2009

Planting & Managing Switchgrass
as a Dedicated Energy Crop

BLADE™
ENERGY CROPS

CONTENTS

Blade has established the largest research network of energy crops in the nation, including leading universities and institutions.

FOREWORD

This guide was developed to provide agricultural producers and biomass procurers with the most current information on the establishment, management and harvest of switchgrass as an energy crop for biofuels and biopower. While switchgrass has been widely planted for prairie restoration, erosion control and, to some extent, forage, its use as an energy crop is still evolving.

Because we foresee upcoming innovations in genetics, seed technology and farm equipment – as well as developments in the biomass markets – growers are encouraged to inquire with Blade Energy Crops in future growing seasons to learn about new developments in the management of switchgrass as an energy crop.

In preparing this guide, we have drawn from our collective experience with switchgrass and our collaborative partners at The Samuel Roberts Noble Foundation and South Dakota State University, among others. We'd also like to acknowledge the contributions of the leading institutions and plant scientists who pioneered agronomic practices for this new crop, and whose findings are incorporated here.

ABOUT SWITCHGRASS

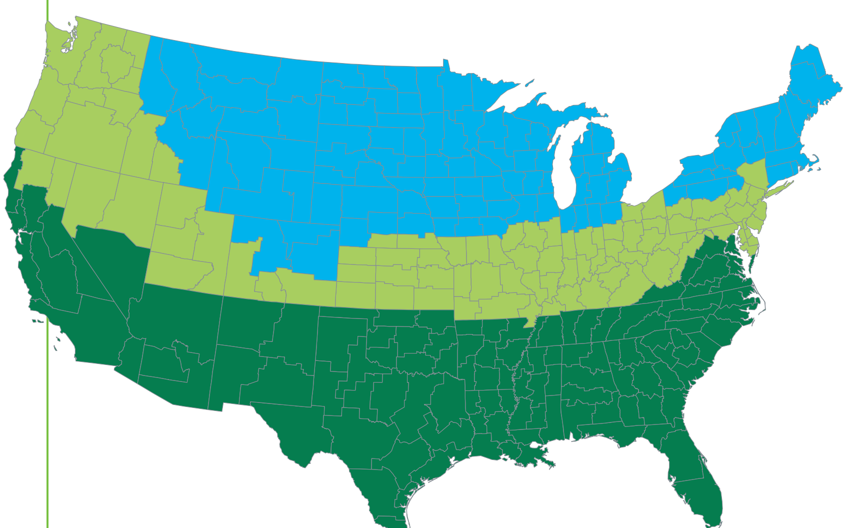
Switchgrass is a perennial plant native to the tallgrass prairies of the United States. Its native range covers most of the continental U.S. east of the Rocky Mountains and extends into Mexico and Canada. Switchgrass has been identified by the U.S. Department of Energy as a leading dedicated energy crop because it tolerates a wide range of environmental conditions and offers high biomass yield, compared to many other perennial grasses and conventional crop plants. While the use of switchgrass as an energy crop has been the subject of scientific investigation for the past couple of decades, large-scale commercial cultivation as a biomass crop is just now emerging, in response to the increasing demand for renewable energy.

STAND ESTABLISHMENT

Variety selection - Hardiness zone and latitude (day length) are important considerations when selecting a variety to plant. Although switchgrass was historically distributed across most of North America, commercially available varieties were developed from regionally adapted plant populations, and varieties fall into roughly three ranges in the United States: southern, mid and northern.

While moving a variety north of its point of origin can result in delayed maturity – and, thus, greater biomass yields – doing so may result in winter kill. As a rule of thumb, a variety should not be moved more than 300 miles, or one hardiness zone, north of its point of origin.

Two types of switchgrass are available for planting: lowland and upland.



Lowland types tend to grow taller and more rapidly than upland types. They are also coarser, display a bunching growth habit and fare better in heavier and wetter soils. Where adapted, lowland varieties currently have higher yield potential than upland varieties.

In contrast, upland types are typically shorter and finer stemmed. They favor drier soils, and existing varieties tend to be more susceptible to rust (*Puccinia spp.*) and other diseases than lowland varieties.

