

# INTEGRATOR

## Tannins in the soil

The tannins that we associate with good red wine and bright fall colors may also play a role in managing soil and livestock, according to Jonathan Halvorson, USDA-ARS Research Soil Scientist at the Northern Great Plains Research Laboratory in Mandan, ND.

Tannins are a common, but highly diverse, class of phenolic plant secondary compounds that undergo complex chemical reactions and biological transformations when they enter soil. Much of Dr. Halvorson's recent research has focused on understanding the effects of tannins on soil processes that could be used

to manage the quantity and quality of soil organic matter and nutrient cycling in agricultural systems.

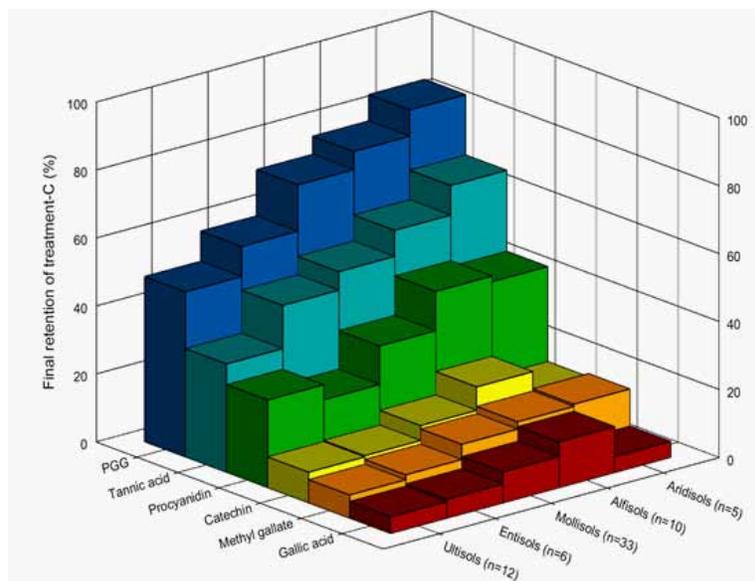


Fig. 1 Tannins in soil types

to manage the quantity and quality of soil organic matter and nutrient cycling in agricultural systems.

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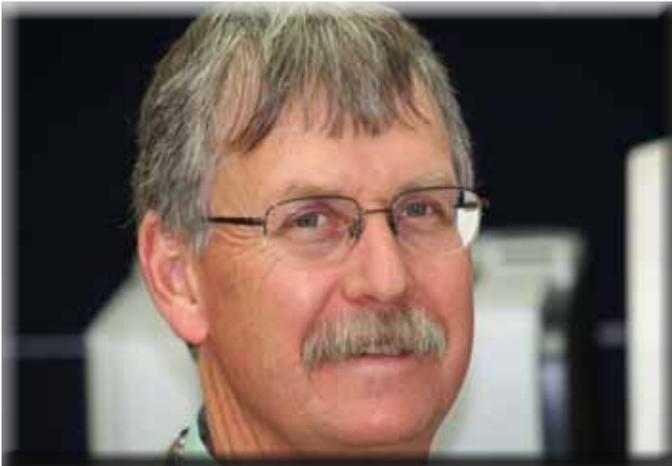
Dr. Halvorson and his colleagues have shown a) soils have a high affinity and a fixed capacity for different classes of tannins while related phenolic compounds are less attracted to soil; b) retention of tannins is associated with reduced

solubility of organic nitrogen in soil and increased soil cation exchange capacity (CEC), a common indicator of soil fertility; c) tannin effects are influenced by depth, soil properties, and management; and d) tannins and related compounds interact with specific pools of organic matter such as glomalin and metals such as aluminum, iron, manganese, and calcium.

Most recently, Halvorson and his collaborators investigated tannin effects in a broad range of soils. They added solutions of tannins and related non-tannin phenolic compounds soil gathered from ARS locations throughout the United States and one Canadian province.

They found meaningful amounts of each phenolic compound, especially the tannins, were retained by a wide variety of soils. Soils from the central and western U.S. and eastern Canada retained the greatest amount of treatment carbon, while soils from the southeast U.S. retained the least.

