yield/acre	\$/ton	Total/acre	Yield/acre	\$/ton	Total/acre	Yield/Acre	\$/ton	Total/acre	Yield/acre	\$/ton	Total/acre
Biomass (ton)	0.0	50.00	\$0.00	3.0	50.00	\$150.00	6.0	50.00	\$300.00	6.0	50.00	\$300.00
Land payment subsidy			\$65.00			\$65.00			\$65.00			\$0.00
Establishment subsidy			\$24.56			\$8.11			\$0.00			\$0.00
<b>Total Revenue</b>			<b>\$89.56</b>			<b>\$223.11</b>			<b>\$365.00</b>			<b>\$300.00</b>
Operation	Number of operations	Total/acre	Total/acre	Number of operations	Total/acre	Total/acre	Number of operations	Total/acre	Total/acre	Number of operations	Total/acre	Total/acre
Field prep	1.0	\$15.80	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Planting and seed	1.0	\$32.75	\$0.00	0.3	\$10.81	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Dry fertilizer application	2.0	\$10.68	\$0.00	1.0	\$5.34	\$5.34	2.0	\$10.68	\$10.68	2.0	\$10.68	\$10.68
Herbicide application	2.0	\$11.96	\$0.00	1.0	\$5.98	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Harvesting/Baling	0.0	\$0.00	\$0.00	4.0	\$76.00	\$152.00	8.0	\$152.00	\$152.00	8.0	\$152.00	\$152.00
Transport to farm gate	0.0	\$0.00	\$0.00	4.0	\$12.72	\$25.44	8.0	\$25.44	\$25.44	8.0	\$25.44	\$25.44
Mowing	1.0	16.38	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Operations subtotal		\$87.57	\$87.57		\$10.85	\$10.85		\$182.78	\$182.78		\$188.12	\$188.12
Materials	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre
Nitrogen (lb-N)	60.0	\$0.55	\$33.00	60.0	\$0.55	\$33.00	60.0	\$0.55	\$33.00	60.0	\$0.55	\$33.00
Phosphorus (lb-P <sub>2</sub> O <sub>5</sub> )	2.0	\$0.49	\$0.98	2.0	\$0.49	\$0.98	2.0	\$0.49	\$0.98	2.0	\$0.49	\$0.98
Potassium (lb-K <sub>2</sub> O)	14.6	\$0.47	\$6.86	14.6	\$0.47	\$6.86	14.6	\$0.47	\$6.86	14.6	\$0.47	\$6.86
Lime (ton)	1.0	\$18.55	\$18.55	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Herbicide (gal/acre) atrazine	1.0	\$8.05	\$8.05	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Herbicide (gal/acre) glyphosate	0.0	\$7.62	\$0.00	0.0	\$7.62	\$0.00	0.0	\$7.62	\$0.00	0.0	\$7.62	\$0.00
Herbicide (gal/acre) acetochlor	1.0	\$18.00	\$18.00	0.0	\$18.00	\$0.00	0.0	\$18.00	\$0.00	0.0	\$18.00	\$0.00
Herbicide (gal/acre) 2,4-D	0.0	\$18.00	\$0.00	1.0	\$18.00	\$18.00	0.0	\$18.00	\$0.00	0.0	\$18.00	\$0.00
Materials subtotal		\$85.44	\$85.44		\$58.84	\$58.84		\$40.84	\$40.84		\$40.84	\$40.84
Financial	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre
Operating interest	@ 7.5%	\$173.01	\$6.49	@ 10%	\$22.16	\$22.16	@ 10%	\$14.44	\$14.44	@ 10%	\$14.44	\$14.44
Rental rate per acre	1.00	\$90.00	\$90.00	1.00	\$90.00	\$90.00	1.00	\$90.00	\$90.00	1.00	\$90.00	\$90.00
Insurance premium												
Financial subtotal			\$96.49		\$112.16	\$112.16		\$104.44	\$104.44		\$104.44	\$104.44
<b>Total costs per acre</b>			<b>\$269.50</b>		<b>\$281.85</b>	<b>\$281.85</b>		<b>\$328.06</b>	<b>\$328.06</b>		<b>\$333.40</b>	<b>\$333.40</b>
<b>Income over total cost per acre</b>			<b>-\$179.94</b>		<b>-\$58.75</b>	<b>-\$58.75</b>		<b>\$36.94</b>	<b>\$36.94</b>		<b>-\$33.40</b>	<b>-\$33.40</b>

Table 3. Projected financial returns for growing miscanthus for biomass.

