



CenUSA Extension and Outreach: Perennial Grass Bioenergy Research and Knowhow for Producers, Students and Stakeholders

Bioenergy research is translated into practical know-how by extension educators, farmers and Master Gardeners.

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The CenUSA Extension and Outreach Team

On the streets, in the fields, and online, the CenUSA Extension and Outreach Team collaborators (<https://cenusa.iastate.edu/outreach-extension>) deliver programming and educational materials critical to the CenUSA Bioenergy vision.

The mission of the Extension team was to help farmers and others learn about the environmental impacts of perennial grass production and utilization of biochar, best practices for growing and supplying perennial grasses for the biofuels/bioproducts industry, potential markets that may develop for the grasses; and to help farmers evaluate how grasses might work in their operations once a market develops.

Accomplishing this mission was a team effort led by Project Co-Directors Jill Euken and Sorrel Brown from Iowa State University, along with 33 collaborators from seven universities and volunteer Extension Master Gardeners from Minnesota and Iowa.



Citizen Science and Farm Research Provide Hands-On Learning

Under the direction of professional scientists and their institutions, citizen science projects amplified the impact of the CenUSA program. Farm demonstration sites and garden research plots provided hands-on learning opportunities for participants and produced valuable research data for CenUSA to share with the public.



Figure 1. CenUSA Bioenergy field day in Dawson, NE. Photo: CenUSA

Extension and outreach professionals and farmers in Indiana, Iowa, Minnesota, and Nebraska established nine on-farm demonstration sites. Farmers established plots, collected data, and shared information with others at field days. Extension agents provided guidance, organized the field days, tours of plots, and informational meetings, which eventually reached more than 5,000 agricultural producers, consultants, and agricultural industry leaders.



Figure 2. Citizen Science: Master Gardeners in MN and IA conduct biocar research



University of Minnesota Extension and outreach professionals and Extension Master Gardener volunteers established five citizen science research garden sites studying biochar (a charcoal like coproduct of pyrolyzing biomass for energy production) as a soil amendment. More than 7,000 people visited the sites and/or participated in educational programs, and exhibits.

Programs for Youth

Two groups of Extension collaborators focused specifically on youth outreach programming. Purdue University Extension and outreach professionals created interactive electronic lessons and established demonstration plots of perennial grasses for STEM (science, technology, engineering, and math) career events, reaching more than 900 high school students. [Plot or Career event Picture] Faculty and student interns at Iowa State University combined forces to create C6 BioFarm , a robust suite of STEM materials, for middle-school-aged youth <http://www.extension.iastate.edu/4h/content/c6-biofarm>. C6BioFarm includes an iPad app, supporting curricula and an iBook. These materials are available online (<http://www.extension.iastate.edu/4h/content/c6-biofarm>) to teachers and other youth mentors, such as 4-H and FFA leaders. C6BioFarm underwent two pilot tests, reaching 350 and 330 youth and adults respectively. The C6 program has been used by more than 2000 people.



Figure 3. C6 at the Iowa State Fair. Photo: CenUSA

“The main purpose of C6BioFarm is to help connect the idea that fuels can be made from renewables and to help increase options for agriculture,” said Jay Staker, director of Extension science, engineering and technology at Iowa State University and a member of



CenUSA's Extension and Outreach Team. "The sub purpose is to help people better understand agriculture production in STEM careers and the economy." (Fig. 4)



Figure 4. C6 BioFarm iPad game

Challenges

Education efforts by Extension and outreach were not without challenges. Most notable was the lack of an established market for perennial grasses – due to lack of commercial facilities to process the grasses and depressed fossil fuel prices. Without biomass markets, it was not possible (in fact, it was unethical) for team members to encourage farmers to transition acres to production of perennial grasses.

The Extension team overcame this challenge by focusing on helping people understand that markets could develop. The easily accessible educational materials generated by the project team will help farmers, industry leaders and Extension and outreach professionals move rapidly to produce perennial grasses once a market for them opens up.

Resources for Ongoing Learning

Working with CenUSA scientific researchers, the Extension team developed an in-depth portfolio of online educational materials, providing science-based information in easily understandable terms. Publications include decision support tools, fact sheets, research summaries, and videos. These educational materials will producers, industry leaders,

Extension and outreach professionals proceed quickly to produce perennial grasses when a market for them becomes more widely available. These materials are available at the CenUSA web site (<https://cenusa.iastate.edu>), and CenUSA's video sites (<https://vimeo.com/cenusabioenergy>) and <https://www.youtube.com/user/CenusaBioenergy> (<https://www.youtube.com/user/CenusaBioenergy>)).

