

U.S. Department of Energy Bioenergy
Technologies Office
2017 Project Peer Review

The Prairie Farm: An Experiment in Bioenergy
Production, Landscape Restoration, and
Ecological Sustainability

PI: W. Carter Johnson, South Dakota State Univ.

CoPIs: Arvid Boe, Cody Zilverberg, Tom Schumacher, and
Vance Owens

Our Project Goal...

To develop a fresh, alternative approach to farming in the western corn belt by conducting farm-scale research to demonstrate how to make a sustained and earned living from restored natural grassland on converted cropland while protecting and enhancing the natural environment (multi-functional agriculture)

Multi-Functional Agriculture

“Farming produces not just food, fiber, and energy but also a host of societal benefits, including cleaner water, sequestered carbon, landscape amenities such as wetlands and wildlife habitat, and rural community employment”

-G. A. Wilson. 2007. Multifunctional Agriculture. CABI Publ.

Key Project Outcomes

- Seven-year project generated considerable hard data on the production, management, and marketing of biomass feedstock at the landscape scale to inform the nascent cellulosic biofuel industry.
- Abundant ecosystem services were recovered on low-input restored grassland creating a better balance between economics and environment than currently exists in high-input grain farming.

EcoSun Prairie Farms, Inc.

Est. April, 2007

South Dakota Non-Profit Corporation

**IRS designated as 501 (c)(3) public
charity**



EcoSun Prairie Farms, Inc.

Prairie Farm Guiding Principles

- Restoration of drained wetlands to re-establish sub-irrigated conditions for high grass biomass and seed production
- Low input approach (less iron, fuel, biocides, etc.)
- Improved water retention and quality
- Greater atmospheric health through carbon sequestration
- Improved soil quality

Guiding Principles (ctd.)

- Use perennial, not annual, plants that are locally adapted and native
- Develop multiple income streams

Income Streams

Present

- Native grass hay/biofuel feedstock
- Native plant seed (upland and wetland)
- Specialty meats (e.g., grass-fed beef)
- Competitive research funding

Future

- Carbon credits
- Cellulosic biofuels
- Recreation (ecotourism, fee hunting)

Collaborating Organizations

- **The Nature Conservancy** (\$100,000 in kind for seed)
- **U. S. Fish and Wildlife Service** (\$150,000 cost-share for seed, fencing, wetland plugs)
- **University of Minnesota** (subcontract for biofuel feedstock research \$30,000)
- **Millborn Seed Co.** (cost-share seed \$15,000)
- **Agricultural Research Service** (staff support for economics analysis)
- **POET** (forage quality analysis for ethanol production)
- **South Dakota State University** (use of farm equipment and greenhouse space)

Re-establishing upland prairie across farmed landscapes

Subproject 1



**Grass drilling in
soybean stubble**



**Aerial spreading of seeds
on snow**



Seed harvest in virgin prairie

2007



2009



Mixed diversity planting





High diversity planting

A large, conical pile of light-brown, fibrous material, identified as switchgrass seed, is the central focus of the image. The pile sits on a concrete floor inside a dark barn. In the background, there are wooden stalls, a red and white bucket, and other farm equipment. The lighting is dim, highlighting the texture of the seed.

