Change to Baseline Farm Data

The overall objective of the project was to obtain information on production and management of warm season perennial grasses (WSPG) in New York (NY) for use as dedicated crops for bioenergy and expand their production in the state. The rationale for establishment of on-farm trials of WSPG was to educate producers on how to establish and manage these grasses and through regional field days encourage local farmers to consider production on their own farms. The goal was also to influence acceptance of WSPG as alternatives crops for production in NY. At the time this project was re-started in June of 2010 two (Tom Lee, Second Chance Farm, Madrid, NY; Pete Tracy, Sweet Pea Farm, Waterloo, NY) of the original six producers listed on this proposal were still participating in the project. The other producers did not continue with the project due to a variety of reasons (poor stands of WSPG and weedy, fields sold, WSPG too green in late summer). Prior to the initiation of this project, Tom had no WSPG on his farm and had no experience with their production. In 2007 (funding from first grant 2007-2009), our project established a 5 acre strip trial (switchgrass and big bluestem) on his farm. Since that time he has planted an additional 37 acres of switchgrass and now has a total of 42 acres. He also purchased pellet equipment and is producing densified biomass pellets for direct combustion. Our project held two well attended field days on his farm, and Tom has hosted several additional field days to educate other farmers, interested landowners, government agency staff, and others, on the production and potential use of WSPG for bioenergy. The yield of the switchgrass cultivar ‘Cave-in-Rock’ (CIR) was the highest of all in the trials harvested in 2011 at just over six tons per acre. Tom is optimistic about the future of bioenergy in the state but will not plant additional fields of switchgrass until alternative markets for these crops develop. The strip trial on Pete Tracy’s farm was established in 2009 with the second round of funding from the NYFVI. For this project, one of our goals was to have farmers use their own seeding equipment to establish the trials. Pete used a Krause 5215 grain drill. The switchgrass cultivar ‘Shawnee’ established well on his farm and yielded 4.5 tons/acre with no inputs. Pete Tracy (also a member of our advisory board), sold the biomass harvested this year for bedding at $100/ton. Even though he was impressed by the yield, he indicated that he will plow the field and plant corn next year. Pete had no prior experience with switchgrass and said he would consider planting more if there were dependable markets. In addition to the strip trials, small plot replicated trials of five species of WSPG were established in five counties: Chemung, Clinton, Genesee, Jefferson, and Tompkins. The trial in Genesee County was located on producer Steve Rigoni’s farm. Yield and biomass quality data were collected from the small plot trial on his farm in the fall of 2009. The total mean for all five grass species was 3.0 dry tons/acre (dt/a). Switchgrass had the highest mean yield (3.4 dt/a) of the five WSPG evaluated at that location. Highest yielding entries were a switchgrass in monoculture ‘Blackwell’ 4.7 dt/a and a switchgrass
CIR/Pete’eastern gamagrass mixture at 4.8 dt/a. The big bluestem variety ‘Bonanza’ had the lowest mean (1.8 dt/acre). Steve Rigoni chose to replant the area with corn after the 2009 harvest. The other four small plot trial locations were at the NRCS Plant Materials Center in Big Flats, the William H. Miner Agricultural Research Institute in Chazy, the Cornell University Agricultural Experiment Station in Ithaca, and at the Belleville-Henderson Central School in Belleville, NY. The project was successful in educating and showcasing production and management practices for WSPG to hundreds of farmers and landowners. However there are few markets available aside from the emerging bedding market, thus the new fields planted are small in number and size and there has been little increase in overall production of WSPG in NY. All of the other producers where on-farm trials were established have since planted that acreage to commodity crops to take advantage of the high prices and crop insurance. The take home message is that WSPG should be established on marginal land to provide additional revenue from acreage not in active production, rather than competing with other crops on highly productive land.