Revenue	Miscanthus Year 1			Miscanthus Year 2			Miscanthus Years 3-5			Miscanthus Years 6+		
	Yield/acre	\$/ton	Total/acre	Yield/acre	\$/ton	Total/acre	Yield/acre	\$/ton	Total/acre	Yield/acre	\$/ton	Total/acre
Biomass (ton)	0.0	50.00	\$0.00	5.0	50.00	\$250.00	10.0	50.00	\$500.00	10.0	50.00	\$500.00
Land payment subsidy			\$65.00			\$65.00			\$65.00			\$65.00
Establishment subsidy			\$602.25			\$198.74			\$0.00			\$0.00
<b>Total Revenue</b>			<b>\$667.25</b>			<b>\$513.74</b>			<b>\$565.00</b>			<b>\$500.00</b>
Operation	Number of operations	Total/acre	Total/acre	Number of operations	Total/acre	Total/acre	Number of operations	Total/acre	Total/acre	Number of operations	Total/acre	Total/acre
Field prep	1.0	\$15.80	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Planting and seed	1.0	\$803.00	\$0.00	0.3	\$264.99	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Dry fertilizer application	2.0	\$10.68	\$0.00	1.0	\$5.34	\$5.34	1.0	\$5.34	\$5.34	1.0	\$5.34	\$5.34
Herbicide application	2.0	\$11.96	\$0.00	1.0	\$5.98	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Harvesting/Baling	0.0	\$0.00	\$0.00	6.7	\$126.67	\$253.33	13.3	\$253.33	\$253.33	13.3	\$253.33	\$253.33
Transport to farm gate	0.0	\$0.00	\$0.00	6.7	\$21.20	\$42.40	13.3	\$42.40	\$42.40	13.3	\$42.40	\$42.40
Mowing	1.0	16.38	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Operations subtotal		\$857.82	\$0.00		\$424.18	\$0.00		\$301.07	\$301.07		\$301.07	\$301.07
Materials	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre
Nitrogen (lb-N)	50.0	\$0.55	\$27.50	50.0	\$0.55	\$27.50	50.0	\$0.55	\$27.50	50.0	\$0.55	\$27.50
Phosphorus (lb-P <sub>2</sub> O <sub>5</sub> )	2.0	\$0.49	\$0.98	2.0	\$0.49	\$0.98	2.0	\$0.49	\$0.98	2.0	\$0.49	\$0.98
Potassium (lb-K <sub>2</sub> O)	14.6	\$0.47	\$6.86	14.6	\$0.47	\$6.86	14.6	\$0.47	\$6.86	14.6	\$0.47	\$6.86
Lime (ton)	1.0	\$18.55	\$18.55	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Herbicide (gal/acre) atrazine	1.0	\$8.05	\$8.05	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00	0.0	\$0.00	\$0.00
Herbicide (gal/acre) glyphosate	0.0	\$7.62	\$0.00	0.0	\$7.62	\$0.00	0.0	\$7.62	\$0.00	0.0	\$7.62	\$0.00
Herbicide (gal/acre) acetochlor	1.0	\$18.00	\$18.00	0.0	\$18.00	\$0.00	0.0	\$18.00	\$0.00	0.0	\$18.00	\$0.00
Herbicide (gal/acre) 2,4-D	0.0	\$18.00	\$0.00	1.0	\$18.00	\$18.00	0.0	\$18.00	\$0.00	0.0	\$18.00	\$0.00
Materials subtotal		\$79.94	\$79.94		\$53.34	\$53.34		\$35.34	\$35.34		\$35.34	\$35.34
Financial	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre	Quantity	Cost/unit	Total/acre
Operating interest	@ 7.5%	\$937.76	\$35.17	@ 10%	\$22.16	\$22.16	@ 10%	\$14.44	\$14.44	@ 10%	\$14.44	\$14.44
Rental rate per acre	1.00	\$90.00	\$90.00	1.00	\$90.00	\$90.00	1.00	\$90.00	\$90.00	1.00	\$90.00	\$90.00
Insurance premium												
Financial subtotal		\$125.17	\$125.17		\$112.16	\$112.16		\$104.44	\$104.44		\$104.44	\$104.44
<b>Total costs per acre</b>			<b>\$1,062.93</b>			<b>\$589.68</b>			<b>\$440.85</b>			<b>\$440.85</b>
<b>Income over total cost per acre</b>			<b>-\$395.68</b>			<b>-\$75.94</b>			<b>\$124.15</b>			<b>\$59.15</b>

## Table notes

- Custom rates and input prices are in 2012 prices and assume custom rates for field activities such as spraying and harvest.
- The budgets assume the biomass is baled in 1,500-pound large round bales and left at the farm gate.
- BCAP establishment subsidy and first five year land rental payments are included even though that assistance may not be available to all producers.
- Price of planting miscanthus is assumed to be \$803 per acre. That cost could change as miscanthus rhizomes become more available and less expensive.
- Year 2 includes a cost of replanting at a rate of 33 percent for miscanthus and 25 percent for switchgrass.
- The field is mowed in Year 1 and no biomass is removed. In Year 2, the yields are reduced from their maximum potential.
- The price of biomass is held constant at \$50 per ton. That price is extremely uncertain and could change in either direction.
- The fertilizer application rate is 1.20 because nitrogen fertilizer is applied every year at a total of one pass per year, whereas phosphorus and potassium are applied every fifth year, an average of 0.2 passes per year.

## More information

More information on bioenergy grass production is available on the Commercial Agriculture Program's Missouri Crop Resource Guide website at <http://crops.missouri.edu/bioenergy>.

Archive version:  
For the most recent information,  
see extension.missouri.edu.