Establishing and Managing Perennial Grass Energy Crop Demonstration Plots

Researchers, farmers, and industry representatives across the country are interested in testing the performance of energy crops. Setting up a test plot in your region can be useful in showing producers the potential for growing bioenergy feedstocks on their farms. The test plot can demonstrate best management practices and yield potential as well as how to establish perennial grasses quickly and economically. Additionally it can also demonstrate differences between the forage and bioenergy strains of various perennial grasses. Here are suggestions from CenUSA researchers for establishing your own energy crop test plot.

**CenUSA Researchers:**
Rob Mitchell is a research agronomist with USDA-ARS and a professor of agronomy at the University of Nebraska-Lincoln. Jeffrey Volenc is a professor of agronomy at Purdue University. Their role in the CenUSA project is analyzing both the agronomic potential and environmental impacts of promising bioenergy crops and management systems using a network of fourteen fields strategically located across the Central United States. So far, the project has established test plots on marginally productive land (land considered marginal for row crop production) in Illinois, Indiana, Iowa, Minnesota, Nebraska and Wisconsin. Pamela Porter is an Outreach Specialist for the University of Wisconsin. She assists CenUSA in developing science based materials for Extension educators and the agricultural and horticultural industry.

**Choosing and Setting Up a Test Plot Site**
Each site should be a size that would work on a farm. As such, there are no standard dimensions, but CenUSA recommends a minimum plot size of one-fourth acre for each species. Planting and harvesting are facilitated best by planting long narrow strips, like those used in most row crop yield trials.

Select the species and cultivars of perennial grasses you are interested in testing. You might wish to evaluate one species of grass or mixtures of grass species. Seed each plot with high-quality, certified seed. The interest of your audience and geographic location will determine which perennial
grasses to plant and which cultivars to select, but a good selection of perennial grasses for the Great Plains and Midwest could include:

- Switchgrass
- Big bluestem
- Indiangrass
- A low-diversity mixture, such as switchgrass, big bluestem, indiangrass, and sideoats grama
- A high-diversity mixture of approximately 10 species including native grasses, legumes, and forbs.

Switchgrass (*Panicum virgatum*) is a warm-season perennial grass native to the tall-grass prairie region of the U.S. (an area commonly known as the cornbelt). It is considered the leading grass energy crop because of its ease of propagation, high yield potential, compatibility with conventional farming, low input requirements, and excellent conservation and wildlife attributes (Kszos et al., 2000). Other perennial grasses being evaluated for energy use include big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), and prairie cordgrass (*Spartina pectinata*). Miscanthus (*Miscanthus x giganteus*) is a high-yielding, non-native perennial grass feedstock that may fit well in many areas. However, it may not offer as many conservation attributes as one of the native perennial grasses.

### Establishment

In the central Great Plains and Midwest, time planting for two to three weeks before or after the optimum corn-planting date—earlier is better than later. Seed at a rate of 30 pure live seed (PLS) per square foot planted 1/4- to 1/2-inch deep in 6- to 7-inch rows. This is typically 4 to 6 pounds per acre of PLS. If you’re seeding small plots, seed from the center of alley to the center of alley to ensure complete seed coverage in the plot. Make sure the drill is calibrated accurately. You can find two videos explaining how to calibrate a drill here:

- [Drill Calibration Walk Through](#) (4:59 min)
- [No Till Drill Calibration Training Video](#) (20:06 min)

For plantings that include big bluestem or indiangrass which have fluffy (or chaffy) seeds, use a no-till drill with a seed box attachment for chaffy seeds. Switchgrass seed is clean, flows easily and doesn’t require a seed box attachment for chaffy seed. No-till seed into soybean stubble or clean-tilled field and pack firmly enough to leave a faint footprint in the soil when you walk on it. If tillage is used, prepare the seedbed as you would for alfalfa.