**Profitability, Competitiveness, Sustainability Improvements**

Through research trials of warm season perennial grasses (WSPG), this project identified management practices and the grass species / varieties that are well adapted to marginal soils and have the potential to be the most profitable and sustainable for producers in NY. Switchgrass as a group had the highest yields (2-7 tons per acre dry matter) while big bluestem had the lowest yields. These yields were achieved on acid soils, soils with limited rooting depth and poor drainage as well as on good quality land. WSPG may actually improve soil drainage by their deep and fibrous roots that were able to penetrate fragipans. Switchgrass harvested in a one-cut system and baled as dry hay would be the most profitable management system. Tom Lee, Second Chance Farm, Madrid, NY, (lonelee@whmail.com) gave a definition of marginal land as land where two to three out of five years, the crop marketable yield and value is less than the cost of crop inputs. WSPG, specifically switchgrass will not compete with commodity crops that are grown on good land and that have the advantages of crop insurance and government subsidies. Switchgrass grown on marginal and currently unproductive or erodible lands provides improvements to farm profitability, competitiveness and sustainability through achieving high and relatively stable yields of usable biomass over many years with low crop inputs, flexible planting and harvest dates, and low labor inputs. Switchgrass can be planted and harvested with currently available equipment. From the quality data, the British Thermal Units (BTUs) of switchgrass is similar to wood. As wood products increase in cost due to increased demands from wood pellet and other wood industries, grass biomass for combustion, pyrolysis/gasification, or conversion to ethanol will be a valuable alternative to wood. Other uses of switchgrass would increase demand for it in the market place and for use on farms. These alternative uses could be for conventional and organic dairy ration roughage and bedding for livestock operations. Switchgrass and other WSPG are slow to establish but once established (1-2 years), yield well. Improvements in seed quality and treatments, seedling vigor, and cold and weed pressure tolerance could further reduce seeding rates, establishment costs and yield lag in the establishment years, thereby improving profitability. As markets develop and mature, producers will find that they have fields they can plant to switchgrass or other WSPG that will help them optimize their land, labor, and equipment infrastructure. Due to the bulky nature of WSPG bales, use of this biomass resource will be primarily local. Significant potential exists to enhance rural economic development and sustainability through production of these grasses and to supply additional income to farm operations.
Knowledge Gain

At the farm level, producers participating in the project were able to obtain hands-on experience with production and harvest of warm season perennial grasses (WSPG), specifically big bluestem and switchgrass. Problem areas in the production system identified by producers were the lack of a first year harvest, need for herbicides to control weeds during the establishment year, and more options for marketing the crop. WSPG need to be cut at a higher height than other forage crops. This higher cutting height (8-10 inches) is important in the establishment year when mowing to control weeds to ensure that the plant growing point is not damaged. In the fall, it is important to cut switchgrass at a 6-8 inch cutting height. Cutting lower than this or at the normal 4-5 inch height leads to tire punctures, resulting in extra expense and equipment downtime. Incidence and severity of plant diseases were monitored and characterized via observation of stands established by producers and through the replicated small plot cultivar evaluation trials. Samples from these trials were diagnosed in Gary Bergstrom’s field crop pathology laboratory at Cornell University in Ithaca. Proof of pathogenicity experiments were conducted for a number of new diseases; pathogen cultures and DNA sequences were deposited in national repositories. Foliar rusts, particularly Puccinia emaculata on switchgrass, were identified as significant yield threats that may increase with increasing production in the region. Anthracnose diseases (of switchgrass and indiangrass) and Bipolaris leaf spot diseases of several warm season grasses were also identified as potential problems for future production. Alan Taylor’s seed technology program in Geneva modified a seed germination test originally developed by the USDA in Lincoln, NE to determine the germination percentage of seedlings from soil (sand) in a controlled environment. Commercial seed lots of Trailblazer, Cave-in-Rock, Kanlow and Alamo were obtained from four companies, and germination testing was conducted at the New York State Seed Testing Laboratory in 2011. Germination tests were conducted by placing seeds on moist blotters, and providing a controlled temperature environment. The temperature regime of 30/15C with 30C for 8 hours with light and 16 hours in dark at 15C was adapted from the Association of Official Seed Analysts rules for testing seeds. In summary, switchgrass seed quality of commercial seed lots varied tremendously and only one seed lot had high seed quality, defined as having germination percentage in the 90’s. Seeds of each variety were aged at 30C and 50% relative humidity to simulate long-term storage. This combination of temperature and relative humidity would deteriorate seed quality in less than a half year, and would be harsher than seed storage in common storage by a seed company or farmer. Therefore, the time frame of storage is reduced from a few years to several months. The initial germination of Trailblazer was 94% and only declined to 89% after 3 months storage. Cave-in-Rock in the same study declined from 75% to 57%, while both Kanlow and Alamo declined from about 67% to 48%. In general, seeds with high percent germination can better maintain their seed quality in storage compared to seeds with lower initial germination. A critical component identified consistent through all trials is the importance of seed quality, including the need for reliable seed tag labels, to ensure good stand establishment. Collectively, obtaining a high quality switchgrass lot is the exception and not the rule as found in most agronomic and vegetable crop seeds. It is recommended that a standard germination test should be conducted to validate information on the label. Moreover, the switchgrass seed industry has the potential to make significant improvements to produce high quality seed lots to help secure rapid and complete switchgrass establishment. Yield and quality data were collected on the strip trials and replicated plot trials. Over all trials, switchgrass yielded the best. The highest yielding varieties were Cave-in-rock, Shawnee, Blackwell, and Shelter. They yielded ~4 - ~4.4 dry tons per acre in all years in all yield trial locations. Overall yields increased ~70% between the
first and second production years and then stabilized with little differences between second, third, and fourth production years. Total mean percent cellulose increased each year in every trial, reflecting the increasing maturity of the plants in the trials. Mean increase was approximately 10% over three years in Big Flats, Belleville, and Ithaca trials. Later-maturing varieties such as Kanlow and Atlantic had higher percent ash and percent mineral content than earlier maturing varieties such as Sunburst. For more detailed information about yield and data characteristics, see the attached file: 2011_WSPG_Summary.pdf. Additional quality samples were taken at harvest in 2011. These samples have been ground and are awaiting quality analysis. When the analysis is complete, a final information package will be made available on the project website.