Switchgrass seed

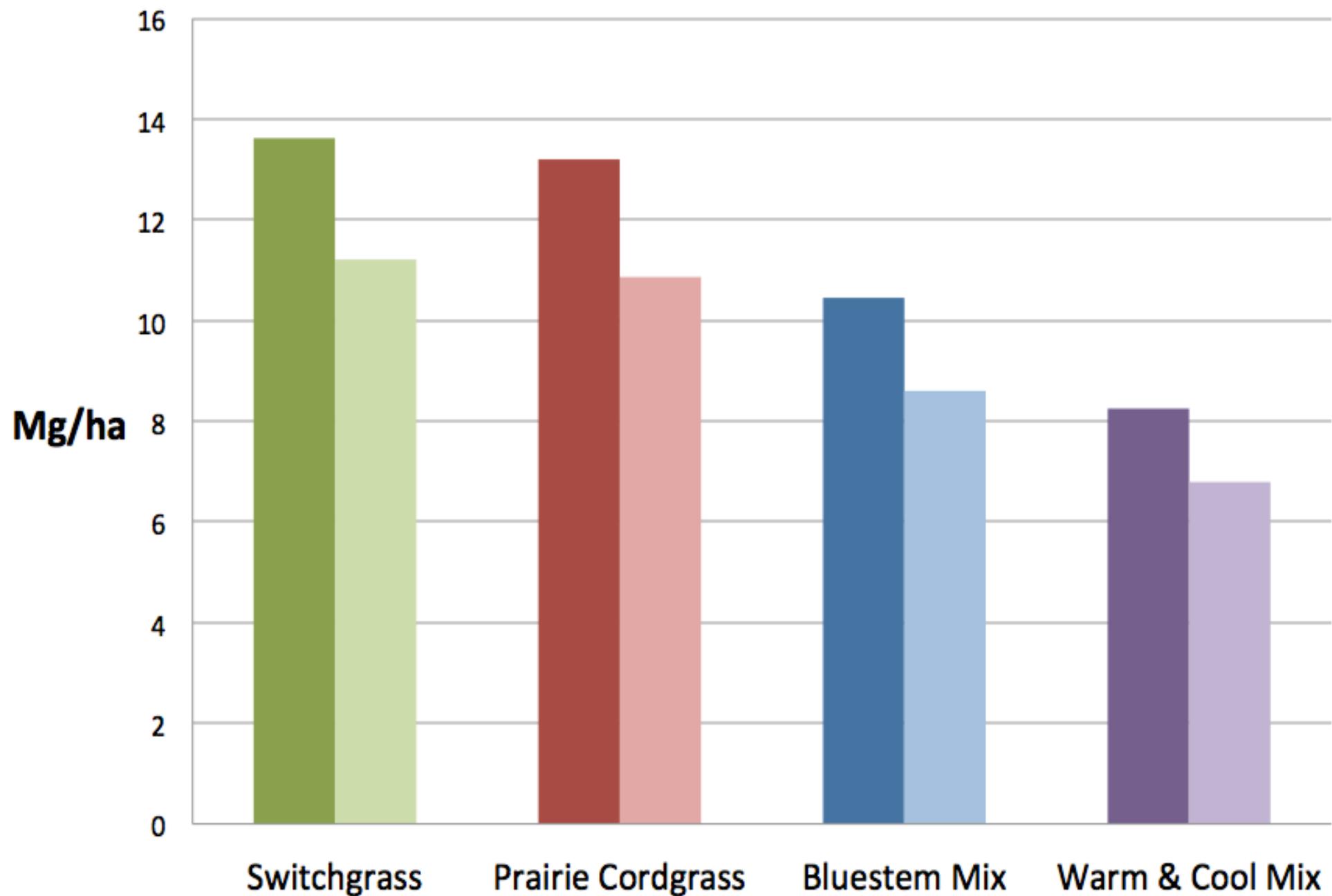


Big bluestem native hay

Prescribed fire



Mean Biomass at the Prairie Farm, 2010-2012



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ELSEVIER



Biomass yield from planted mixtures and monocultures of native prairie vegetation across a heterogeneous farm landscape



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Findings from subproject 1

- Productive, native grassland valuable as seed, hay, and biofuel feedstock can be quickly and successfully established on retired cropland.
- Three-year average biomass yields ranged from 9.7-13.2 Mg/ha for the different mixtures planted.
- A strategic placement of monocultures and mixtures of species across the farm landscape offers a livable income and desired ecosystem services.

Re-vegetating wetlands across the landscape

Subproject 2



Construction of ditch plug



Berm reconstruction



After reconstruction



Planting cordgrass plugs



Planted Cordgrass



First-year cordgrass

2008



2009



A photograph of two women standing in a field of tall, green cordgrass. The woman on the left has reddish-brown hair and is wearing a white button-down shirt under a light-colored blazer. The woman on the right has short white hair and is wearing a red polo shirt and sunglasses. Both women are smiling and holding stalks of the grass. The background shows a vast field of similar grass under a bright sky.

Mature prairie cordgrass



**Cordgrass plugging
with tree planter**



Prescribed burn in wetland



Haying in dry wetland



Growing *Spartina pectinata* in Previously Farmed Prairie Wetlands for Economic and Ecological Benefits

Cody J. Zilverberg • W. Carter Johnson • Arvid Boe •
Vance Owens • David W. Archer • Craig Novotny •
Malia Volke • Brett Werner

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Abstract Wetlands in the Prairie Pothole Region of the U.S. are threatened by continued drainage and conversion to cropland. Commercial incentives may increase wetland restoration in lieu of easements. Therefore, we evaluated two commercially available populations of prairie cordgrass (*Spartina pectinata* Link) by comparing two planting techniques and identifying zones of maximum plant vigor and biomass pro-

second experiment, 2 years after establishing plants by transplanting at 0.9- or 1.5-m spacing, biomass no longer differed between treatments. Our economic analysis indicated establishment costs could be recovered with < 10 years of biomass and seed harvests. Because prairie cordgrass can be established using conventional techniques and provides positive net revenue, it should be considered for incorporation into

Findings from subproject 2

- Wet soils limit planting options in wetlands; plugging was labor intensive but highly successful.
- Prairie cordgrass, a wetland obligate plant, yielded the highest biomass of all plantings.
- Restoring wetlands with native, economically valuable plants such as cordgrass produced the highest per acre farm income from seed and hay sales.