Generally, tannins and one non-tannin phenolic compound (gallic acid), reduced nitrogen solubility with reductions linearly related to retention of treatment carbon and differing by soil type. However, all the treatments decreased extraction of soluble



## Message from Matt

Welcome to the February 2014 issue of the INTEGRATOR. This issue highlights some important partnerships and collaborations critical to the success of the Northern Great Plains Research Laboratory. This year marks the 30th anniversary of the Area 4 Soil Conservation Districts Cooperative Research Farm, a partnership between farmers in the Area IV Soil Conservation Districts and the NGPRL. The Area 4 research farm enables scientists at the lab to take small-plot results and test them at the farm scale under actual farm

management. David Archer and Mark Liebig highlight some early research from the farm that continues to have relevance to conservation agriculture today. Other partnerships and collaborations spotlighted are the Northern Great Plains Research Triangle, the collaborative oilseeds biofuels project, and the energy beet research lead by NDSU. Partnering and collaboration are key values of the research team at NGPRL. We are very grateful to the Area IV Soil Conservation Districts and to all farmers and ranchers we serve for their trust and support in partnering with us.

A handwritten signature in black ink that reads "Matt Sanderson".

Matt Sanderson  
Research Leader

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## New Faces



Dr. Jiacheng Shen joined the NDSU Department of Agricultural and Bio-Systems Engineering in January as a Research Specialist under the supervision of Dr. Igathi Cannayan. He is located at the Northern Great Plains Research Laboratory and belongs to the NDSU research group. Dr. Shen's current project is the utilization of flood affected woody biomass and was funded by North Dakota Forest Service. His previous experience involved bio-fuel production from lignocelluloses materials using both biochemical and chemical methods.

## Quantifying the value of soil organic matter: Legacy research at NGPRL

David Archer and Mark Liebig

This year is the 30th anniversary of the Area 4 SCD Cooperative Research Farm, which is recognized nationally as a critically important location for conducting long-term research on dryland cropping systems ([www.area4farm.org](http://www.area4farm.org)).

One of the most influential research findings from the Northern Great Plains Research Laboratory originated from a study conducted at the Area 4 Soil Conservation District Research Farm in 1984-1987 by Armand Bauer and Al Black.

The study was one of the first to clearly quantify the relationship between soil organic matter and crop yield.

Specifically, their findings showed an increase in soil organic matter of 893 lb. per acre (or 1 metric ton per hectare) equated to an increase in spring wheat yield and total biomass of 14 and 31 lb. per acre, respectively.

These results have been cited in scientific research papers throughout the world and have been used in countless conservation, extension, and educational publications and presentations.

Contrary to what many thought at the time, the research indicated that the soil productivity benefit was likely due to improved nutrient availability, and not improved water availability.

The study provided valuable information for producers. It also raised many questions that are the subject of current research at the NGPRL, including identifying practices that can economically build soil organic matter, understanding how organic matter contributes to soil productivity and other ecosystem services, and finding ways to measure the composition and function of organic matter.



Al Black

Specific research projects include research on use of cover crops to build soil organic matter, methods for establishing cover crops in annual cropping systems, integrating perennial and annual crops integrated crop livestock systems, and long term soil quality management in annual cropping systems.

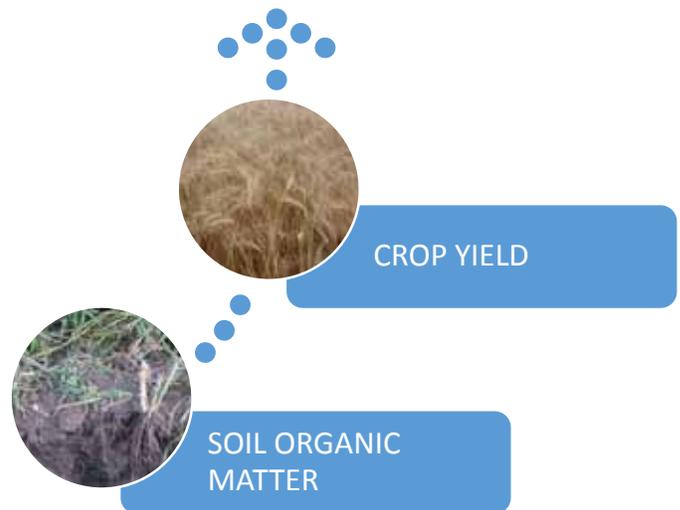
The study conducted by Armand Bauer and Al Black was part of a long history of research conducted at the Area 4 farm on cropping systems and conservation management.

In 2010, Bauer was the first soil scientist ever inducted into the North Dakota Agricultural Hall of Fame. Black was recognized as the second in 2014.

The summer issue of the INTEGRATOR newsletter will provide a historical look at the Area 4 farm, the valuable research that has come from the farm, and how that research tradition is being continued for the benefit of producers in the Northern Great Plains.