**Outreach**

Exhibit, Seneca Falls, NY (8/11/10) New York State Curriculum Development Workshop Boyce Thompson Institute, Ithaca, NY (7/14/11)(7/21/11)Empire Farm Days Exhibit, Seneca Falls, NY (8/10/11)Paul SalonTitle: Cornell Biofuel Education Grant Tour.Presenter: Paul Salon and Martin van der GrintenAudience number 12Location: Big Flats PMCDescription: Gave tour of the biomass energy projects to secondary school teachers at the Big Flats PMC as part of a Cornell grant to train teachers on bioenergy. provided information on NYFVI biomass energy grant.Date presented: 6/17/2011Title: Boyce Thompson Institute Biomass Energy TourPresenter: Paul Salon and Martin van dAudience Type: Oral Credit: PMC & PMSAudience Number: 11Location: Big Flats PMCDescription: Another group of teachers part of the Cornell Bioenergy education grant. Boyce ThompsonInstitute participants provided information on NYFVI biomass energy grant.Date presented: 7/26/2011Title: Annual Perennial Biofeedstock Energy WorkshopPresenter: Paul SalonAudience Number 100Location: Big Flats PMCDescription: Gave presentation during the tour of the bioenergy projects being conducted at Big FlatsPMC. I also moderated and organized the speaker session.Date presented: 8/3/2011Title: Developments in Perennial Herbaceous Biomass CropsPresenter: Paul SalonAudience Number: 30Location: Penn. State University, State College, PA.Description: Power point presentation at the Cellulosic Supply Chains for Bioenergy Short CourseProgram at Penn. State presented information from the NYFVI biomass project.Date presented: 11/10/2011Title: Annual Perennial Biofeedstock Energy WorkshopPresenter: Paul SalonAudience Number 100Location: Big Flats PMCDescription: Gave presentation during the tour of the bioenergy projects being conducted at Big FlatsPMC. I also moderated and organized the speaker session.Date presented: 7/28/2010.Title: Switchgrass establishment for bioenergy productionPresenter: Paul SalonAudience Number: 50Location: Seneca Falls, NYDescription: Gave poster presentation in front of a switchgrass demonstration plot at Empire Farm DaysDate presented: 8/10-12/2010