Grass-Fed Beef



Mortenson Ranch Heifers

Prairie-Raised Beef



EcoSun Prairie Farms

Brookings, SD

www.ecosunprairiefarms.org



Marketing grass-fed beef

Increasing biodiversity in switchgrass plantings

Subproject 3

Pairing
experiments

Switchgrass
and Canada
Milkvetch (upper
photo)



Big bluestem and
shorter pairings
(lower photo)

Findings from subproject 3: Increasing switchgrass biodiversity

- Reliance on switchgrass monocultures for biofuel feedstock may miss opportunities for higher biomass and more ecosystem services.
- Certain native species, such as little bluestem, prairie cordgrass, and cup plant out-produce switchgrass on more extreme sites in heterogeneous fields.
- Tailoring mixtures of plants including forbs (flowers) to soils where they are best adapted for growth increases whole field biomass and numbers of insect pollinators, butterflies, and wildlife.



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Strategic use of native species on environmental gradients increases diversity and biomass relative to switchgrass monocultures



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ABSTRACT

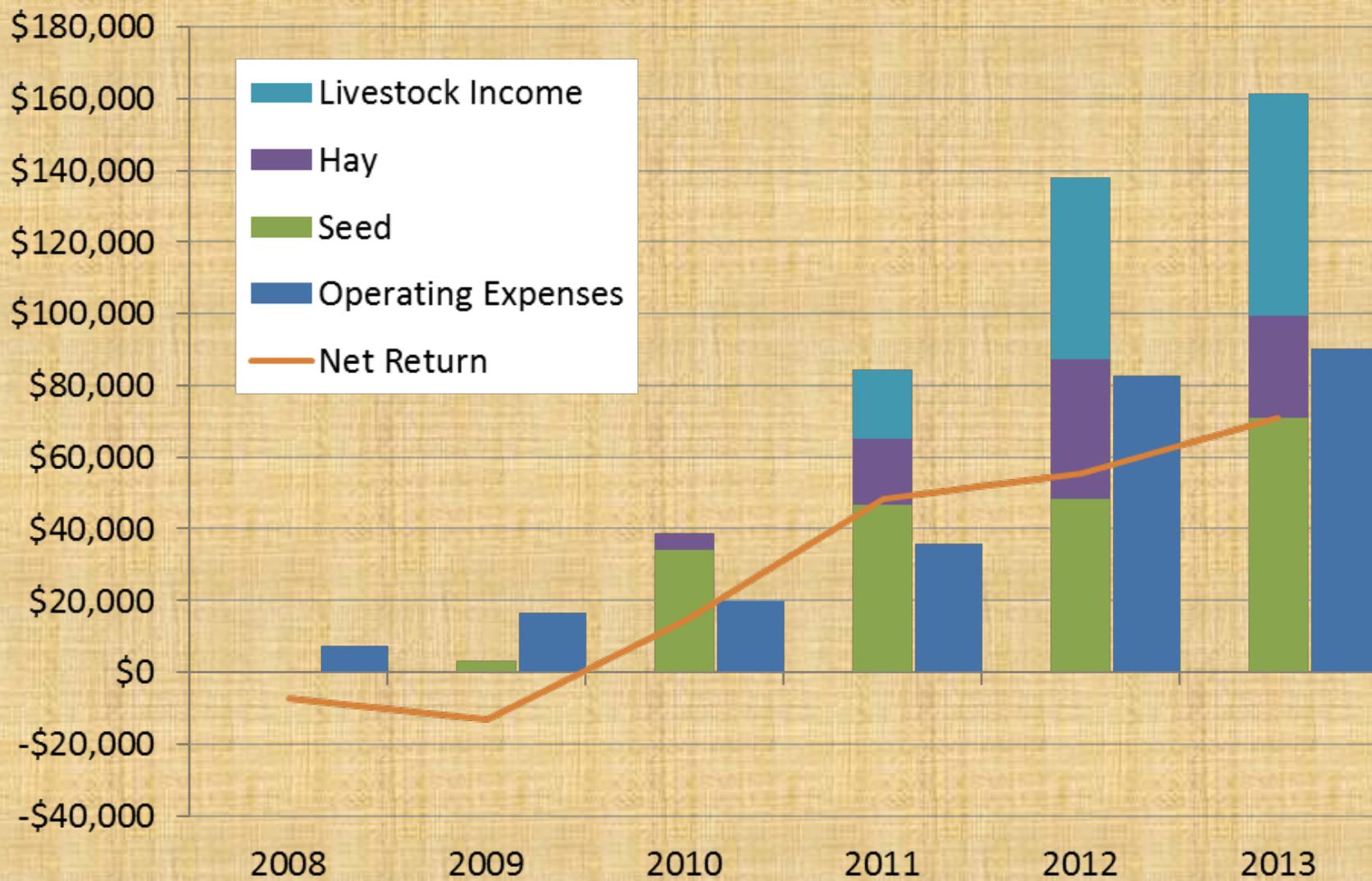
Switchgrass (*Panicum virgatum*) monocultures are a leading feedstock choice for producing cellulosic biofuels. However, in natural stands, switchgrass is only dominant in a narrow ecological niche of the Tallgrass Prairie. This suggests that strategically selected monocultures or binary mixtures of species,

