Creating a Sustainable Biofuels and Bioproducts System for the Midwest

Reaching Our Objectives:

More than 40 million acres of land within the Central United States could be shifted from row crop production to perennial crops, reducing runoff of agricultural nutrients and helping to make agriculture more sustainable and profitable.

Since 2012, CenUSA’s systems approach has made important contributions to this goal, laying the groundwork for a sustainable, regional system for biofuels and bioproducts.

Feedstock Development

Plant breeders from USDA ARS created ‘Liberty’, a new switchgrass variety which yields 40% higher and is widely adapted throughout the Midwest, by combining yield traits from southern lowland types with winterhardiness of upland types.

Eight gene pools of switchgrass were identified, which could improve commercial varieties, and an NIR calibration to analyze switchgrass properties was developed.

Sustainable Feedstock Production Systems

Researchers created an extensive library of information on leading bioenergy crops through a network of 14 research fields across the Central United States. Result: 28-peer reviewed publications. They developed best management practices for growing and managing switchgrass, showing that it is well-suited to marginal soils where crops like corn and soybean are less productive.

Feedstock Logistics

Engineers designed methods and equipment that decreased field drying time of switchgrass by 50%, increased bale densities and reduced grinding energy, thereby improving harvest, handling and transportation efficiency, and storage costs.

The project team developed methods to determine optimal machinery selection for switchgrass harvest and transportation, evaluated different switchgrass storage scenarios and conducted an analysis of feedstock supply costs.

System Performance Metrics, Data Collection, Modeling, Analysis, and Tools

A multidisciplinary scientific team assessed the impacts of introducing switchgrass and miscanthus, perennial biofuel crops, on cropland exceeding 2% slopes for watersheds in Indiana, Iowa and across the Corn Belt. When the grasses were introduced, nitrate, total P or sediment losses were found to decrease between 1% to 52%, depending on the combinations of pollutants and the watershed system.
Feedstock Conversion/Refining

A new way of looking at the pyrolytic process—using perennial grasses in a thermal process to extract sugars and then substitute the sugars in a traditional fermentation—was developed. This technology, along with Renmatix’s supercritical hydrolysis and ADM’s acetosolv processing, will lead to conversion of grasses into biofuels and value-added products such as biochar, bioasphalt, cellulose pulp, fermentable sugars and carbon fibers.

Markets and Distribution

Researchers developed production cost estimates for switchgrass, using best production practices for the Midwest. From those, a new decision tool was created that guides producers in understanding how net returns to switchgrass production on their land compare with alternative land uses.

Based on market experiences of commercial cellulosic production, economists show that conventional agricultural systems do not supply enough residues to meet the cellulosic ethanol mandate, leaving room for grasses and other biomass to be competitive in that market.

Health and Safety

A new probabilistic risk assessment model was developed to estimate the difference in human safety risk between two agricultural production systems over a region. The model will improve the understanding of risks in biomass feedstock production as compared to the current crop production systems.

Results were presented at professional meetings and in journal and Extension publications.

Education

Sixty-six students went through CenUSA’s undergraduate interdisciplinary internship program in which interns worked on research projects at several universities.

Seventeen online education modules were created, covering relevant topics across the bioenergy supply chain.

The Massive Open Online Course (MOOC): Introduction to Perennial Grasses for Biofuels was created, using CenUSA education and extension materials. It is a packaged curriculum, allowing free public access to an online self-paced learning experience for farmers, industry leaders and students.

Extension and Outreach

More than 5,000 farmers and agricultural industry leaders, 600 Extension Educators, 3,000 youth and 6,000 gardeners/horticulturalists gained new knowledge of CenUSA research by participating in seminars, workshops, field days, conferences, and camps.

A range of decision support tools and easy-to-use information on seeding rate, planting depth and equipment, weed control, harvest, crop yield, soil health and fertility are found in more than 50 publications and videos created by the CenUSA team and archived on the eXtension and CenUSA Bioenergy websites.

Commercialization

Results of partnerships with commercial businesses:

- Renmatix patented a process that could lead to cost-effective production of industrial sugars from perennial grasses on a commercial scale.
- Archer Daniels Midland is testing pulping potential of perennial grasses for use in producing personal care products such as paper towels and toilet paper.
- Vermeer Corp. advised CenUSA and hosted demonstration plots of switchgrass and other perennial grasses.