Current varieties available include EG 1101 (an improved Alamo type) and EG 1102 (an improved Kanlow type). These are the first commercially available varieties developed with bioenergy in mind. In trials, these lowland varieties have shown 10 percent to 30 percent higher biomass yields than comparable varieties.

Sunburst, Trailblazer and Blackwell are well-known upland varieties identified for bioenergy use, based on their region of adaptation and performance.

Other switchgrass varieties include Alamo, Blackwell, Carthage, Cave-in-Rock, Dacotah, Forestburg, Kanlow, Nebraska 28, Pathfinder, Shawnee, Shelter and Summer. Some of these varieties date back as far as the 1940s, and were simply plants selected from wild populations.

Where ranges overlap, current lowland types of switchgrass will generally out-yield upland types. Here, an improved lowland variety EG 1102 (right), continues to grow, while Trailblazer (the upland variety on the left) has begun setting seed, a stage where plant growth slows or stops. *Photo courtesy of Emily Heaton, Ph.D.*

Buying seed by the Pure Live Seed (PLS) standard – Native grass seed inherently includes more inviable seeds and inert matter (such as chaff, weed seeds and seed hulls) than, for example, corn seed, which is relatively easy to condition and bag. As a result, planting rates are based on the calculation of Pure Live Seed (PLS).

PLS % = [% Purity] x [% Viable]

[% Viable] = % Dormant + % Germination

In quality seed stocks, purity is typically 98 percent or better. Viable seeds include both those that are dormant (hard seed) and non-dormant. Since the viable seed percentage used to calculate PLS percentage includes dormant seeds, a high PLS percentage does not necessarily mean high germination percentage; PLS and germination are separate indicators of the seed. Care should be taken when reading the seed tag.

Treating seed to break dormancy, and seed storage – In perennial grass seed, dormancy is part of a plant reproductive strategy that limits seed germination until conditions are optimum for seedling survival. For the cultivation of switchgrass, however, it may be desirable to break dormancy to allow for greater control over establishment and maximize the number of seedlings per acre. One of the most effective methods of breaking dormancy is post-harvest ripening. As seed ages, dormancy will naturally decrease. Seed dormancy is typically reduced if the seed is aged for one year at room temperature. Seed older than two years may become less viable and have poor seedling vigor under field conditions.

Blade products will be labeled with recent seed test data to indicate the current level of dormancy for a particular seed lot. Seed should be stored at room temperature in dry conditions to avoid spoilage.

Cold-wet stratification is an alternative method to accelerate the breaking of dormancy. The essential elements of this process include soaking the seed in water for approximately one day, draining excess water and storing the hydrated seed in cold temperatures (40°F) for several weeks. This process is not recommended except for producers with prior experience.

Seed treatments and coatings – Seed treatment technology is not generally available for switchgrass. However, leading grass seed developers and crop protection companies are making progress, and new systems and products may be ready as early as 2010.

Soil type - Switchgrass is broadly adapted and will perform well in a wide range of soil types, although it may prefer soils of finer texture. Loam and sandy soils allow for roots and crown to spread more easily than do denser clay soils. Whatever the soil type, successful establishment requires planting when the soil temperature is warm and moisture is available. Sandy soils dry out more quickly, potentially limiting establishment success and biomass yields.

Soil pH between 5.0 and 8.0 supports optimum growth .

Field preparation – As with other crops, controlling weeds, seed placement and good seed-to-soil contact are among the key elements for the successful establishment of switchgrass. The process begins with field preparation and, particularly, weed control. Weed pressure can be minimized in several ways:

Planting an herbicide-tolerant annual crop in preceding years will significantly reduce the soil weed seed bank.

Establishing switchgrass into pasture sods or following crops with heavy surface residues is difficult and takes more preparation because heavy organic residues from roots and aboveground vegetation can provide a poor environment for switchgrass seedling establishment. Also, sods that appear killed by herbicides can bounce back through new rhizome and tiller production.

As a general rule of thumb, your footprint in the prepared seedbed should indent less than ¼ inch.