“Grassonomics”

**Payoff for landscape
restoration**

Grassland Products Sold in 2014

- Hay (summer and fall cut) ~ 400 tons
- Prairie-raised beef (retail and wholesale ~ 5,000 pounds
- Native plant seed (switchgrass, cordgrass, sedge, wedgegrass) ~ 8,000 pounds



Profitable prairie restoration: The EcoSun Prairie Farm experiment

Cody Zilverberg, W. Carter Johnson, David Archer, Scott Kronberg, Thomas Schumacher, Arvid Boe, and Craig Novotny

Ongoing conversion of grassland to cropland in the northern Great Plains, declining wildlife populations, and worsening soil and water quality prompted a South Dakota group to search for agricultural practices that would balance environmental concerns with farm economics. Thus was

Dakota. Guaranteeing five years was important for EcoSun because of the investment required to restore prairie and the low yields obtained from perennial plants in the establishment year. Restoration efforts began in 2008 with establishment of 24 ha (60 ac) of switchgrass (*Panicum virgatum*) monocultures

harvested, the only income was from switchgrass seed. The next year, a small quantity of summer hay and native wetland plant seed was added. By year five, the farm was generating revenue from many different sources: seed harvested from three grass species planted in monocultures (switchgrass: 3,435



A Service of SDSU Extension

The EcoSun Prairie Farm: **An Experiment in Bioenergy Production, Landscape Restoration, and Ecological Sustainability**

Cody J. Zilverberg
W. Carter Johnson
David Archer
Thomas Schumacher
Arvid Boe

Summary

- Seven-year project generated considerable hard data on the production, management, and marketing of biomass feedstock at the landscape scale to inform the nascent cellulosic biofuel industry.
- Abundant ecosystem services were recovered on low-input restored grassland creating a better balance between economics and environment than currently exists in high-input grain farming.

**“I Am The Grass.....
Let Me Work”**

Carl Sandburg “Grass” 1918

Outreach, publications & funding

DOCUMENTARY FILM

Grass Roots: The Prairie Farm Story (40 minutes runtime). Available at:
<http://www.thegrassrootsfilm.com/>

POST-DOCTORAL RESEARCHERS

Chang Oh Hong and Cody Zilverberg.

GRADUATE STUDENTS & GRADUATE THESES

Teoh, K.H. 2015. Improving ecosystem services and yield of bioenergy feedstocks through topographically matched polycultures. MS thesis. South Dakota State University, Brookings, SD.

Bourlion, N. 2012. Private and public benefits of innovative mix crop systems intended for biofuels production in eastern South Dakota. MS thesis. South Dakota State University, Brookings, SD.

Simon, B. 2012. Prairie wedgegrass: life history and potential for wetland restoration. South Dakota State University. Brookings, SD.

Heimerl, R.K. 2011. Comparisons of soil within a till plain across contrasting land uses. MS Thesis. South Dakota State University.

Vahyasala, I.E. 2011. Soil structure changes in bioenergy crop management systems. Ph.D. Dissertation, South Dakota State University. Brookings, SD.

Erickson, L. thesis in preparation.

UNDERGRADUATE STUDENT WORKERS

Erin Beck, Nathan Ulmer, Levi Waddell, Levi Ringquist, Michael Mulvey, Charles Brunel, Seth Owens, Alan Mayer, and Ben Stout. The EcoSan Prairie Farm was also the central subject of Erin Beck's undergraduate honors project, "EcoSan Prairie Farms in Retrospect: Assessing a Sustainable Grass Farm Model" (May 2015).

FARM TOURS (SAMPLE OF THE MANY TOURS PROVIDED)

