Vermont Grass
Energy Field Day

Wednesday, July 21, 2010
Meach Cove Farm Trust
Shelburne, VT

Sponsored by:
Welcome to the Vermont Grass Energy Field Day

The objective of this field day is the highlight ongoing research and activities of the Vermont Grass Energy Partnership made up of the Vermont Sustainable Jobs Fund, the Biomass Energy Resource Center (BERC) and the University of Vermont (College of Agriculture and Life Sciences and UVM Extension). This partnership started in 2008 to address a number of issues related to the production, distribution and use of perennial grasses for energy, particularly for heating applications. The Partnership has been investigating agricultural best practices for high-biomass producing perennial grasses, pelletization of grass and grass/wood blends and testing the performance and emissions of grass pellet fuels in high-efficiency biomass heating systems. The results of this multi-phase analysis will eventually lead to recommended strategies on how best to cultivate and utilize grass energy in Vermont.

The Vermont Sustainable Jobs Fund (VSJF), a not-for-profit organization located in Montpelier, was created by the Legislature in 1995 to accelerate the development of Vermont’s green economy. VSJF uses early stage grant funding and technical assistance to catalyze and accelerate the development of markets for sustainably produced goods and services. The organization’s current focus is on the intersection between sustainable agriculture, sustainable forest products, and renewable energy in the form of biofuels (<http://www.vsjf.org/projects/1/vermont-biofuels-initiative>).

The University of Vermont is the Land Grant institution of Vermont with a mission to improve the quality of life of Vermonters by conducting research and providing educational programs and practical information concerning Vermont communities, families and homes, farms, businesses, and the natural environment. The College of Agriculture and Life Sciences (CALS) conducts research spanning from the basic life sciences, to agriculture and food systems; to nutrition and health; to community development and entrepreneurship. UVM Extension is located throughout the state linking the citizens of Vermont to the University, providing timely, research-based information and education. http://www.uvm.edu/

The Biomass Energy Resource Center (BERC) is a national nonprofit organization based in Montpelier, Vermont. Its mission is to achieve a healthier environment, strengthen local economies, and increase energy security across the United States through the development of sustainable biomass energy systems at the community level. As a private, nonprofit organization, BERC is an independent and impartial organization that conducts fair and objective studies. BERC maintains complete neutrality while conducting routine due diligence on biomass resource supply for projects and government agencies throughout the US. In addition to its work on wood fuels, technologies, and applications, BERC is working to expand the use of agricultural biomass as a viable fuel for community energy projects. http://www.biomasscenter.org/

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Grass Biomass Energy Field Day

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A special thanks to the many collaborators and advisors in this project:
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Chris Davis, manager, Meach Cove Farm Trust, Shelburne, VT
Roger Rainville, Borderview Farm, Alburgh, VT
Sam Lincoln, Lincoln AgriSource LLC, Randolph Center, VT
Sosten Lungu, Vermont Technical College, Randolph Center, VT
Paul Salon, USDA-NRCS Plant Materials Station, Corning, NY
Jerry Cherney, Extension Forage Specialist, Cornell University

A special thanks to U.S. Senator Patrick Leahy and the U.S. Department of Energy for their generous support of ongoing renewable energy research and education in Vermont.

UVM Extension helps individuals and communities put research-based knowledge to work. University of Vermont Extension, and U.S. Department of Agriculture, cooperating, offers education and employment to everyone without regard to race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or familial status.
Warm Season Grass Biomass Evaluation

The objective of these studies is to evaluate the potential biomass production, quality characteristics and adaptability of native, warm season grasses including switchgrass, big bluestem, indiangrass and miscanthus. There is also a polyculture treatment made up of a mixture of switchgrass, big bluestem and a native prairie legume called Showy Tick Trefoil (*Desmodium* spp). Two locations were seeded in Vermont in 2009, Meach Cove in Shelburne and the UVM Horticultural Research Farm in South Burlington. An additional two locations were seeded in 2010, Borderview Farm in Alburgh and Vermont Tech in Randolph Center. Each location represents different soil types and elevations.

We had not anticipated harvesting any of the plots of the warm season grass trials in the seeding year; however, the switchgrass had grown so well (one cultivar exceeding four feet in height), that we did harvest those treatments. The other grasses (big bluestem and Indiangrass) germinated and grew but at a much slower rate and were not harvested.