Contributors to this Report

Authors

- **Jill Euken**, Deputy Director, Bioeconomy Institute, <http://www.biorenew.iastate.edu/> at Iowa State University
- **Amy Kohmetscher**, Distance Education Specialist, The Ohio State University
- **Susan J. Harlow**, Freelance Journalist

CenUSA Feedstock Conversion, Refining and Biofuel Co-Products Team Publications

CenUSA Project Resources - Research-based information on the opportunities and challenges in developing a sustainable system for the thermochemical production of biofuels from perennial grasses grown on land marginal for row crop production is available at www.cenusa.iastate.edu

Fact Sheets, Guides and Articles

Biochar: Prospects of Commercialization. 2014. David Laird and Pam Porter. https://cenusa.iastate.edu/files/cenusa_2019_018.pdf

- CenUSA Biochar Research Flyer (PDF). David Laird and Jill Euken. https://cenusa.iastate.edu/files/cenusa_2019_055.pdf

CenUSA Feedstock Conversion, Refining and Co-Products and-co-products. 2017. Ryan Smith. https://cenusa.iastate.edu/files/cenusa_2019_004.pdf

CenUSA Extension and Outreach: Perennial Grass Bioenergy Research and Knowhow for Producers, Students and Stakeholders. 2017. Jill Euken. https://cenusa.iastate.edu/files/cenusa_2019_005.pdf

CenUSA Feedstock Development Creates Improved Switchgrass Varieties. 2017. Michael Casler & Susan Harlow. https://cenusa.iastate.edu/files/cenusa_2019_001.pdf



CenUSA Feedstock Logistics: Innovative Systems for Harvest, Transportation, and Storage of Perennial Grass Biomass - Kevin Shinnars. 2017.

https://cenusa.iastate.edu/files/cenusa_2019_002.pdf

Control Weeds in Switchgrass (*Panicum Virgatum* L.) Grown for Biomass. Rob Mitchell. 2014. https://cenusa.iastate.edu/files/cenusa_2019_009.pdf

Economics of Switchgrass for Biofuel. Richard Perrin. 2014.

https://cenusa.iastate.edu/files/cenusa_2019_021.pdf

Estimated Cost of Establishment and Production of "Liberty" Switchgrass: Perennial Grass Decision Support Tool. Mainul Hoque, Georgeanne Artz & Chad Hart. 2015.

https://cenusa.iastate.edu/files/cenusa_2019_015.pdf

Fast Pyrolysis Efficiently Turns Biomass into Renewable Fuels. Robert Brown. 2015.

https://cenusa.iastate.edu/files/cenusa_2019_019.pdf

Guidelines to Growing Perennial Grasses for Biofuel and Bioproducts. Rob Mitchell. 2017. https://cenusa.iastate.edu/files/cenusa_2019_010.pdf

- Logistical Challenges to Switchgrass (*Panicum virgatum* L.) as a Bioenergy Crop- Amy Kohmetscher & Stuart Birrell. 2013. https://cenusa.iastate.edu/files/cenusa_2019_016.pdf

Master Gardeners' Safety Precautions for Handling, Applying and Storing Biochar. Charles Schwab & Mark Hanna. 2012.

https://cenusa.iastate.edu/files/cenusa_2019_023.pdf

- Plant Breeders Create New and Better Switchgrass Varieties for Biofuels. Michael Casler. 2016. https://cenusa.iastate.edu/files/cenusa_2019_011.pdf

Storing Perennial Grasses Grown for Biofuel. Kevin Shinnars. 2015.

https://cenusa.iastate.edu/files/cenusa_2019_017.pdf

Successfully Harvest Switchgrass Grown for Biofuel. Kevin Shinnars & Pam Porter. 2017. https://cenusa.iastate.edu/files/cenusa_2019_014.pdf

Switchgrass (*Panicum virgatum*) for Biofuel Production. Rob Mitchell. 2016.

https://cenusa.iastate.edu/files/cenusa_2019_008.pdf

Switchgrass (*Panicum virgatum* L) Stand Establishment: Key Factors for Success. Rob Mitchell. 2013. https://cenusa.iastate.edu/files/cenusa_2019_012.pdf

Test Plots Show How Perennial Grasses Can Be Grown for Biofuels. Rob Mitchell, Jeff Volenec. 2013. https://cenusa.iastate.edu/files/cenusa_2019_013.pdf



Utilization of Mature Switchgrass as Roughage in Feedlot Diets. Chris Clark & Dan Loy. 2016. https://cenusa.iastate.edu/files/cenusa_2019_022.pdf