- 28 Aug. 2014. Farm tour with Jeff Oien, Tatanka Wetland Bank, Crooks, SD.
- 2 Aug. 2014. Farm tour with farmers from Willow Creek Farm, Heron Lake, Minnesota.
- 17 Oct. 2013. Farm tour with Dr. Craig Spencer and ecology class from Augustana College.
- 23 Sept. 2013. Farm tour with Dr. Carol Johnston and Wetland Ecology class from SDSU.
- 6 Sept. 2013. Farm tour with woman farmer's group from Nebraska.
- 20 Oct. 2013. Agricultural economics class led by Dr. Mike Miller from SDSU.
- 26 July 2013. Focused field tour open to invited stakeholders.
- 24 June 2013. Farm tour with Dr. Craig Spencer and an ecology class from Augustana College.
- 2 Oct. 2012. Farm tour with Dr. Mike Miller and economics class from SDSU.
- 20 Sept. 2012. Grassland ecology class (OLLI organization) led by Dr. Larry Tieszen (EROS and Augustana College).
- 3 Aug. 2012. Economics of grass farming. Public field tour.
- 9 July 2012. Farm tour with Dr. Meghan Jarchow, USD.
- 2 May 2012. Farm tour with staff from non-point source program SD DENR.
- 10 Oct. 2011. Farm tour with staff from POET.
- 15 Aug. 2011. Julia Ness of Land Stewardship Project and America's Grasslands: Status, Threats and Opportunities Conference.
- 1 Aug. 2011. Farm tour with 20 students from Virginia Tech.
- 15 July 2011. Public field tour.
- 2 Nov. 2010. Farm tour with Chris Mixat, Graduate Student, SDSU.
- 26 Oct. 2010. Farm tour with staff from Millborn Seed Co.

- 16 Aug. 2010. Prairie establishment for biofuels and wildlife. Public field tour.
- 8 Oct. 2009. Farm tour with Jerry Wilson, writer, *SD Magazine*.
- 20 Aug. 2009. Farm tour with Kurt Spence.
- 19 Aug. 2009. Farm tour with Todd Mortenson (SD rancher).
- 24 July 2009. Farm tour with Dr. Meghann Jarchow, current faculty member and sustainability program director, University of South Dakota, Vermillion.
- 3 June 2009. Field tour with Dr. Laura Jackson, current Director of the Tall Grass Prairie Center, UNI, Cedar Falls, IA.
- 30 Sept. 2009. Agriculture for a changing environment: discussion of carbon and energy enterprise and research in agriculture.



PEER-REVIEWED PUBLICATIONS

- Zilverberg, C.J., K. Tooh, A. Boe, W.C. Johnson, and V. Owens. 2016. Strategic use of native species on environmental gradients increases diversity and biomass relative to switchgrass monocultures. *Agriculture, Ecosystems and Environment* 215:110-121.
- Schumacher, T, A Eynard, R Chintala. 2015. Rapid cost-effective analysis of microbial activity in soils using modified fluorescein diacetate method. *Environmental Science and Pollution Research* 22:4759-4762.
- Olson, K.R., A.N. Gennadiyev, R.G. Kovach, and T.E. Schumacher. 2014. Comparison of prairie and eroded agricultural lands on soil organic carbon retention (South Dakota). *Open Journal of Soil Science* 4:136-150.
- Zilverberg, C., W.C. Johnson, D. Archer, S. Kronberg, T. Schumacher, A. Boe, and C. Novotny. 2014. Profitable prairie restoration: the EcoSun Prairie Farm experiment. *Journal of Soil and Water Conservation* 69:22A-25A.
- Zilverberg, C.J., W.C. Johnson, A. Boe, V. Owens, D. Archer, C. Novotny, M. Volke, and B. Werner. 2014. Growing *Spartina pectinata* in previously farmed prairie wetlands for economic and ecological benefits. *Wetlands* 34:853-864.
- Zilverberg, C.J., W.C. Johnson, V. Owens, A. Boe, T. Schumacher, K. Reitsma, C.O. Hong, C. Novotny, M. Volke, and B. Werner. 2014. Biomass yield from planted mixtures and monocultures of native prairie vegetation across a heterogeneous farm landscape. *Agriculture, Ecosystems, and Environment* 186:148-159.

BOOK CHAPTERS

- Kiniry, J.R., M.N. Meek, T.E. Schumacher, C.J. Zilverberg, F.B. Fritsch, and V.G. Kakani. 2014. Modeling to evaluate and manage water and environmental sustainability of bioenergy crops in the U.S. in *Advances in Agricultural Systems Modeling 5: Practical Applications of Agricultural System Models to Optimize the Use of Limited Water*. Abaja et al., ed. ASA, CSSA, SSSA. pages 139:160.
- Reitsma, K.D., R. K. Heimerl, and T.E. Schumacher. 2011. Estimating Soil Productivity and Energy Efficiency Using the USDA Websoil Survey, Soil Productivity Index Calculator, and Biofuel Energy Systems Simulator. Pp. 425 – 463, In Clay, D.E. and J. F. Shanahan (eds.) *GIS Applications in Agriculture, Volume 2: Nutrient Management for Improved Energy Efficiency*. CRC Press, Boca Raton.