It is important to smooth out these surfaces and reduce the cover of the surface residues as much as possible, either through mowing or disking, before planting switchgrass. If planting into pasture or another perennial crop, all existing vegetation should be killed with a broad-spectrum herbicide. In any case, excess surface residue should be removed to avoid hairpinning at planting. Approximately 50 percent of the ground should appear bare.

Once the field is clear of weeds and crop residue, the seed bed should be prepared so as to be smooth, firm and clod-free. As a general rule of thumb, your footprint in the prepared seedbed should indent less than ¼ inch, which generally requires roller packing or cultipacking. The

Switchgrass should be planted at shallow depths: ½ inch to ¼ inch in fine soils, or ¾ inch in coarse soils.

seedbed should be firm, but not so firm as to restrict root growth. No-till soil preparation is preferred for soil conservation. If tillage is used, the field should be cultipacked.

A field that is prepared as described here will allow for more uniform depth control at planting and better seed-to-soil contact.

Planting methods (equipment, rate, depth, row spacing) – On smooth, firm, weed-free surfaces switchgrass may be drilled or broadcast. Drilling involves planting in rows using either a conventional or no-till drill. Drills should be equipped with press wheels for good seed-to-soil contact. Broadcast seeding refers to techniques where seed is spread uniformly across the soil surface. Broadcast seeding should be followed by cultipacking or rolling to ensure good seed-to-soil contact. Broadcasting is not recommended in killed pasture, sods or surfaces with heavy amounts of residue. Instead, switchgrass seed should be drilled. Regardless of method, switchgrass should be planted at shallow depths: ½ inch to ¼ inch in fine soils, or ¾ inch in coarse soils.

Research has shown that switchgrass produces similar yields across a range of seeding rates and row spacings. At lower plant population densities, individual plants are able to exploit more space and soil resources, attain greater size and maintain biomass yields equivalent to those grown at higher

Reducing weed competition is one of the most critical aspects to achieving successful establishment of switchgrass.

plant population densities. Seeding rates of switchgrass average 5 pounds of PLS per acre, with up to 10 pounds applied to sites with poorer growing conditions, and as low as 2 pounds per acre under optimal conditions.

Planting time - The most common time to plant switchgrass is in the spring. Switchgrass will germinate at soil temperatures of 50°F. However, seedling growth is best when soil temperatures reach 65°F and air temperatures reach 75°F to 85°F. When soil moisture and temperatures are adequate, emergence may occur as early as three days after planting (DAP) and may be nearly complete by 14 DAP. For successful establishment, soil should remain moist for at least one month after planting. When soil moisture and temperatures are less than ideal, emergence is slower or seedling establishment may fail.

Early fall or winter plantings are sometimes used to naturally break dormancy of the seed and improve germination. However, doing so can result in greater weed pressure, as there will be less opportunity to treat the first flush of weeds with a broad-spectrum herbicide without damaging emerging switchgrass seedlings. Early spring and late fall plantings have not consistently proven successful and are not recommended.

Weed control in the establishment year - Reducing competition from weeds is one of the most critical aspects to achieving successful establishment of switchgrass. Competition from grassy weeds, such as crabgrass, Johnsongrass and nutsedges, often leads to seeding failures.

As mentioned previously, an excellent way to suppress weedy grasses is to control them with an alternative, herbicide-tolerant annual crop the season before planting switchgrass. In addition, it is extremely important to delay planting in spring until the dominant grassy weeds have emerged. At that time, they can be sprayed with a broad-spectrum herbicide, such as glyphosate, before planting.

At the end of the first growing season (left image), this switchgrass planting experienced significant weed pressure. However, by the end of its second season (right image), switchgrass was fully established. *Photos courtesy of Randy Meidinge, Ducks Unlimited, Inc.*

Research on the use of other pre-emergent and post-emergent herbicides in switchgrass production is preliminary. Several herbicides are being evaluated to determine if they will consistently allow switchgrass to establish. Although some of these herbicides have proven effective in testing, they are not currently labeled for switchgrass in most states. Check with your local extension office for a list of approved herbicides, since some counties prohibit the use of certain herbicides during specific times of the year, due to potential drift to important crops in the region.

Both of these stands are off to a good start and should become densely populated with switchgrass by end of the second season.