Research Summaries and Case Studies

Switchgrass Hay Could Be a Useful Roughage in Beef Diets While Offering a Market Alternative to Biofuels. Chris Clark. 2017.

https://cenusa.iastate.edu/files/cenusa_2019_032.pdf

- Biochar Can Improve the Sustainability of Stover Removal for Bioenergy. David Laird. 2013. https://cenusa.iastate.edu/files/cenusa_2019_026.pdf

Biofuel Quality Improved by Delaying Harvest of Perennial Grass. Emily Heaton. 2017. https://cenusa.iastate.edu/files/cenusa_2019_027.pdf

Competition for Land Use: Why Would a Rational Producer Grow Switchgrass for Biofuel? Keri Jacobs. 2015. https://cenusa.iastate.edu/files/cenusa_2019_031.pdf

Making Business Decisions with Precision Data Can Encourage Perennial Grass Production. Susan Harlow. 2016.

https://cenusa.iastate.edu/files/cenusa_2019_006.pdf

Management Practices Impact Greenhouse Gas Emissions in the Harvest of Corn Stover for Biofuels. Virginia Jin. 2015.

https://cenusa.iastate.edu/files/cenusa_2019_028.pdf

Minnesota Watershed Nitrogen Reduction Planning Tool. Bill Lazarus. 2015.

https://cenusa.iastate.edu/files/cenusa_2019_029.pdf

Near-Infrared (NIR) Analysis Provides Efficient Evaluation of Biomass Samples- Bruce Dien. 2015. https://cenusa.iastate.edu/files/cenusa_2019_024.pdf

Research Finds Strong Genetic Diversity in Switchgrass Gene Pools. Michael Casler. 2017. https://cenusa.iastate.edu/files/cenusa_2019_025.pdf

Case Study: Renmatix Processes Biomass into Sugars for Industrial Use. Susan Harlow. 2016. https://cenusa.iastate.edu/files/cenusa_2019_007.pdf

2014 Extension Master Gardener's CenUSA Biochar Demonstration Gardens: Is biochar a good soil amendment for home gardens? Lynn Hagen

https://cenusa.iastate.edu/files/cenusa_2019_030.pdf



FAQs (Frequently Asked Questions)

Can I use my regular haying equipment to harvest switchgrass grown for biofuel? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

Can the use of conservation tillage help reduce greenhouse gas emissions from cropland soils where residues are used for biofuel? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

Can you feed switchgrass to livestock until a biofuel market develops for it? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

How can I get a switchgrass crop to dry faster in the field once it's been cut for biomass? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

How can I reduce dry matter losses to a biomass crop during storage? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

How do I grow switchgrass to provide biomass to be used in the production of biofuels? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

How high should I cut switchgrass? I am growing it as a bioenergy crop. https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

Is there a market for switchgrass for biofuel and how do I get started? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

Should I begin establishing switchgrass in case they put a cellulosic ethanol plant near by? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

Should I fertilize switchgrass when I plant it? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

What effects do corn stover removal rates have on greenhouse gas emissions from cropland? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

When should I plant switchgrass? https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

Why is it important to be able to grow a consistent and uniform



supply of a biomass feedstock?

https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

Will switchgrass grow well in my region?

https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

Will weeds be a problem after my switchgrass stand is established?

https://cenusa.iastate.edu/files/cenusa_2019_faq.pdf

Webinars

Aphid Resistance in Switchgrass CenUSA Bioenergy - Kyle Koch,

<https://www.youtube.com/watch?v=jIfZVGmbVHQ>

- Biochar 101: An Intro to Biochar - Kurt Spokas.
<https://www.youtube.com/watch?v=qL2LmAEIsU4>
- Biochar and Beyond with ARTi - Matt Kieffer, Juan Proano and Bernardo del Campo. <http://bit.ly/1opLBfG>
- Competition for Land Use: Why would the rational producer grow switchgrass for biofuel? - Keri Jacobs.
<https://www.youtube.com/watch?v=nQbWCdMHggE>

Diversifying Cellulosic Feedstocks. DK Lee.