OTHER PUBLICATIONS

- Brule, J. February 26, 2014. TEDx Brookings reinvents rural. *Collegian*. (Carter Johnson was one of the speakers of the first TEDx event in Brookings).
- Zilverberg, C. 2013. The Prairie Farm: bringing back grass. *Grassroots* 15(2):2. March 2013.
- Zilverberg, C.J., W.C. Johnson, and A. Boe. 2013. Increasing biodiversity of native perennial biofuel crops on the Prairie Farm. *Proceedings of the 2013 meeting of the South Dakota Academy of Science* 92:175.
- Carrels, P. 2013. The state—and fate—of prairie. *Outdoor America* (Isaac Walton League of America Quarterly Magazine). Issue no. 4, pp. 30-39.
- staff writer. 2012. Re-greening agriculture: South Dakota State University scientists create working farm that grows native grasses. *Pines and Prairie* (Sierra Club): February, 2012.
- Sorenson, L. 2012. EcoSun Tests Grass-Based Business. *Dakota Farmer* (September, 2012) by Loretta Sorenson (free-lance writer) (article reviewing economic prospects for EcoSun Prairie Farm project).
- Sorenson, L. 2012. Researchers Evaluate Grass Farming's Potential. *Hay and Forage Grower* magazine (based on interview with C. Johnson).
- Carrels, P. 2011. Remaking Prairie, Re-Greening Agriculture: Creating a Working Farm Growing Native Grass. *Prairie Fire, The Progressive Voice of the Great Plains* (centerfold article describes research and demonstration work on the Prairie Farm).
- no author listed. 2011. Second Civitas (Honors) Lecture Features Ecologist. *Augustana College Mirror* (front page: Promoting lecture by C. Johnson as part of Civitas lecture series).
- no author listed. 2011. EcoSun Prairie Farms tour planned for July 15 near Colman. July 1, 2011, *Farm Forum*.

- Reitsma, K.D., T.E. Schumacher, V.N. Owens, D.E. Clay, A. Boe, and P.J. Johnson. 2011. Switchgrass Management and Production in South Dakota. iGrow, South Dakota State University Extension. <http://igrow.org/up/resources/03-2006-2011.pdf>.
- Wilson, J. 2011. South Dakota's Best Prairies. South Dakota Magazine (Prairie Farm project featured).
- Winchester, C. 2011. Taking Grass to the Next Level: Prairie Farm Rooted in Desire to Sustain Land. Sioux Falls Argus Leader Newspaper (front page).
- Woodard, R. 2011. They're Farming a Sea of Grass: Four Ph.D.s Out to Prove Tall-Grass Farming can be Profitable. Brookings Register (front page).



PRESENTATIONS

- Zilverberg, C.J., K. Teoh, W.C. Johnson, A. Boe, and V. Owens. 2015. Increasing diversity of native biofuel plantings using simple mixtures. Presented at the 68th Society for Range Management Annual Meeting, Sacramento, CA. February 3.
- Johnson, W.C., A. Boe, V. Owens, and C.J. Zilverberg. 2014. Biofuel feedstock crops in sub-irrigated lowlands, final report. Presented at the 2014 North Central Regional Sun Grant Center Annual Meeting, 27-28 Mar., 2014. Minneapolis, MN.
- Zilverberg, C.J., W.C. Johnson, A. Boe, V. Owens, D. Archer. 2014. Increasing diversity of biofuel crops. Presented at the 2014 North Central Regional Sun Grant Center Annual Meeting, 27-28 Mar., 2014. Minneapolis, MN.
- Johnson, C. 2014. Paper for Green Week Program. "South Dakota's Prairie Landscape" SSU/SDSU, April 28, 2014.
- Johnson, C. 2014. South Dakota's Prairie Farm. SDSU Plant Science GSA "We Talk Science" seminar series, October 21, 2014.
- Johnson, C. 2014. How Would Aldo Leopold Farm. Augustana College classroom presentation, October 23, 2014.
- Johnson, C. 2014. Profitable Prairie Restoration: the Eco-Sun Prairie Farm Experiment. The Great Lakes Chapter of the Society for Ecological Restoration, University of Minnesota, March 28-29, 2014.
- Zilverberg, C.J., W.C. Johnson, and D. Archer. 2013. Restoring prairie for agricultural production and profit. America's Grasslands Conference. Manhattan, KS.
- Johnson, C. 2013. The Prairie Farm story. NFS III. Food, People and Environment. (Dr. Shelly Brandenburger).
- Zilverberg, C.J., W.C. Johnson, A. Boe, V. Owens, and D. Archer. 2013. Improving production, resilience, and biodiversity of perennial grass mixtures and monocultures as biofuel feedstocks across environmentally heterogeneous landscapes. Presented at the 2013 North