Broadleaf weeds are not typically considered a problem to establishing switchgrass. Application of glyphosate before planting typically controls both grassy and broadleaf weeds. After switchgrass emerges, pigweeds and other broadleaf weeds also emerge rapidly and may begin to shade out switchgrass seedlings. A broadleaf herbicide, such as 2,4-D Amine, can be used to control these species once switchgrass reaches the four-leaf stage. Always read and follow the label directions for all herbicide products.

In the absence of thoroughly tested and labeled herbicides, mechanical forms of weed control can be an effective alternative. When mowing to control weeds, take care to avoid clipping off the leaves of the seedlings, and especially avoid cutting below the growing point. Mow weeds to the height of the switchgrass seedlings as necessary during the establishment year.

Experience has shown that the presence of weeds alone at the end of the first year is not necessarily an indicator of stand failure. As long as a suitable number of viable switchgrass seedlings are present at the end of season one, the stand can still become densely populated in the following year.

Establishment year fertilization with nitrogen (N) - Because of slow seedling growth, N fertilizer should not be applied during the seeding year because it encourages weed competition.

Establishment year fertilization with phosphate (P) or potassium (K) - Soils should be tested for pH, P, and K before planting. Lime is typically not required unless pH drops below 5.0. If deficiencies of P and K exist (less than 10 ppm or 20 pounds P/A, less than 90 ppm or 180 pounds K/A), these nutrients can be applied and cultivated into the soil before planting.

Judging stand establishment success – Under good soil moisture and temperature conditions, germination of switchgrass usually takes from three to 14 days. Generally, a field of switchgrass that contains one plant per square foot at the start of the second growing season is considered successfully established. It is important, however, that distribution of the seedlings or plants is monitored across

Rule of Thumb: Add 5–10 pounds of N per acre for each ton of biomass harvested per acre.

the field. Some plantings may have spotty success with several seedlings per foot squared in one area and zero in another. Seedlings that develop tillers should survive the winter in cold climates, as long as an adapted cultivar has been planted.

Harvesting establishment year biomass – A successfully established switchgrass stand should allow for harvestable biomass in the first year. However, first-year biomass yields may only be 30 percent to 40 percent of mature stand yields. Full productivity will most likely not be achieved until the third year. First-year harvests should commence after the plants have reached maturity and at least 60 days before a killing frost, to allow for regrowth, or following senescence and a killing frost. Grazing or harvesting young, immature switchgrass for forage is not recommended during the establishment year.

Intercropping with nurse or cover crops – Nurse or cover cropping may improve stand establishment and reduce inputs. Such crops can help switchgrass become established by keeping the soil moist and shading weeds (early in the growing season) or, in the case of legumes, adding nitrogen to the soil. Such cover crops should be removed early so as not to shade the switchgrass seedlings. Research is under way to investigate region-specific cover crop species for use with switchgrass. This work is preliminary, and sorting out the optimal cover crop will depend on many variables. In coming years, agronomists expect to be able to make recommendations tailored to specific growing regions and agronomic systems.

Another approach under investigation is the planting of spring annual forage crops, such as rye, in rotation. This may be particularly beneficial in the first two years, before the switchgrass stand reaches full maturity. Such crops occupy the earlier part of the growing season and can be harvested for biomass before shading impacts the emerging switchgrass. As noted above, more research must be done before a specific recommendation can be made on this type of cropping system.

STAND MANAGEMENT

Nitrogen fertilization in post-establishment years – The amount of N fertilizer to apply depends on the region of adaptation, yield goal and productive potential of the site where switchgrass is grown. Studies in the southern United States have suggested that N fertilization at 50 pounds to 150 pounds per acre will maximize biomass yields of fully established stands, with responses varying depending on the soil type and initial level of fertility. Studies in midrange locations have found a lower requirement for N (50 pounds to 100 pounds per acre), presumably due to lower overall biomass yield.

Often, when greater volumes of biomass are harvested and removed, more nutrient replacement is required to sustain productive stands. A general guideline, from Parrish et al. (2008), recommends that 10 pounds of nitrogen be added per acre for each ton of biomass harvested per acre. In areas with high rainfall, that rate can be lowered to 5 pounds per acre per ton harvested. Excessive N fertilization may promote lodging and reduce stand density.

