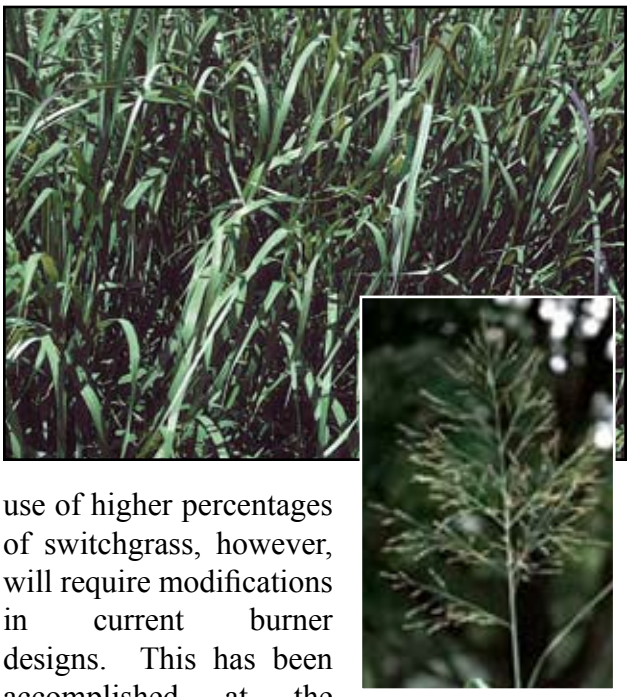
UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE

Switchgrass for Biomass



Introduction

Switchgrass (*Panicum virgatum*) is a tall-growing, warm-season, perennial bunchgrass native to portions of Kentucky. Once a major component of the Midwestern prairies, switchgrass stands have dwindled as natural grasslands have given way to expanding farms and developments.

There has been interest in recent years in re-establishing switchgrass. It is currently most widely recommended for soil and wildlife conservation uses, but switchgrass can also be used to provide mid-summer grazing in pasture systems. In addition, switchgrass is being researched as a potential biomass crop to produce energy.

Biomass is any organic matter that can be converted to electricity or fuel. Organic matter can be transformed to usable energy by direct combustion, liquid fuel production (e.g. ethanol), and the manufacture of synthetic gases. Switchgrass appears to be well-suited for all of these processes; however much of the current research and testing is focused on co-firing switchgrass with coal to produce electricity and on the conversion of switchgrass to ethanol.

Direct combustion of biomass is similar to the technology used for burning coal. In fact, small percentages of switchgrass can be co-fired with coal in existing power plant boilers. Burning only 10 percent switchgrass with coal generates electricity with lower emissions (fewer pollutants) than burning coal alone. The use of higher percentages of switchgrass, however, will require modifications in current burner designs. This has been accomplished at the Maysville, Kentucky Spurlock Power Station, where a relatively new clean coal generating unit has been modified to burn alternative fuels, such as switchgrass.

Switchgrass shows promise as an economical and efficient source of cellulosic ethanol. Unlike corn for ethanol production, switchgrass can be grown on marginal land and would not compete with food crop production. Some researchers have reported that switchgrass can yield five times more energy than it takes to produce it, a substantial improvement over corn's net energy output.

Renewable energy sources like switchgrass have the potential to help reduce our dependency on finite supplies of fossil fuels, although most experts believe it is unlikely that biofuels will totally replace them.

NEW CROP OPPORTUNITIES CENTER

Marketing and Market Outlook

There currently are no existing biomass markets for switchgrass in Kentucky. While this crop holds promise as an alternative energy source, work is still in the research and development phase here. Chariton Valley in Southern Iowa and Gadsden in Alabama, where switchgrass is being used at electricity-generating power plants, are currently the nearest markets.

At present, co-firing with coal appears to offer the most realistic potential use of switchgrass for bioenergy in Kentucky. University of Kentucky (UK) researchers are currently involved in a co-firing project in which switchgrass will be used to supplement coal for electricity production. Twenty growers within 60 miles of the Maysville generating plant are participating in the study. Researchers are examining cropping systems, analyzing plant composition, considering sustainability, determining net energy output, and evaluating the economics of switchgrass production for biomass.

In addition to the co-firing study, UK is conducting research on the potential of switchgrass for ethanol production. The conversion of switchgrass to ethanol is a complicated process requiring a biorefinery. While Kentucky does not have one, several states, including Tennessee and Georgia, are building pilot-scale biorefineries. The possibility of compressing switchgrass into fuel pellets for thermal energy production will also be examined in UK studies.

Production Considerations

Site selection and planting

Switchgrass can be grown on marginal land and is adaptable to a variety of soil types. It is most productive, however, when grown on moderately-well to well-drained sites of medium fertility. Freshly harvested seed has a low germination rate and must be treated to break dormancy.

Switchgrass can be seeded into a tilled or no-till field in the late spring. Establishment is generally slow and difficult, often taking from 2 to 3 years. In some cases reseeding will be necessary in order to produce a uniformly vigorous stand. However, once established, this perennial grass will continue to yield for 10 or more years. Plants can reach a height of 7 to 10 feet under favorable growing conditions.

Pest management

Switchgrass is a hardy plant that is bothered by few insects and diseases. It does not compete well with other grasses and broadleaf weeds until well-established. Therefore, good pre-plant weed control is essential to the establishment of a good stand.

Harvest

Established switchgrass stands can be harvested either once or twice per year with conventional haying equipment. With some varieties, the total biomass yield is similar whether cutting once or twice. Cutting once has the economic advantage of being cheaper than cutting twice. In addition, cutting once will remove fewer nutrients from the soil; harvest will occur after frost when the nitrogen and some of the potassium have moved back into the root system.

When the crop is harvested after frost, it is cut at a height of 6 inches. The cutting height should be 8 to 10 inches when harvested during the growing season.