- Central Regional Sun Grant Center Annual Meeting. 26-27 Mar., 2013. Chicago, IL.
- Johnson, W.C., A. Boe, V. Owens, C. Zilverberg, and C. Novotny. 2013. Biofuel feedstock crops in sub-irrigated lowlands. Presented at the 2013 North Central Regional Sun Grant Center Annual Meeting. 26-27 Mar., 2013. Chicago, IL.
- Johnson, C. 2013. Solutions to the demise of the North American prairie. Invited guest lecture. Amherst College, Amherst, MA. September 17, 2013.
- Johnson, C. 2012. Landscape-Scale Biomass Production, Economics, and Environmental Quality. Program Review Presentation, North Central Sun Grant Research Center, Indianapolis, IN.
- Johnson, C. 2012. South Dakota's Prairie Farm, An Experiment in Ecological and Economic Sustainability. Invited Keynote, David Fee Memorial Lecture. SDSU Celebration of Faculty Excellence. February, 2012.
- Johnson, C. 2012. South Dakota's Prairie Farm. Invited Presentation, Sierra Club-Living Rivers Group, Vermillion, SD. March, 2012.
- Johnson, C. 2012. South Dakota's Prairie Farm. Invited Presentation, Earth Day Celebration at the McCrory Garden Education and Visitor Center, sponsored by SDSU and the City of Brookings. April, 2012.
- Johnson, C. 2012. Sustainable Agriculture. Guest Discussion Leader, Green Drinks Program, Tré Lounge, Sioux Falls. July, 2012.
- Johnson, C. 2012. Grass Roots: The Prairie Farm Story. Invited Presentation, S.D. Master Gardeners Annual Convention, McCrory Gardens Visitor and Education Center, September, 2012.
- Boe, A. 2011. South Dakota's Prairie Farm Project—An Experiment in Grassland Farming. Invited Lecture, Brookings, SD.
- Eynard, A and T.E. Schumacher. 2011. A rapid, cost-effective, and greener FDA method for soil quality analysis. Soil Carbon Sequestration Conference Abstracts, University of Guam, Mangilao, Guam, August 2011.
- Eynard, A , T.E. Schumacher, and R.A. Kohl. 2011. Soil Polysaccharide Measurements in the

- Eynard, A , T.E. Schumacher, and R.A. Kohl. 2011. Soil Polysaccharide Measurements in the Evaluation of Soil Quality for Multifunctional Agriculture. Soil Carbon Sequestration Conference Abstracts, University of Guam, Mangilao, Guam, August 2011.
- Heimerl, R.K., T.E. Schumacher, J.A. Schumacher, W.C. Johnson. 2011. Spatial comparison of soil properties between native prairie and restored agricultural land. SWCS Annual Conference Abstracts, Washington D.C., July 2011.
- Johnson, C. 2011. Presentation on the progress being made at the EcoSun Prairie Farm. Green Drinks seminar series, Sioux Falls, SD. July 25, 2011.
- Johnson, C. 2011-2015. Documentary film. "*Grass Roots: The Prairie Farm Story*," Research sponsored by the Sun Grant Center is reviewed in this film. Showings of the film were given at McCrory Gardens Visitor and Education Center, Brookings, SD, September 15, 2011; to a food and nutrition class at SDSU (Dr. Shelly Brandenburger) on November 27, 2011, April 17, 2013, November 16, 2013, April 21, 2014, and spring 2015; at the Dakota Rural Action Annual Meeting, Dahl Art Center, Rapid City, September, 2011; at International Conference on Sustainability, SDSU, May 2011; at Honors Program Colloquium, SDSU, September 2011; at Peace and Justice State Convention, October 2011.
- Johnson, C. 2011. South Dakota's Prairie Farm: An Experiment in Ecological and Economic Sustainability. Contributed Paper, Conference on America's Grasslands: Status, Threats, and Opportunities, Sioux Falls, SD. August, 2011.
- Johnson, C. 2011. Dakota Grasslands, Wetlands, and Climate Change: Last Nail or Silver Lining? Invited Keynote Address, Annual Meeting of the South Dakota Academy of Science, Oacoma, SD.



- Johnson, C. 2011. South Dakota's Prairie Farm, An Experiment in Ecological and Economic Sustainability. Invited Lecture. Inaugural Civitas (Honors) Lecture Series, Augustana College, Sioux Falls, SD. March, 2011.
- Johnson, C. 2011. Production of Biomass Across Heterogeneous Landscapes. Program Review Presentation, North Central Sun Grant Research Center, Orlando, FL. January 2011.
- Johnson, C. 2011. Biofuel Feedstock Production at the Prairie Farm. Seminar, NRCS Plant Materials Center, Bismarck, ND.
- Schumacher, T.E., A. Eynard, R.K. Heimerl, K.D. Reitsma, J.A. Schumacher, D.E. Clay, S.L. Osborne, S. Stetson, and S.K. Papiernik. 2011. Management Impacts on Biologically Active Carbon within Eroded Landscapes. Soil Carbon Sequestration Conference Abstracts, University of Guam, Mangilao, Guam, August 2011.
- Vahyala, I.E., T.E. Schumacher, and S. Osborne. 2011. Soil Structure Changes In Bioenergy Crop Residue Management Systems. ASA-CSSA-SSSA Conference Abstracts, San Antonio Texas, October 2011.