Harvest timing is another factor to consider. In general, a one-cut harvest after senescence allows maximum nutrient recycling and the least amount of added nitrogen. Green cuts earlier in the growing season or multiple cut systems will require the addition of more N. If weed competition is still present, N should not be applied until seedlings reach a height of 3 inches to 5 inches. Earlier application would favor weeds and the invasion of cool-season grasses.

Phosphorous (P) and potassium (K) fertilization in post-establishment years - Hay and forage harvesting depletes soil of nutrients. The same can be said of harvesting switchgrass for bioenergy. Generally, as more biomass is produced and harvested, more P and K will be needed to sustain productive stands. Research is ongoing to determine how much P and K is removed with biomass harvests. The amount removed depends on both the frequency of biomass harvest and the timing of those harvests. In the meantime, soil P and K levels should be monitored at least every three years, and nutrients applied as needed to maintain moderate soil test levels. P and K can be topdressed during spring before regrowth of established stands.

Relationship between rainfall/irrigation and yield – Once established, switchgrass can survive extreme periods of drought, but biomass yield will be decreased. Moisture received in the spring, as growth commences, is more likely to maximize biomass yield than moisture received late in the growing season. Under non-irrigated conditions, switchgrass will do best in regions with greater than 20 inches of average annual rainfall. If irrigation is available, it can be used to help establish stands and maximize biomass yields. As expected, biomass yield is responsive to soil moisture levels and increased moisture will generally translate into increased biomass. If irrigation is used during establishment, it is important to monitor weeds, as their growth rates often exceed that of switchgrass seedlings.

Weed control in post-establishment years - Once a switchgrass stand reaches full maturity, and the canopy is closed, weed pressure will be minimal. However, some weed control may still be required in the second year. A dormant application of glyphosate can be used to control winter weeds. Atrazine may be used to control annual grass weeds, and mowing or 2,4-D is helpful in controlling broadleaf weeds, once switchgrass is at the four- to five-leaf stage. Always read and follow the label directions for all herbicide products.

Insect pests in switchgrass – Currently no insect is recognized as a major threat to switchgrass. However, there are reports of grasshoppers, stem-boring moths (Northern Great Plains), nematodes (Texas), crickets and corn flea beetles causing minimal damage. If insects are abundant in your area, granular systemic insecticides can be used in the row at planting.

Diseases in switchgrass - Rust, spot blotch, smuts, barley yellow dwarf virus and

Rust (*Puccinia spp.*) symptoms appear as small, dark pustules that run with the leaf veining; they may cover the entire leaf.

Panicum mosaic virus have all been reported in switchgrass. In general, southern or lowland varieties tend to be more disease resistant than upland or northern varieties. In trials, EG 1101 and EG 1102, lowland varieties from Blade Energy Crops, have both shown increased resistance to rust diseases (*Puccinia spp.*) relative to Alamo and Kanlow, the respective cultivars from which they were derived.

BIOMASS HARVEST

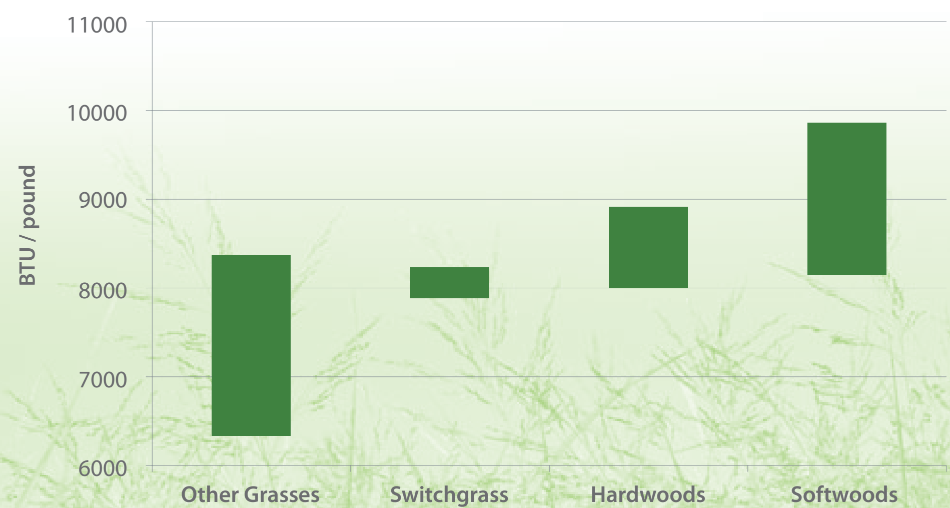
Harvest frequency and timing – The issue of harvest frequency and timing for dedicated energy crops becomes part of a larger question concerning the agronomic system used to deliver a continuous, year-round supply of biomass to a biorefinery or biopower facility. Thus, management practices will have to be optimized to achieve maximum sustainable yields while recognizing the needs of the end user.

