

NEWBio Switchgrass Budget for Biomass Production

Switchgrass (*Panicum virgatum*), a perennial warm-season grass, is an excellent crop for soil and water conservation, wildlife habitat, and more recently as feedstock for bioenergy. There are numerous varieties of switchgrass; check with local extension offices for the most appropriate variety for biomass production in your area.

This fact sheet provides an enterprise budget for growing switchgrass as a dedicated energy crop. The objective is for growers to understand the inputs, costs, and potential revenues involved in cultivating switchgrass. An example budget is described, but because each situation is different and prices can vary, a spreadsheet for adjusting inputs and prices to individual conditions is available at extension.psu.edu/natural-resources/energy/field-crops/resources. The scenario provided in this fact sheet is based on growing the crop in Pennsylvania. All quantities and prices are on a per-acre basis. The costs are based on farm custom rates published by Penn State Extension from USDA-NASS for 2014. The budget is based on a 15-year timeline. This fact sheet does not discuss transportation costs of harvested switchgrass from the field to processing facility, which will vary from site to site. Additional information on switchgrass is available at www.newbio.psu.edu.

Soil Test

The first step is to evaluate the land quality for growing switchgrass, which includes a soil test. Switchgrass grows in soil that is moderately well drained or better with a pH of 5.5–7.0. It can also tolerate low levels of pH, nitrogen, and phosphorus. A standard soil test is recommended to determine the nutrient availability for switchgrass establishment. The test is generally done based on a grid sampling of 5-acre units every three years. Ignoring the cost for collecting the sample, on a per-acre basis, and assuming \$15 per soil test, testing will cost \$3 per acre in year 1 (establishment year) and an average of \$1 per acre for each year thereafter.

Site Preparation

The amount of work needed to prepare a site varies depending on the previous land use. If the growing site is already in grain crop production, less site preparation will be required than for unmanaged pasture or brushland. We have budgeted for the nongrain cropland. Clearing undesirable brush and weeds with a brush mower will cost about \$25 per acre. Next, any lime and soil nutrient applications should be made the fall before planting. The land should be plowed in the spring (unless erosion is not a concern) with a moldboard plow at a one-time cost of around \$24 per acre.

After plowing, the land most likely will require two disking passes and two soil finishing passes to create a firm seedbed, at total costs of roughly \$35 per acre and \$38 per acre, respectively.

Soil Amendments

Because it is adapted to many soil conditions, switchgrass does not usually need significant amounts of soil amendments if it is allowed to fully mature and dry down before harvest. Nitrogen, phosphorus, potassium, and lime requirements, as recommended by research at Penn State, are as follows. Fertilizer application is charged at an annual cost of \$11 per acre. Manures or other organic amendments can also be used at appropriate substitution rates and methods of application.

- Nitrogen fertilizer is typically applied at about 10 pounds per ton of planned harvested biomass, so in the first harvest year (year after establishment) about 50 pounds of N should be applied at greenup for the anticipated 5 tons per acre. As the yield increases to 7 tons per acre in subsequent years, these costs will increase. Based on the assumption of yields in this scenario, the first application costs \$28 per acre, increases to \$39 per acre by year 3, and so on.
- Phosphorus (P_2O_5) is typically applied at 4 pounds per ton of biomass (by soil test recommendation) 6 months before planting and each harvest season thereafter. As the yield increases, these costs will increase. Based on the assumption of yields in this scenario, the first application in year 2 costs \$13 per acre, increases to \$18 per acre by year 4, and so on.
- Potassium (K_2O) is typically applied at 15 pounds per ton of biomass (by soil test recommendation) 6 months before planting and each harvest season thereafter. As the yield increases, these costs will increase. Based on the assumption of yields in this scenario, the first application in year 2 costs \$36 per acre, increases to \$50 per acre by year 4, and so on.
- Lime, if needed, is generally added 6 months prior at 4 tons per acre for about \$152 per acre, and then at 2 tons per acre every fourth year, which annualized is about \$18 per year. This includes application costs.

Note: If harvest is delayed until after late November, some of the nutrients may have either leached to the soil or returned to the stem base or roots. This will likely reduce nutrient (phosphorus and

potassium) needs for the following year, thus making switchgrass production more economical.