Biomass yields of the harvested switchgrass cultivars ranged from 0.9 to 1.8 tons of dry matter per acre (Table 1). ‘Shawnee’ and ‘Kanlow’ were the highest yielding cultivars at both locations. ‘Kanlow’ did very well at the Meach Cove site. It is the only lowland cultivar in this study and is very adapted to wet soils. The Meach Cove site is clay, and with the excessive rain this season, I would have expected this cultivar to do well. Also, it was the only cultivar that never went into a seedhead phase. This may explain why there was such a difference in dry matter yield between the Oct. 1 and the Nov. 4 harvest dates at the UVM Hort Farm site. We did not get a good killing frost at this location until mid to late October and I think the ‘Kanlow’ not being sensitive to day length like the other cultivars, continued to grow. One concern in our northern climate is that the lowland types will not persist very well. We shall see how this cultivar performs over the next few years. ‘Shawnee’ is a newer upland type cultivar that was selected from ‘Cave-N-Rock’ for higher productivity and improved forage quality. In this seeding year, it yielded as well as ‘Kanlow’ and consistently higher than ‘Sunburst’ and numerically better than ‘Cave-N-Rock’. Being an upland cultivar, it will be very interesting to see how it performs over the next few years. Sunburst did the poorest in this seedling year; however, being an upland cultivar, it may perform much better once fully established.

Generally, the highest yields were at Meach Cove, a clay site compared to the UVM farm, a sandy loam site. Although much of the season had higher than normal rainfall (which probably helped in the establishment of the grasses), August turn somewhat dry and some of the plants at the UVM site started showing signs of drought stress which may help explain the differences in yield.

More information on this trial can be found at [http://pss.uvm.edu/vtcrops/?Page=energycrops.html](http://pss.uvm.edu/vtcrops/?Page=energycrops.html).
09 Warm Season Grass Species/Cultivar Evaluation Trial - Meach Cove Farm

Planted: 6/14/09

Treatments | Trt | Species     | Cultivar
SCNR        |      | Switchgrass | Cave-N-Rock
SSHAN       |      | Switchgrass | Shawnee
SKAN        |      | Switchgrass | KanloW
SSUN        |      | Switchgrass | Sunburst
BBNIA       |      | Big bluestem| Niagara
BBPRA       |      | Big bluestem| Prairievew
MISC        |      | Miscanthus x Giganteous
IPA         |      | Indiangrass | PA Ecotype
RCG         |      | Reed Canarygr. | Palaton
POLY        |      | Polyculture | Cave N Rock Prairievew Desmodium
Switchgrass Seeding Rate Study

The objective of this trial was to determine an optimum seeding rate of switchgrass. The existing recommendation is to plant at 8 to 10 lbs. of Pure Live Seed (PLS) per acre. Due to its tendency to have a high amount of dormant seed, it is often challenging to determine a seeding rate that is economical. Some seed lots can have %PLS as low as 20%. In this study, we compared two different seed sources of ‘Cave-In-Rock’ and two other cultivars varying in % PLS. The lowest seeding rate of 8 lbs. was expected to be less than optimum when factoring in PLS.

We were able to take a seeding year harvest although we had not planned on it. From the first year results, we found that only the lowest seeding rate (8 lbs. per acre), which was targeted to be less than normally recommended, showed a lower significant biomass yield in the seeding year (averaged across all cultivar seed sources). Its yield was not dramatically lower than the higher rates probably due to higher tiller weights since the plants had more space to grow. But even at this low seeding rate, stands were at populations considered adequate (according to northeastern university recommendations). This may have been due to good seedbed preparation and weed control as well as the use of a seed drill that placed the seed at a optimum depth with good surface compaction (use of press wheels) following seeding. We plan to harvest the treatments one more year.

Biomass yield, tiller populations and tiller weight of four switchgrass cultivar/seed sources planted at four seeding rates.

<table>
<thead>
<tr>
<th>Seeding Rate</th>
<th>UVM Hort. Farm</th>
<th>Meach Cove</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D.M Yield</td>
<td>Tiller Pop.</td>
</tr>
<tr>
<td></td>
<td>(t/a)</td>
<td>(no./ft²)</td>
</tr>
<tr>
<td>8</td>
<td>0.81 b</td>
<td>35 b</td>
</tr>
<tr>
<td>12</td>
<td>0.91 ab</td>
<td>40 b</td>
</tr>
<tr>
<td>16</td>
<td>0.98 a</td>
<td>50 a</td>
</tr>
<tr>
<td>20</td>
<td>0.98 a</td>
<td>55 a</td>
</tr>
</tbody>
</table>

* Any means with the same letter are not significantly different (P< 0.05)
## 09 Switchgrass Seeding Rate Study - Meach Cove Farm