**Industry Changes**

Many significant changes in the bioenergy industry have occurred since the initiation of this project in 2007 and then again through renewal of the project in 2009 and 2010. These changes have been driven primarily by the need for alternative energy due to the rising cost of fossil fuels. Several new biomass based energy companies have emerged in NY. The majority of these companies can be found on the New York Biomass Energy Alliance web-site (http://www.newyorkbiomass.org/). At the farm level, two farmers participating in this project, Steve Rigoni (srigoni@frontiernet.net) and Tom Lee (lonelee@whmail.com), have been strong supporters for production and use of biomass for energy. Outreach from this project has increased the awareness on the production and use of perennial grasses for bioenergy for producers across the state but the bottom line for farmers is yield and marketability. As markets for the biomass become more available, we are confident that the interest among farmers for producing WSPG will increase. As a result of the outreach from this project, several research programs at Cornell have received funding for new projects. For example, Cornell was selected as a research site for the Regional Bioenergy Feedstock Partnership funded by the NorthCentral SunGrant Region and the US Department of Energy to investigate the production and management of switchgrass in NY. Our project also received USDA/NIFA funding for a collaborative research project (with investigators from the Department of Biological and Environmental Engineering, Brian Richards) to study carbon sequestration and greenhouse gas emissions from perennial grass production systems in NY. Beneterra Agritech, a new biomass energy company in NY, is partnering with Cornell on the project by establishing research field
sites in central NY. Tiffany Fleming, at Boyce Thompson Research Institute, received funding from the Northeast Sun Grant Center for a switchgrass germination study for curriculum development. The basis for this research project came directly from outreach conducted by Hilary Mayton and Alan Taylor. Both Hilary and Alan are Co-project investigators for the project “Community germination studies for biomass feedstocks in New York State: An outreach module for student-driven authentic research in high school science classrooms.”

Farm Success Stories

By far the greatest success story is our collaborative effort with Tom Lee, owner of Second Chance Farm, Madrid, NY (lonelee@whmail.com). When the project started, Tom had zero acres of warm season perennial grasses on his farm. With funding from the NYFVI in 2007, our program established a 5-acre strip trial on his farm. Since then he has planted an additional 37 acres of switchgrass on his own and now has a total of 42 acres. He has hosted several field day events in collaboration with our project and has worked separately with several other groups (in St. Lawrence Co.) to demonstrate the potential for warm season grass production and utilization in NY. Several media publications have been released on the success of his farm operation.

Photos, Presentations, Charts, Publications

Project publications (Project generated publications Final.pdf)
4/28/12 Project generated publications

switchgrass disease poster (SwitchgrassDisPoster7 29 11.pdf)
4/28/12 Switchgrass disease poster

2011 Project summary (2011 WSPG Summary.pdf)
4/28/12 2011 Project summary

Project presentations (Project Presentations NYFVI Final List.pdf)
4/28/12 Project presentations

2011 Photos (2011NYFVIPhotos.pdf)
4/28/12 Project pictures 2011

2010 Photos (2010NYFVIPhotos.pdf)
4/28/12 Project pictures 2010

Final Report Summary Statement

The project obtained practical agronomic and variety information on warm season perennial grasses for bioenergy production. Switchgrass varieties Cave-in-rock, Blackwell, and Shawnee out yielded other grasses, averaging 4 to 7 tons per acre without fertilizer. Bioenergy crop usage has technical hurdles in pellet and stove manufacturing, and economical conversion to liquid fuels. Furthermore, high commodity prices are driving crop systems to annual grain production. Markets for bioenergy crops are underdeveloped. When they emerge, biomass from low input grass systems will be profitable and economically viable. Seed quality and stand establishment impacted yield. Pest pressure on these grasses
should be monitored as acreage increases. Research for improvements in seed, seedling vigor, and pest resistance will enhance establishment on marginal lands. Warm season grasses grown on marginal land will optimize producers’ resources through sustainable low input production. In addition, they will contribute to energy independence and enhance economic vitality of farm operations.