Planting

Switchgrass is planted by seed. About 8 pounds of pure live seed per acre should be used. The assumed price per pure live seed is about \$10 depending on the vendor. Total seed cost is about \$80 per acre. Seeds are planted with a drill at a custom rate cost of about \$18 per acre.

Weed Control

Weed management during the planting season is crucial for establishment since the crop is sensitive to weed competition. An initial burndown with 32 ounces of glyphosate, costing an estimated \$7 per acre, should be applied in sufficient time prior to land preparation to kill perennial and other problem weeds. A postemergence herbicide using 8 ounces of quinclorac is also suggested during the establishment year at a cost of about \$23/acre, and in year 2 2,4-D may be needed to kill any winter annuals at a cost around \$3 per acre. The sprayer cost for the three passes discussed above is about \$11.50 per acre per spray (total of \$34.50). Contact your county extension office for the latest herbicide recommendations.

Maintenance Costs

As mentioned above, some fertilizer applications are made over time as needed. By year 3, there should be no need for more herbicides because the grasses shade out the weeds. Currently, no pests are found to significantly damage switchgrass performance.

Harvesting Costs

Switchgrass can be harvested in year 2 and every year thereafter. However, in year 2 only 70 percent of the yield is achieved (5 tons per acre); and in full production, year 3 and thereafter, 7 tons per acre is expected. Traditional hay mowing and baling equipment is used. Mower/conditioning will cost around \$16 per acre per year. Baling, assuming 15 percent moisture in the grass and an average weight of 863 pounds per bale, costs about \$125 per acre at full yield (i.e., to bale 7 tons). Baling costs are lower in the first year because yield per acre is lower.

Yield and Revenues

Switchgrass is expected to yield an average of about 7 dry tons per acre per year. At an assumed farm-gate price of \$55 per dry ton for a mature yield of 7 tons per acre, annual revenue would be \$385 per acre per year. There is no revenue in the first year. In the second year, we assume that only 70 percent of the yield, or 5 tons per acre, is achieved, for revenue of \$275 per acre.

Net Revenues and Financial Analysis

The last columns of the spreadsheet show the total costs, revenues, and present value of each item. The total costs over 15 years are estimated to be \$4,258 per acre, while total revenues are estimated at \$5,280 per acre. Net revenue is \$1,022 per acre for the 15-year

budget period. The payback period—which tells investors how long it will take for revenues to cover establishment costs—is 5 years using the financial assumptions in this scenario.

Because this project occurs over a 15-year period, you need to account for the time value of money to get an accurate value. Money received in future years is not worth as much as in earlier years. The time value of money is reflected in an interest (discount) rate used by investors. This allows investors to compare alternative projects over the same lifetime, especially since there are other uses for the land (i.e., opportunity costs). To account for future values, revenues and costs not received today are “discounted” to the present, hence net present value (NPV). If the NPV is positive, it implies that investors receive at least their acceptable rate of return (discount rate). The NPV in this scenario, using a 4 percent rate, is \$655 per acre. This NPV would obviously change if the discount rate, project length, and the costs and revenues were changed. Annualizing the NPV gives us an equal annual income (EAI) value of \$59. The EAI compared to an annual rental on the land expresses NPV as an annual return, so it can, for example, be a good investment.

Summary

Switchgrass is one of the faster-growing warm-season grasses. It has relatively low establishment and maintenance costs compared to energy crops. Any payback period can be shortened, especially if cost-share monies are available for planting costs and/or prices per ton or yields per acre are higher. Switchgrass has other economic impacts on the whole farm operation. It has been used for summer grazing for livestock, particularly when cool-season grass production slows during hot, dry summer periods. It is an excellent grass to reduce soil and water erosion and for improved wildlife habitat. Management for these opportunities may reduce biomass energy yields, but USDA programs are available that may be used to support such conservation options. Carbon sequestration is another potential benefit of switchgrass that may produce “carbon credits.”