*Bauer, A., and A.L. Black. 1994. Quantification of the effect of soil organic matter content on soil productivity. Soil Sci. Soc. Am. J. 58:185-193.*

<https://www.soils.org/publications/sssaj/pdfs/58/1/SS0580010185>



Armand Bauer



# Research Results Conference

**NOON - 4:00 P.M. CDT**  
**MONDAY, MARCH 3, 2014**  
**SEVEN SEAS CONFERENCE CENTER**  
 2611 OLD RED TRAIL, MANDAN, ND



## 30 YEARS OF CHANGE AT THE AREA 4 SCD RESEARCH FARM

DON TANAKA

## WHAT HAPPENED ON THE RESEARCH FARM THIS YEAR...AND WHY?

MARK LIEBIG & DAVE ARCHER

## INDUSTRIAL BEET AND AFFECTED WOOD PROCESSING

IGATHI CANNAYEN, NDSU

## CONVERTING PERENNIAL TO ANNUAL CROPS

JOHN HENDRICKSON

## BUILDING SOIL C WITH ALFALFA

NICANDO SALENDRA

## AGGREGATION AGGRAVATION

KRIS NICHOLS

WWW.AREA4FARM.ORG LUNCH PROVIDED CCA CEUS 701.667.3001

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## Long-term livestock production-weather relationships on the northern Great Plains

Matt Sanderson



The USDA-ARS Northern Great Plains Research Triangle is composed of scientists at the Cheyenne, WY; Mandan, ND; and Miles City, MT locations. This team has pooled long-term data on livestock production and climate from each location to determine site-specific influences of seasonal weather patterns on cattle production. The team published three scientific articles on this research in 2013.

In the first study, 30 years (1982-2011) of yearling steer weight gain data from the High Plains Grassland Research Station near Cheyenne, WY were combined with weather data from the same period. The main finding from this modeling study was that temperature was the strongest predictor of beef production. Production was highest during years with cool, wet springs and warm, wet summers.

In the second study, 37 years (1975-2012) of cow-calf production data from Cheyenne were combined with weather data to model associated effects. The main findings were (1) that Herefords were more sensitive to seasonal weather patterns than crossbreds and (2) wet springs and wet winters particularly increased Hereford beef production on northern mixed grass prairie, whereas crossbreds did not show any weather effect patterns.

In the third study, 70 years (1936-2005) of data on gains of yearling Hereford steers from the Northern Great Plains Research Laboratory at Mandan were combined with weather data to quantify long-term patterns. The main findings were (1) that production was highest during years with cool, wet springs and warm, wet summers, (2) that heavy stocking rates were more sensitive to seasonal weather variation, (3) that cool, wet springs and warm with wet summers were best for beef production at moderate and heavy stocking rates, but light stocking rates were not impacted by seasonal weather differences, and (4) when poor weather conditions are forecasted for spring or summer, ranchers should lighten their stocking rate to reduce economic risks.

The ultimate goal of this research is to improve the utility of decision support tools for developing stocking rate alternatives and grazing management strategies by incorporating weather variables that are forecasted up to a year in advance.

The team members include Justin Reeves, postdoc at Cheyenne; Justin Derner, Research Leader at Cheyenne; Matt Sanderson, Research Leader at Mandan; Mark Peterson, Research Leader at Miles City; John Hendrickson, Research Range Scientist at Mandan; Scott Kronberg, Research Animal Scientist at Mandan; Lance Vermeire, Research Range Scientist at Miles City; and Matt Rinella, Research Range Scientist at Miles City.

*Reeves, J.L., J.D. Derner, M.A. Sanderson, M.K. Petersen, L.T. Vermeire, J.R. Hendrickson, S.L. Kronberg, and M.J. Rinella. 2013. Temperature and precipitation affect steer weight gains differentially by stocking rate in northern mixed-grass prairie. Rangeland Ecology & Management 66:438-444. <http://afrsweb.usda.gov/SP2UserFiles/Place/54092500/5.%20Reeves%20et%20al.%202013%20REM.pdf>*

*Reeves, J.L., J.D. Derner, M.A. Sanderson, M.K. Petersen, L.T. Vermeire, J.R. Hendrickson, S.L. Kronberg, and M.J. Rinella. 2013. Seasonal temperature and precipitation effects on cow-calf production in northern mixed-grass prairie. Livestock Science 155:355-363. <http://www.usmarc.usda.gov/SP2UserFiles/person/48041/3.%20Reeves%20et%20al.%20Livestock%20Sci.pdf>*