- Owens, V., C. Hong, S. Osborne, T. Schumacher, and D. Clay. 2010. Environmental Impact of Growing Herbaceous Perennials for Bioenergy Abstract 2010.57726, Agronomy Society National Meetings, Long Beach, CA, Oct.31 - Nov. 3, 2010.
- Riedell, W.E., S.L. Osborne, T.E. Schumacher, J.L. Pikel Jr. 2010. Native Grassland Management effects on Biomass Production and Soil C Sequestration. Soil and Water Conservation Society 65th International Annual Conference Abstracts, St. Louis, MO, July 18-21, 2010.
- Reitsma, K.D., T.E. Schumacher, D.E. Clay, C.O. Hong, C.G. Carlson, D.D. Malo, T. Trooien, L. Janssen, G. Warman, A. Boe, V.N. Owens, P.O. Johnson, G. Erickson, and I. Graves. 2010. Cellulosic Feedstock Productions in Fields of Complex Topography. Annual International Meeting, Soil and Water Conservation Society. St. Louis MO. July 21, 2010.
- Johnson, C. 2010. South Dakota's Prairie Farm: An Experiment in Economic and Ecological Sustainability. Invited seminar, University of Northern Iowa (sponsored by UNI Tallgrass Prairie Center and the College of Natural Sciences/Humanities and Fine Arts). April, 2010.
- Johnson, C. 2010. The Prairie Farm Concept and South Dakota's Alternative Energy Future. Invited speaker, Annual Conference of the SD Association of Conservation Districts, Pierre, SD (Alternative Energies Session).
- Johnson, C. 2010. Prairie Farm Research. Invited banquet speaker, Annual Meeting of the Eastern Dakota Water Districts, Brookings, SD.

- Johnson, C. 2010. Research Progress in Biofuel Feedstocks. North Central Sun Grant Research Center meeting, Brookings, SD.
- Johnson, C. 2010. Landscape Scale Lignocellulosic Biomass Production, Economics and Environmental Quality. Program Review Presentation, North Central Sun Grant Research Center, Reno, NV.
- Clay, D.E., T. Schumacher, S.A. Clay, and V. Owens. 2009. The agronomic and environmental cost of removing corn stover. Symposium: The environmental and ecological challenges of biomass production. Abstract 2009.51901 American Society Agronomy National Meetings, Pittsburg PA, Nov. 1-5, 2009.
- Johnson, C. 2009. South Dakota's Prairie Farm. Invited seminar, Iowa State University Sustainable Agriculture Colloquium, Ames. February 11, 2009.
- Johnson, C. 2009. South Dakota's Prairie Farm. Invited seminar, Ecology and Environmental Biology Seminar Series, SDSU, Brookings. February 3, 2009.
- Johnson, C. 2008. South Dakota's Prairie Farm. Invited seminar, Plant Science/NCARL Seminar Series, Brookings, SD. December 2008.
- Schumacher, T.E., Skiles, P., Clay, D., Carlson, G., Malo, D.D., Trooien, T, Warman, G., Boe, A., and Owens, V. 2008. Precision Conservation Using Multiple Cellulosic Feedstocks. 2008 SWCS Annual Conference (Tucson, AZ) Abstract Book page 115.



Carter Johnson presents the EcoSun concept at Amherst College, MA in September, 2013.

POSTERS

- Teoh, K.H., C.J. Zilverberg, W.C. Johnson, and A. Boe. 2015. Targeted polycultures as high-yielding bioenergy feedstock. Poster presented at the 68th Society for Range Management Annual Meeting, Sacramento, CA. February 5.
- K. Teoh, C.J. Zilverberg, W.C. Johnson, and A. Boe. 2015. High diversity biofuel crops, outperform switchgrass monoculture. Presented to the South Dakota State University Sigma Xi 2015 chapter award competition, Brookings, SD. April 14.
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Prairie Restoration Philosophy

“Our goal must change from preserving nature as separate from humans to the more necessary task of remaking ourselves so that we might function as a part of nature. Some humans are at work at this fundamental challenge just now...”

R. Manning. “Grassland”

Prairie Restoration Philosophy

“There is, after all, the possibility of a richer future. That is the promise of grass The grass can live again. Unlike forest, it recovers rapidly, some of it in a matter of five or ten years. There is a possibility of resurrection in a real and physical sense.”

R. Manning. “Grassland”

Problem Statement

“The most insane example of till farming occurred (and is still occurring) in our own Great Plains, where vast acreages of prairie grasses were plowed up and turned into a dust bowl. Had that land been left in grass, and had forage crops been improved to carry more animals per acre, this whole area would be thriving today instead of surviving as a huge no-man’s land of subsidized corn and soybeans dotted with decaying towns and farmsteads.”

Gene Logsdon All Flesh is Grass