Using the Spreadsheet

This scenario discussed above was developed to show the different costs and revenues involved in growing switchgrass. An example spreadsheet using this scenario of costs and revenues is shown on the next page. A spreadsheet can be downloaded from extension.psu.edu/natural-resources/energy/field-crops/resources to fit specific grower conditions. You can change the quantity of inputs and their respective prices (shown in yellow cells), allowing you to adapt costs and revenues to your situation.



		Quantity	Unit	Price/ Unit	Year 1 (Estab- lishment)	Year 2	Year 3	Years 4-15	Total	Present value
SELECT CASH EXPENSES										
Plant material										
	Seed	8	8 lb/A	\$10.00	\$80.00	\$0.00	\$0.00	\$0.00	\$80.00	\$80.00
Soil fertility										
	Nitrogen	10	lb/expected ton/acre	\$0.56	\$0.00	\$28.00	\$39.20	\$39.20	\$537.60	\$403.00
	P ₂ O ₅	4	lb/expected ton/acre	\$0.63	\$0.00	\$12.60	\$17.64	\$17.64	\$241.92	\$181.00
	K ₂ O	15	lb/expected ton/acre	\$0.48	\$0.00	\$36.00	\$50.40	\$50.40	\$691.20	\$519.00
	Fertilizer application	annually	per acre	\$10.60	\$0.00	\$10.60	\$10.60	\$10.60	\$148.40	\$112.00
	Lime	see inputs	ton	\$38.00	\$152.00	\$17.54	\$17.54	\$17.54	\$397.54	\$337.00
	Soil testing		per soil test	\$15.00	\$3.00	\$1.00	\$1.00	\$1.00	\$17.00	\$14.00
Weed control										
	Burndown	32 oz	acre	\$6.50	\$6.50	\$0.00	\$0.00	\$0.00	\$6.50	\$7.00
	Postemergence	8 oz	acre	\$23.00	\$23.00	\$0.00	\$0.00	\$0.00	\$23.00	\$23.00
	Postemergence	8 oz	acre	\$3.00	\$0.00	\$3.00	\$0.00	\$0.00	\$3.00	\$3.00
	Sprayer (3 sprays)	3	acre	\$11.50	\$23.00	\$11.50	\$0.00	\$0.00	\$34.50	\$34.00
Establishment and maintenance										
	Brush mowing	1	acre	\$24.90	\$25.00	\$0.00	\$0.00	\$0.00	\$24.90	\$25.00
	Moldboard plow	1	acre	\$23.90	\$24.00	\$0.00	\$0.00	\$0.00	\$23.90	\$24.00
	Disking (2 passes)	2	acre	\$17.50	\$35.00	\$0.00	\$0.00	\$0.00	\$35.00	\$35.00
	Soil finish (2 passes)	2	acre	\$18.90	\$38.00	\$0.00	\$0.00	\$0.00	\$37.80	\$38.00
	Drill	1	acre	\$18.30	\$18.00	\$2.00	\$0.00	\$0.00	\$20.59	\$20.00
Harvesting										
	Mowing/conditioning	1	acre	\$16.20	\$0.00	\$16.00	\$16.00	\$16.00	\$226.80	\$171.00
	Baling (large, round)	16.22	bale	\$7.70	\$0.00	\$85.00	\$125.00	\$125.00	\$1,708.37	\$1,281.00
TOTAL CASH EXPENSES					\$427.00	\$223.00	\$277.00	\$277.00	\$4,258.00	\$3,306.00
REVENUES										
Biomass	Mature yield (estimation)	7	dry ton		0	5	7.0	7	96	
	Revenue stream			\$55.00	\$0.00	\$275.00	\$385.00	\$385.00	\$5,280.00	\$3,961.00
REVENUE ABOVE EXPENSES (NPV)										
					-\$427.00	\$52.00	\$108.00	\$108.00	\$1,022.00	\$655.00
EQUAL ANNUAL INCOME (Annualized over 15 years)										\$59.00
BREAKEVEN PAYBACK PERIOD										5 years

Assumptions	
Interest rate	4%
Number of years of growth (years 4-15)	12
Inputs	
Establishment lime	4 tons/acre
Maintenance lime	2 tons/acre
Weight of bale	863 lb

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