<https://www.youtube.com/watch?v=xNxP01ou9IM>

- Overview of Switchgrass Diseases - Stephen Wegulo.
<https://www.youtube.com/watch?v=xYKAYfKRHVs>
- Perennial Herbaceous Biomass Production and Harvest in the Prairie Pothole Region of the Northern Great Plains - Susan Rupp.
https://www.youtube.com/watch?v=_gCaHpfKcJY
- Role of Biochar in Achieving a Carbon Negative Economy. David Laird
- Safety Issues in On-Farm Biomass Production - Douglas Schaufler.
<https://learn.extension.org/events/1406>
- Switchgrass and Bioenergy Crop Logistics. Stuart Birrell
<https://www.youtube.com/watch?v=OGEd4KZOE2Q>
- Switchgrass and Perennial Grasses, Biomass and Biofuels, Part 1 (Captions)- Ken Vogel. <https://www.youtube.com/watch?v=N1FcOSbRkfm>
- Switchgrass and Perennial Grasses, Biomass and Biofuels, Part 2- Ken Vogel.
<https://www.youtube.com/watch?v=QDkIHRGh6PI>



- Switchgrass Cost of Production - Marty Schmer.
https://www.youtube.com/watch?v=AsrWGhjr4_Y
- Switchgrass Decision Tool – Keri Jacobs and Chad Hart.
<https://www.extension.iastate.edu/agdm/crops/html/a1-29.html>
- Switchgrass Economics in the North Central Region of the USA (Captioned) - Richard Perrin. <https://www.youtube.com/watch?v=FMqPIA5C4kk>
- Switchgrass Establishment, Weed Control, and Seed Quality– Rob Mitchell.
<https://www.youtube.com/watch?v=7xVFMqBvCvQ>
- Switchgrass Production Industry Perspectives - David Stock.
<https://www.youtube.com/watch?v=xPjG44eyDOI>
- Thermochemical Conversion of Biomass to Drop-In Biofuels – Robert Brown.
<https://www.youtube.com/watch?v=Ua8She55qTc>
- Thermochemical Option: Biomass to Fuel – Robert Brown.
<https://www.youtube.com/watch?v=6dkV9OKw2F8>

Instructional Video

- Biochar: An Introduction to an Industry - David Laird.
<https://www.youtube.com/watch?v=Vccp-zcYvdg>
- CenUSA Bioenergy-Opportunities in Biofuel.
<https://www.youtube.com/watch?v=VrisN7RliRo>
- The CenUSA Legacy - Pam Porter.
https://www.youtube.com/watch?v=yUs_5vOGgAI
- 2012 CenUSA Bioenergy Overview.
<https://www.youtube.com/watch?v=VrisN7RliRo>
- 2012 CenUSA Bioenergy Farmer Focus - Kevin Ross.
<https://www.youtube.com/watch?v=Ve8IwPMFchq>
- CenUSA Bioenergy 2015 Summer Undergraduate Research Internship - Raj Raman.
<https://www.youtube.com/watch?v=jD6MqMTSzgc>
- No-Till Drill Calibration Training Video (+Captions) – Rob Mitchell [Needs Link].
<https://www.youtube.com/watch?v=izBHivo5xfw>
- Commercialization Update: Opportunities for Perennial Biofeedstocks - Rob Mitchell.
<https://www.youtube.com/watch?v=jtrGuZ-DDAs>



- Enhancing the Mississippi Watershed with Perennial Bioenergy Crops - Pam Porter.
<https://www.youtube.com/watch?v=87UHZn73Yj4>
- Entomology Research: Examining Insect Populations and Exploring Natural Plant Resistance (Captions) - Tiffany Heng-Moss.
<https://www.youtube.com/watch?v=zml0BMJ-NRY>
- Harvesting Native Grass for Biofuel Production (+Captions)– Rob Mitchell.
<https://www.youtube.com/watch?v=ybDGWJa6pzc>
- Hazards of Biomass Production on Marginal Land - Douglas Schaufler,
<https://www.youtube.com/watch?v=ybDGWJa6pzc>
- How to Measure Stand Establishment Using a Grid– John Guretzky,
<https://www.youtube.com/watch?v=AXZN7-PmldU>
- Intro to No-Till Drill Calibration for Switchgrass (+Captions)– Rob Mitchell,
https://www.youtube.com/watch?v=7TPLfWLkd_U
- Optimizing Harvest of Perennial Grasses for Biofuel– Kevin Shinnors,
<https://www.youtube.com/watch?v=NMt5Ct-65-Y>
- Plant Breeding to Improve Yield and Sustainability of Perennial Grasses - Michael Casler,
<https://www.youtube.com/watch?v=jsNXBIJ-GzY>
- Plant Pathogen Risk Analysis for Bioenergy Switchgrass Grown in the Central USA - Gary Yuen,
<https://www.youtube.com/watch?v=1GdZdI5IRqQ>
- Switchgrass Planting Practices for Stand Establishment – Rob Mitchell,
<https://www.youtube.com/watch?v=vwBQ3aYpfmM>
- University of Minnesota Extension Master Gardener Biochar Research Summary - Julie Weisenhorn,
<https://www.youtube.com/watch?v=zZX7u5kjLWU>

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