With respect to minimizing input costs and maximizing stand sustainability and yield, the best time to harvest a switchgrass stand is post-senescence (two to three weeks after a killing frost). This will allow nutrients in the shoot to be recycled to the root for winter storage. In the southern U.S., where the growing season is longer, an early fall harvest will allow for some regrowth before winter and aid weed control.

Delaying the biomass harvest until the following spring (for example, to allow for "just-in-time" delivery to a biorefinery over the winter) will further promote nutrient recycling and reduce ash content and moisture. This may be desirable for end uses involving combustion or thermochemical conversion. However, 20 percent to 30 percent of the dry matter yield may be lost by overwintering.

Comparison of Energy Content for Biopower

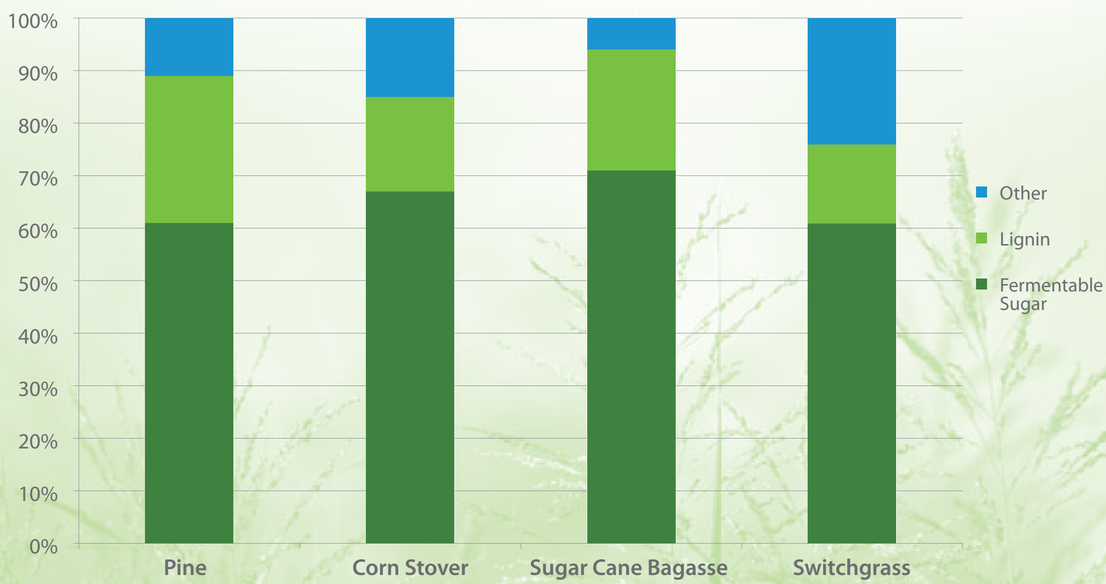
BTU per pound is a good measure of expected performance in combustion and thermochemical processes.



Energy content measured in British Thermal Units per pound of several potential biomass feedstocks. BTU per pound provides a relative measure of the amount of energy that can be released from a given feedstock in a combustion or thermocemical conversion process. Switchgrass falls within the range for woody feedstocks and is at the high end of the range for other perennial grass species.

Chemical Composition of Biomass Feedstocks

Fermentable sugar content (dark green bar) is a key indicator of maximum theoretical yield.