**Planting Date:** 6/14/2009  
**Plot Size:** 5' x 23'

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Trt</th>
<th>Cultivar</th>
<th>Seeding Rate lbs total seed/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIR07</td>
<td>20</td>
<td>Cave-N-Rock</td>
<td>8</td>
</tr>
<tr>
<td>CIR09</td>
<td>12</td>
<td>Cave-N-Rock</td>
<td>12</td>
</tr>
<tr>
<td>KANL</td>
<td>16</td>
<td>Kanlow</td>
<td>16</td>
</tr>
<tr>
<td>SHAN</td>
<td>20</td>
<td>Shawnee</td>
<td>20</td>
</tr>
</tbody>
</table>

### Table

| Row | CIR07 | CIR07 | CIR07 | CIR07 | CIR07 | CIR07 | CIR07 | CIR07 | KANL | KANL | KANL | KANL | SHAN | SHAN | SHAN | SHAN | SHAN | SHAN | SHAN | SHAN | SHAN | SHAN | CIR07 | CIR07 | CIR07 | CIR07 |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| 1   | 8     | 16    | 20    | 8     | 12    | 16    | 20    | 8     | 12   | 16   | 8    | 12   | 16   | 8    | 12   | 16   | 8    | 12   | 16   | 8    | 12   | 16   | 8    | 12   | 16   | 20    |
| 2   | 01    | 02    | 03    | 04    | 05    | 06    | 07    | 08    | 09   | 10   | 11   | 12   | 13   | 14   | 15   | 16   | 17   | 18   | 19   | 20   | 21   | 22   | 23   | 24   | 25   | 26    |
| 3   | 201   | 202   | 203   | 204   | 205   | 206   | 207   | 208   | 209  | 210  | 211  | 212  | 213  | 214  | 215  | 216  | 217  | 218  | 219  | 220  | 221  | 222  | 223  | 224  | 225  |
| 4   | 101   | 102   | 103   | 104   | 105   | 106   | 107   | 108   | 109  | 110  | 111  | 112  | 113  | 114  | 115  | 116  | 117  | 118  | 119  | 120  | 121  | 122  | 123  | 124  | 125  | 126  |
This study is in collaboration with Paul Salon at the USDA-NRCS Big Flats Plant Materials Center in Corning, NY. We are interested in these grasses because they are very stemy grasses. With a low leaf-to-stem ratio, we think they have potential to be lower in ash content. Being cool season grasses, they head out in May/June and would be harvested for biomass in July. A repeat of this study is also at the UVM Hort. Farm and at Big Flats in New York. These grasses are primarily grown in the semi-arid West, so long term evaluation for persistence and adaptability is important. Reed canarygrass has been included as a "control" since it considered our best cool season grass biomass option for Vermont.

### Treatments

<table>
<thead>
<tr>
<th>Trt</th>
<th>Species</th>
<th>Cultivar</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBWR</td>
<td>Wildrye</td>
<td>Great Basin</td>
</tr>
<tr>
<td>GMWR</td>
<td>Giant Wildrye</td>
<td>Mammoth</td>
</tr>
<tr>
<td>ATWG</td>
<td>Tall wheatgrass</td>
<td>Alkar</td>
</tr>
<tr>
<td>LTWG</td>
<td>Tall wheatgrass</td>
<td>Largo</td>
</tr>
<tr>
<td>BFIWG</td>
<td>Inter. wheatgrass</td>
<td>Big Flats</td>
</tr>
<tr>
<td>HIWG</td>
<td>Inter. wheatgrass</td>
<td>Haymaker</td>
</tr>
<tr>
<td>BMIWG</td>
<td>Inter. wheatgrass</td>
<td>Beef Maker</td>
</tr>
<tr>
<td>PRCG</td>
<td>Reed Canarygrass</td>
<td>Palaton</td>
</tr>
</tbody>
</table>

- **GBWR**: Great Basin Wildrye
- **GMWR**: Giant Wildrye Mammoth
- **ATWG**: Alkar 9051920
- **LTWG**: Largo
- **BFIWG**: Big Flats
- **HIWG**: Haymaker
- **BMIWG**: Beef Maker
- **PRCG**: Palaton
Other Grass Energy Field Trials

Annual Warm Season Grass Biomass Evaluation

One of the challenges of establishing switchgrass is that it has slow seedling growth and is not very competitive with weeds. One strategy to reduce weed competition is to grow an interim smoother crop that could reduce the weed seedbank before attempting to plant the switchgrass giving it a better chance to grow with fewer weeds. Many of the common annual forages crops could serve this purpose and also produce biomass. The objective of this study is to evaluate the potential biomass production of various annual warm season forage species and cultivars for this purpose. Four cultivars of sorghum-sudangrass and single cultivars of sudangrass hybrid, pearl millet and Japanese millet were seeded at two seeding rates in June of 2010 at two locations, Meach Cove in Shelburne and UVM Hort Farm in South Burlington. Each study has four replications. Yields will be collected at the end of the season.