Switchgrass can be baled in either round or large rectangular bales; however, the latter are considered easier to handle and transport. Stored bales must be kept dry and off the ground, therefore covered storage is preferred.

Labor requirements

Labor requirements are approximately 3 hours per acre per year at a 6 ton yield. This includes fertilizer application and all production practices up to moving bales off the field. It does not include loading and trucking which are assumed a separate transportation charge. This compares to roughly 2 hours per acre per year at a 3 ton yield for hay production.

Economic Considerations

From a practical standpoint, most land that would potentially go into switchgrass production would come out of hay production. Most cropland would be more profitable in its current capacity. Switchgrass production would be best suited on marginal ground that also has decent access for tractor trailers to haul the bales. Thus, the economic analysis presented here compares switchgrass production to land already in hay production. It assumes the same equipment use and the production of large 1,200-pound round bales.

A major factor that impacts profitability of switchgrass compared to hay production is that switchgrass has to be established and this stand would take 3 to 4 years to reach full production. So it is impossible to compare switchgrass to hay production for just the average production year. You need to evaluate the production of both forages over multiple years using an appropriate discount rate for future years' production.

The following table provides a comparison of switchgrass production assuming a peak yield of 6 tons per acre in years 3 to 6 and a hay yield of 3 tons per acre. In this scenario, the long-term profitability of switchgrass and of hay production over a 15-year time horizon is exactly equal.

Even though the net return to switchgrass is higher then hay during the peak production years, the profitability of switchgrass is reduced because of the establishment costs and the loss of production in the first 2 years. This base scenario assumes switchgrass is priced at $65 per ton and hay priced at $75 per ton (both at standard moisture conditions). These two prices are only used as examples. What can be inferred is that switchgrass prices need to be roughly within $10 of hay prices on a per ton basis for switchgrass to be competitive based on the assumptions used here.

Transportation figures for switchgrass are based on the assumption bales will be trucked 50 miles one way at a cost of $11 per ton. For the detailed budget, along with a listing of the other assumptions used in this comparison analysis, refer to the UK Agricultural Economics switchgrass decision aid on their Web site.

Comparative Budget Summary for Switchgrass and Hay (Per Acre)

	Switchgrass Year 1 Production	Switchgrass Full Production (Years 3 to 6)	Hay Production
Yield	0.75 T per acre	6 T per acre	3 T per acre
Price per ton	$65	$65	$75
Total Returns	**$49**	**$392**	**$225**
Variable Costs			
Production	$234	$134	$119
Labor	$11	$34	$24
Trucking and Loading	$9	$69	$0
Total Variable Costs	**$254**	**$237**	**$143**
Returns Above Variable Costs	**($205)***	**$155**	**$82**
Total Fixed Costs	**$41**	**$75**	**$45**
Total Variable + Fixed Costs	**$295**	**$312**	**$188**
Returns Above Variable + Fixed	**($246)**	**$80**	**$37**

**Parentheses indicate a negative number, i.e. a net loss*

Selected Resources

- Forage Identification and Use Guide: Switchgrass (University of Kentucky) http://www.ca.uky.edu/agc/pubs/agr/agr175/swit.htm
- Grain and Forage Crop Guide for Kentucky, AGR-18 (University of Kentucky, 2007) http://www.ca.uky.edu/agc/pubs/agr/agr18/agr18.pdf
- Kentucky Project Examines Switchgrass' Potential to Produce Alternative Fuels (University of Kentucky, 2008) http://www.ca.uky.edu/news/?c=n&d=75
- Native Warm-Season Perennial Grasses for Forage in Kentucky (University of Kentucky, 2004) http://www.ca.uky.edu/agc/pubs/agr/agr145/agr145.pdf
- Pros and Cons of Growing Switchgrass in Kentucky (University of Kentucky) http://www.ca.uky.edu/cmspubsclass/tinymce/jscripts/tiny_mce/plugins/filemanager/files/adreum/biofuels/Switchgrass%20SWOT.pdf
- Switchgrass Decision Aid (University of Kentucky, 2009) *when available* http://www.ca.uky.edu/agecon/index.php?p=29
- Bioenergy Feedstock Information Network http://bioenergy.ornl.gov
- Chariton Valley Biomass Project (Iowa) http://www.iowaswitchgrass.com/home.html
- Costs of Producing Switchgrass for Biomass in Southern Iowa (Iowa State, 2001) http://www.extension.iastate.edu/Publications/PM1866.pdf
- Estimated Costs for Production, Storage and Transportation of Switchgrass (Iowa State University, 2008) http://www.extension.iastate.edu/agdm/crops/pdf/a1-22.pdf
- Growing and Harvesting Switchgrass for Ethanol Production in Tennessee (University of Tennessee, 2008) http://utextension.tennessee.edu/publications/spfiles/SP701-A.pdf
- Management Guide for the Production of Switchgrass for Biomass Fuel in Southern Iowa (Iowa State, 2003) http://www.extension.iastate.edu/Publications/PM1710.pdf
- Switchgrass (Agricultural Marketing Resource Center, 2009) http://www.agmrc.org/commodities__products/biomass/switchgrass.cfm/
- Switchgrass (Iowa State University, 2007) http://www.extension.iastate.edu/Publications/AG200.pdf
- Switchgrass as a Bioenergy Crop (ATTRA, 2006) http://attra.ncat.org/attra-pub/switchgrass.html
- Tennessee Biofuels Initiative (University of Tennessee, 2008) http://www.utbioenergy.org/TNBiofuelsInitiative/

Photos: Seed head courtesy of University of Kentucky Forage Identification and Use Guide AGR-175; Switchgrass field by Lynn Betts, courtesy of USDA NRCS.

Issued 2002; Revised November 2009