Sustainable Development of Perennial Grass Bioenergy on Marginal Soils of New York

Marginal lands constitute the primary land base available for development of both grass and short-rotation woody perennial bioenergy crops in NY and the Northeast. Use of marginal lands for bioenergy can help defuse food vs. fuel competition for prime farmland, provide regionally-distributed sources of energy products, and can prevent reversion of idle lands to scrub.

“Marginal” (a term whose meaning varies regionally) in NY commonly means seasonally wet, poorly drained, and sometimes susceptible to drought in summer. Perennial crops that require minimal soil disturbance once established are a good match for these soils. Unfortunately, the research base on perennial bioenergy grass production and impacts on these soils is very thin, especially for NY and the Northeast. Our goal is to carry out research on marginal soils, assessing crops yields as well as soil and emission impacts for both switchgrass and reed canarygrass.

Primary project  Our core project is a five-year study funded under the first round of the USDA/NIFA Sustainable Bioenergy program. It is being carried out by the Departments of Biological & Environmental Engineering (Soil & Water Group) and Plant Breeding & Genetics at Cornell, with collaboration from Beneterra Agritech, SUNY Cobleskill, SUNY Morrisville and the University of Guelph. We will monitor not only crop yields but also the potential for soil carbon accumulation (sequestration) to take place as extensive rooting systems develop. We will also measure emissions of several key trace-level gases – nitrous oxide [N₂O] and methane [CH₄] – which have a strong impact on the overall “emissions footprint” of the production system. N₂O is a byproduct of denitrification, especially in soils that are partly saturated; application of fertilizer N to crops on seasonally wet soils thus has the potential to increase emissions. It is a persistent gas once in the atmosphere and it catalyzes destruction of atmospheric ozone.

The primary research site is a large field trial at Cornell University. We are completing development of a 16 acre site (Figure 1) near campus which has been historically underutilized due to poor drainage, the worst of which we have addressed. At first glance it appears to be a simple large scale field trial in which four treatments (switchgrass, switchgrass plus N fertilizer, reed canarygrass plus N, and pre-existing grassland as control) are being operated in four replicates each. However, the site was chosen for the fact that each test strip (~1 acre) contains a range of soil moisture conditions that vary from moderately well-drained to poorly drained. Five intensive sampling plots placed within each test strip will allow us to test how this difference in soil drainage status will affect biomass yield, soil carbon trends and emissions.

Figure 1. Primary research site at Cornell with quadruplicate test strips (each ~1 acre) representing four crop treatments.
A micrometerological soils emissions system (Figure 2) will monitor nitrous oxide emission trends at field scale, while periodic testing campaigns using small chambers will allow us to compare the effects among treatments (crop and soil moisture status) on both nitrous oxide and methane releases.

We are also carrying out similar research – although less intensively – at several satellite field sites in NY, which will allow us to examine results under a wider range of soil types.

**Additional work** The experimental sites are of sufficient scale to support additional collaborative research. Expanded testing\(^2\) to be carried out under a new Hatch (federal formula funds) project will allow us to more carefully track soil health parameters (water holding capacity, aggregate stability, hardness, etc.), specific forms of soil carbon, and NPK nutrient flows at the experimental sites.

Our overall intended outcome is to support sustainable perennial grass production in NY’s marginal lands. Near term outcomes include a better understanding of how the range of soil drainage status in marginal soils affects yields, soil carbon accumulation, and trace gas emissions. In the latter stages of the projects we will develop spatial tools that will help predict yields and impacts from site soil, topographic and hydrologic inputs.

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**Project details**
\(^1\)Carbon sequestration and gaseous emissions in perennial grass bioenergy cropping systems in the Northeastern US. USDA/NIFA/AFRI Grant No. 2010-03869 (Dr. Nancy Cavallaro, program leader). Investigators and researchers include Brian Richards, Hilary Mayton, Cathelijne Stoof, Don Viands, Tammo Steenhuis, Todd Walter, Larry Geohring, Ryan Crawford, and Julie Hansen, in collaboration with Doug Goodale (SUNY Cobleskill, Ben Ballard (SUNY Morrisville), Jon Warland (University of Guelph) and John Osborn (Beneterra Agritech). Switchgrass seed donated by Ernst Conservation Seeds.


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