Biochemical conversion processes capture fermentable sugars and convert them to biofuel. Low levels of lignin may increase the availability of the sugar. Other constituents include protein, ash and oil. Like other traits, compositional and conversion traits can be optimized through plant breeding and biotechnology.

In some cases, research has shown that similar biomass yields have been obtained from a single harvest at the end of the season, as compared to two harvests during the season. Because of the extra costs associated with two harvests, harvesting once at the end of the season is likely the most economical option for managing switchgrass as a bioenergy crop. If harvesting for forage, the optimal balance of yield and nutritive value is obtained when switchgrass is harvested at "boot" stage, just before flowering.

Harvest method - Switchgrass can be mowed and baled like other hay. Use of a mower-conditioner, instead of a conventional mower, and raking into windrows can speed drying. In fields with high yields, however, windrows can be too large for proper handling with haymaking equipment. In such cases, it may be best to simply let the material dry in the mown swath before baling. Harvesting mown switchgrass with a silage chopper is an alternative to baling that can speed loading, unloading and processing for bioenergy applications.

Stubble height – Most switchgrass grower guides suggest leaving 4 inches to 6 inches of stubble when harvesting. In cold climates, this stubble will capture snow, providing insulation and reducing crown injury.

Energy conversion characteristics of switchgrass as they relate to biopower or biofuel applications - Biomass conversion processes are of three major types: combustion, thermochemical and biochemical. These processes can be employed to produce energy in the form of liquid transportation fuel (ethanol, butanol, gasoline, diesel and jet fuel), heat and power (electricity), as well as chemical building blocks for industrial processes.

Switchgrass is notoriously difficult to harvest and condition.

Some feedstock materials are better suited to specific biomass conversion processes, based on their chemical composition.

For combustion and thermochemical conversion, a good measure of expected performance is BTU (British Thermal Units) per pound. Switchgrass compares very favorably with other perennial grasses on this measure and also significantly overlaps the range of values for woody feedstocks. This makes it a reasonable choice for these conversion processes.

Biochemical conversion of biomass to biofuel utilizes a process quite similar to that used to convert corn grain to ethanol. It requires the breakdown of complex chains of sugars in the biomass that are then typically fermented to biofuels. The efficiency of this process is dependent on a host of factors that can make the sugar chains more or less accessible. Understanding those factors and modifying them to increase fermentable sugar accessibility is an active area of research. Consequently, our ability to make comparative predictions about fuel yield from a particular feedstock is limited at this time. However, it is generally understood that a high content of these complex chains of sugars is important inasmuch as it establishes the maximum theoretical biofuel yield. In this regard, switchgrass compares well with corn stover and other herbaceous and woody species.

Switchgrass as forage – Current uses for switchgrass beyond bioenergy include forage and soil conservation. Some research has been conducted on managing switchgrass as a dual purpose forage and bioenergy crop. Alternate uses, such as forage, may provide farm income in the absence of a local biorefinery or biopower facility, and may speed the adoption of switchgrass as a bioenergy crop as the industry develops.

See Appendix – *Switchgrass as Forage* for more information on managing switchgrass as a forage crop.

Moisture content of switchgrass - Moisture content from late-summer harvests of switchgrass is greater for lowland types (45 percent) than upland varieties (39 percent). Late-autumn harvested biomass contains about 35 percent moisture; senesced switchgrass harvested the following spring contains about 7 percent moisture.

Seed Use Agreement – Seed varieties from Blade Energy Crops represent the latest in switchgrass technology, and considerable investment, and as a result are sold under a Seed Use Agreement, which permits the use of seed only for planting a commercial crop for sale as biomass. Check with Blade for specific terms.

Stand longevity – A properly managed stand of switchgrass will survive and be productive for many years without the need to replant. Producers may choose to upgrade to a new variety as the next generation of switchgrass products — with even higher yields, new grower-friendly input traits and improved bioenergy conversion properties — become available.

INCENTIVES

The U.S. departments of energy and agriculture as well as many state governments are supporting demonstration and commercial-scale activities for energy crops. The 2008 Farm Bill contains a program, known as the Biomass Crop Assistance Program (BCAP), to help growers seeking experience with nonfood, low-carbon crops, such as switchgrass. Contact the USDA for more information about the status of the program.