If you don’t have grass-seeding equipment, contact your local Extension or USDA Natural Resource Conservation office, or a local equipment dealer. Conservation organizations such as Ducks Unlimited, Pheasants Forever, or The Nature Conservancy may have information on native grasses and or equipment you can borrow or rent. They may also have volunteers who can assist you. A video that demonstrates planting switchgrass and other native warm-season grasses is available at:

- [Switchgrass Planting Practices for Stand Establishment](#) (5:16 min)

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1 In terms of sustainability, ecologists are interested in maximizing the diversity of seeding mixtures for energy crops.
Weed Management
Compared to cool-season grasses, establishing a warm-season grass stand takes more weed management. Weed competition is one of the biggest reasons warm-season grass seedings fail, so weed control in the seeding year is very important, both during and after seeding (Mitchell et al., 2008). Manage weeds in switchgrass with a pre-emergent application of 1 quart of atrazine plus 8 ounces per acre of quinclorac (Paramount®). On big bluestem, indiangrass, and sideoats grama, use a pre-emergent application of 4 ounces per acre of imazapic (Plateau®). On all plots, control broadleaf weeds in the seeding year by mowing in July and/or spraying with one to two quarts per acre of 2,4-D. Biomass grown during the seeding year can be harvested or grazed after a killing frost or left standing in the field over winter. If the residue is left standing over winter, mow the residue for hay or burn before spring greenup.

Always read and follow label directions, and contact your local Extension agent for issues specific to your area—pesticides may not be approved in all states for these purposes.

Harvesting
It is recommended to harvest perennial grasses used for biomass in the fall, after a killing frost. Waiting until after frost allows carbohydrates and nitrogen to be translocated from leaf and stem tissue to roots, increasing plant winter hardiness and reducing future nitrogen fertilizer needs. For large yield trials, harvest each feedstock with field-scale haying equipment (swather and baler). Be sure to bale each plot individually to properly track the yield for each plot. Count and weigh the individual bales to determine the yield for each feedstock. Adjust the yield to a dry matter (DM) basis (see below) in tons of DM per acre.

For small plots, mow alleys to less than a 4-inch stubble height. Determine biomass by cutting and weighing a 3-foot wide swath the length of each small plot, using a flail-type plot harvester with a cutting height of 4 inches. Determine the harvested area in square feet and convert the yield estimate to tons per acre. Do not harvest the outer edges of the plots, to reduce border effects. Weigh the harvested material immediately in the field. If a flail-type plot harvester is not available, clip material by hand from a 3’ x 3’ quadrat to a 4-inch stubble height, weigh the material, and convert yield to DM tons per acre.

To determine dry matter weight, take a subsample of biomass from each plot, weigh and dry each sample at 120 to 130 F (50 degrees C) for at least 72 hours in a forced-air oven. Then reweigh to determine the dry matter (DM) concentration. (Mean DM concentration of these samples will be used to adjust field biomass to an oven dry basis; the oven-dry weight of the hand-collected material will be added back to the harvested material to accurately represent plot biomass). You can find out more about harvesting switchgrass in these two CenUSA videos:

Optimizing Harvest of Perennial Grasses for Biofuel (4:50 min)
Harvesting a Native Grass for Biofuel Production (2:58 min)
Testing Plant Quality
If you are interested in having your plants tested for their fiber or mineral content, collect subsamples prior to harvest, using hand clippers. Clip samples to a 4-inch stubble height from multiple locations within each plot, dry the samples as described above. Use a Wiley mill to grind the samples to pass a 20 to 40 mesh (1 to 2 millimeter) screen. Mix up the ground material. Take several scoops of the ground material (approximately one third of a quart-sized ziplock bag) to make a representative subsample. Send the subsample to a plant analysis laboratory for testing.

How Well is the Stand Doing?
Immediately after harvest, evaluate plant populations using a frequency grid (Vogel and Masters, 2001). Make a frequency grid from a piece of concrete remesh with 6-inch-by-6-inch squares. Cut the remesh into a 5-by-5 square grid containing a total of 25 squares.

Evaluate your stand in the first year, after the grass plants have three to four leaves and are easy to see. Choose at least four locations in the field. At each location place the frequency grid on the ground and count the number of squares that have a grass plant contained inside the square. Record that number. Squares that contain plants count as one (1). Squares without plants count as zero (0). Only those squares that have the base of a plant located inside the square are counted.

Total the 100 squares to calculate the stand frequency percentage for that location. For example: 15 plants/25 squares + 17 plants/25 squares + 23 plants/25 squares + 20 plants/25 squares = 75 plants/100 squares or 75%. This means that 75% of that location had a grass plant growing in it.

Repeat the process at three other locations in your field to calculate an average stand frequency. A stand frequency of 50 percent or greater indicates a successful stand. A stand frequency between 25 and 50% is marginal to good. Stands with less than 25 percent frequency should be reseeded.

A video demonstrating the use of the frequency grid is available on the CenUSA website here: 
How to Measure Stand Establishment Using a Grid (9:05 min)
References:


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