Switchgrass Emergence Study

Often times, a farmer will receive switchgrass seed that has a very low PLS requiring a very high seeding rate. However, dormant seed will eventually germinate. The objective of this study is to evaluate the emergence rate of two different sources of ‘Cave-In-Rock’ seed (one with 20% PLS, Low, and one with about 50% PLS, High) planted at different seeding rates. Emergence counts will be made every two weeks for the remainder of the season. This study is being conducted at both Meach Cove and the UVM Hort Farm.

Nitrogen Response of Reed Canarygrass and Switchgrass

Nitrogen is often the most limiting nutrient for grass growth and yield and, yet, it is also an intensive energy input for a grass biomass production system. A series of N response studies were initiated in 2009 and 2010 on established stands of reed canarygrass (at UVM in South Burlington and on the Lincoln Farm in Randolph Center) and switchgrass (at Borderview Farm in Alburgh). Treatments include three rates of nitrogen (0, 50 and 100 lbs. N/acre) in combination with two the three harvest dates.

Results of these studies will be posted on the UVM Grass Energy website at http://pss.uvm.edu/vtcrops/?Page=energycrops.html.
Establishing Warm Season Grasses

Ernst Conservation Seeds

- Established in 1963 in Meadville, PA
- Family-owned
- Native species for conservation, reclamation, biomass, habitat, and restoration
- 500+ species
- Current production in PA, FL, SC, NC, and MD

Ernst Conservation Seeds

- 30+ years experience with switchgrass establishment, management, seed harvesting, and biomass processing
- Currently pursuing the development of markets for switchgrass biomass
- Area specific varieties
Established switchgrass at Big Flats, NY

This is what we want!!!

Other Warm Season Grasses With Biomass Potential

- Coastal Panic Grass
- Big Bluestem
- Indiangrass
- Prairie Cordgrass
Planting Times for Switchgrass

Spring vs. Fall
The best planting window in the northeast is similar to that of corn, or just slightly later. Spring planting can start as early as April 1st and as late as July 15th.

Optimum planting time is when soil temperature reaches 55°F. At optimal planting time, spraying can be performed close to planting and achieve the best weed control. The earlier we can place the seed in the soil, the more likely it is to develop properly to survive the winter.

Choosing a Field

- Planting in marginal soils decreases competition with conventional row crops.
- Warm season grasses are long-lived perennial crops; therefore, we do not have to worry about planting wet or highly erodible fields every spring.
- Warm season grasses tolerate a pH of 5.5 or higher.

Abandoned field being prepared for switchgrass.

Field Preparation

- Start with pre-tillage spraying
  - Roundup® 1–2 weeks before tillage
- Minimum tillage
  - We are trying to achieve approximately 60% bare soil
  - Specialty tillage tools (True Tandem Turbo Disk)
  - Create a firm seedbed
Field Preparation on Grain Stubble

• Typically, we can plant directly into grain stubble no-till.
• Determining Factors:
  – Weed Control
  – Field Conditions

Planting Depth

• ¼” depth is critical.
• Switchgrass seed flows well through the small seed boxes in most drills.
• Big Bluestem, Indiangrass, and Prairie Cordgrass are fluffy seeds and require a specialty drill to plant.
Examples of 1st and 2nd Year Switchgrass

1st year switchgrass no tilled into low production corn stubble.

Paramount® @ 5.3 oz post-emergence.

Switchgrass planted with oats; oats removed.

1st year switchgrass with excellent weed control.

1st year switchgrass
HARVESTING BIOMASS

Over wintering switchgrass

Mowing switchgrass after snow has melted

Baling switchgrass
ECS/Ernst Biomass, LLC

- Formed in late 2008
- Site location is a portion of northwestern PA KIZ
- Adjacent to ECS main facility
- Currently supplying material in “small” batches for test burns

Ernst Biomass Briquetting Update

- Mechanical briquetter purchased in February 2008 for pilot/demo set-up
- Leased to Carolina-Pacific in summer 2008
- Returned to Ernst, and currently producing briquettes for the Benton School District
- Demonstration orders as far away as IL
Commercial Pelleting at Ernst

• Awarded a DEP-PEDA grant for a densification facility dedicated to warm season grasses
• Additional financing secured
• Anticipated groundbreaking in fall 2010 pending receipt of permits

Commercial Pelleting at Ernst

• Will serve three (3) markets: Utility, commercial, and residential
• Majority of production done in bulk
• Biomass market exceeds existing production

Questions??

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