APPENDIX – SWITCHGRASS AS FORAGE

Forage quality of switchgrass is similar to most other native, warm-season grasses. Its quality mostly depends on maturity. While vegetative during spring, switchgrass has nearly 15 percent crude protein and greater than 70 percent digestible dry matter. By mid-summer, switchgrass is elongating, and crude protein and dry matter digestibility drops to about 8 percent and 60 percent, respectively.

Switchgrass, like most native grasses, can provide good summer forage for beef cows. Managed correctly, switchgrass can be used for either grazing or hay production.

IMPORTANT: Switchgrass, however, should not be fed to other livestock, such as horses, goats and sheep. It contains chemical compounds, called saponins, that may cause severe health problems.

Because of its early spring availability, high yields, perennial life form, wide adaptability and low fertilization requirements, switchgrass may also have value for stocker cattle production. In the South, second-year stands of switchgrass become available for grazing near April 15. To enhance growth and nutritive

value, we recommend fertilizing switchgrass stands with nitrogen at 50 pounds to 100 pounds per acre. Intensive early stocking with young, growing cattle from April 15 through July 15 could take advantage of rapid early-season growth and its associated high quality plant tissue. Under such management, we recommend that switchgrass not be grazed from August through November. The rest period will allow switchgrass enough time to recover leaf area and store energy reserves by fall. Alternatively, one could manage switchgrass with a continuous, season-long stocking with beef cows, in moderate numbers, from late April through September, which is typical of beef cattle rangeland management.

Regardless of management system, a key point to maintaining productive stands is to make sure leaf area is conserved. Grazing is detrimental to plants because it impairs their ability to capture sunlight or energy. Grasses must replace leaf area lost to grazing animals to grow and be productive. Switchgrass is particularly sensitive to the intensity and timing of defoliation. Delay grazing until switchgrass is 12 inches tall and do not graze it below 6 inches. Don't let cattle get ahead of the grass. Improper timing may result in removal of growing points and delays in growth. If sufficient leaf area is maintained, the plant can grow with little need for stored energy in the roots. Stocking rate may need to be adjusted to keep the removal rate equal to the rate of growth.

If switchgrass is severely grazed, and all leaf area is consumed, remove cattle from the pastures. The grasses need time to recover lost leaf area. Energy stored within the roots must be used for new leaf growth. Switchgrass must rebuild leaf area and cycle energy back to the roots to replenish energy reserves before grazing again.

Retain at least 6 inches of leaf area on switchgrass by August to maintain its persistence over winter. Switchgrass needs to store energy in its roots to survive winter and initiate growth the following spring. When spring arrives, the stored energy helps the grasses build new leaves and begin the process of growth and nutrient storage again.

After a killing fall frost, the dead leaf and stem residue may be baled off, left to decompose or be burned off in the spring. Although the grass is dormant, and cattle aren't consuming it, switchgrass remains susceptible to damage during winter. Be cautious if feeding hay to cattle on switchgrass pastures during late winter and early spring. New leaves begin developing in early spring using energy reserves stored in the roots. If these leaves are grazed too early, and the plant needs to develop new ones, the plant becomes susceptible to energy depletion and may weaken and die.

FURTHER READING

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LEGAL NOTICES

This guide is intended to serve as an informational tool for growers to use in the production of switchgrass as an energy crop. The information contained in this guide is based on public and private research that is currently available. Successful farming of any crop requires a high degree of skill. Seed and crop performance are heavily dependent on environmental conditions such as sunlight, moisture, temperature, and soil composition, all of which are beyond the control of any individual. The authors and collaborators who prepared this guide do not guarantee crop yield or performance. In order to maximize a crop's potential, growers must actively manage the crop according to environmental conditions, pests, and diseases as they occur. While no farming guide can predict or address every farming situation, this guide will provide a strong foundation on which to build techniques for producing a switchgrass energy crop.

This guide is not part of the labeling of any seed or pesticide. Growers must always read and follow all instructions in the product labels of seed and pesticide products. Contact the pesticide product manufacturers or local extension agents to confirm that pesticide products are labeled for an intended use. Contact the seed producers to confirm instructions and intended uses on seed.

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