*Reeves, J.L., J.D. Derner, M.A. Sanderson, J.R. Hendrickson, S.L. Kronberg, M.K. Petersen, and L.T. Vermeire. 2014. Seasonal weather influences on yearling beef steer production in C3-dominated Northern Great Plains rangeland. Agric. Ecosyst. Environ. 183:110–117.*

Feel free to pass on this issue of Northern Great Plains Integrator to others interested in agricultural research in the northern Great Plains. Northern Great Plains Integrator is published and distributed by the USDA-ARS, Northern Great Plains Research Laboratory, PO Box 459, 1701 10th Avenue S.W., Mandan, ND 58554. Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD). The United States Department of Agriculture prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital and family status. To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence, SW, Washington, DC 20250-9410 or call 202-720-5964 (voice or TDD). USDA is an equal opportunity provider and employer. Mention of trade or manufacturer names is provided for information only and does not constitute endorsement by USDA-ARS. To be added to our mailing list, request a copy through our website or contact editor: Cal Thorson, Technical Information Specialist, USDA-ARS Northern Great Plains Research Laboratory, 1701 10th Ave., S.W., Mandan, ND 58554. Office:701 667-3018 FAX:701 667-3077 Email: cal.thorson@ars.usda.gov

# Development of HRJ fuel from Brassica in rotation with wheat for the Western United States

Dave Archer

The aviation industry has expressed a strong interest in the development of renewable jet fuel from oilseed crops within the U.S. to supplement its fuel needs and provide a smaller carbon footprint for its industry.

The USDA National Institute of Food and Agriculture (NIFA) identified objectives within its recent Biomass Research and Development Initiative (BRDI) grant program/proposal to address the challenges for the advancement of feedstocks to provide raw materials for Hydrotreated Renewable Jet (HRJ) fuel.

In response, the USDA-ARS successfully assembled a project team to evaluate the potential to optimize each sector of the feedstock supply change for Brassica rotations within the Western U.S. wheat belt.



This project is organized around six objectives:

- Objective 1: Genetically improve feedstocks to enhance oil yield and quality stability across varying western U.S. production conditions and compatibility with hydro-treated renewable jet (HRJ) fuel conversion processes;
- Objective 2: Provide regionalized strategies to integrate sustainable oil seed production into existing land uses in ways that increase farm profitability and rural economic opportunities, while providing biofuel refiners dependable supplies of high quality feedstocks;
- Objective 3: Develop cost-effective processes to remove feedstock oil impurities and identify co-product market opportunities to decrease HRJ fuel production costs and increase system profitability through value-added income streams;
- Objective 4: Lower HRJ production costs by optimizing: (a) conversion technology for genetically improved oilseed feedstocks and pre-treatment requirements, and (b) operational settings to genetically plant oils enhanced for conversion and processing efficiency;
- Objective 5: Develop analyses to provide strategic guidance addressing the uncertainties of expanded oil seed-based HRJ fuel production on select economic, social, and environmental indicators of sustainability; and
- Objective 6: Align participant and stakeholder interests along the supply chain to promote effective development of partnerships for creating new rural economic development opportunities centered on HRJ fuel production. This presentation will provide an overview of research that has begun on this four year project.

*Isbell, T., Long, D.S., Archer, D.W., Lupton, S., Gore, M.A., Jenks, M.A., Tomlinson, T., Steiner, J.J. 2012. Development of HRJ fuel from Brassica in rotation with wheat for the Western U.S. [abstract]. Association for the Advancement of Industrial Crops Conference. p. 29.*

## Well-managed grazing systems: A forgotten hero of conservation

Matt Sanderson

Ecologically sound grazing management is an under-used and under-appreciated conservation tool in the eastern U.S.. Well-managed pasture-based farming systems provide society-wide environmental services while offering productivity and profit to individual producers.

Scientists from USDA Agricultural Research Service in Raleigh NC and Mandan ND collaborated with professional agricultural specialists with the Wisconsin Department of Agriculture, Trade, and Consumer Protection; Winrock International; Michael Fields Agricultural Institute; and USDA Natural Resources Conservation Service to prepare a perspective article that:

1. Summarized the potential of well-managed pasture systems to provide ecosystem services.
2. Discussed the barriers to adoption of well-managed pasture systems.
3. Proposed potential solutions to move well-managed pasture systems forward through education and extension efforts.

Small-scale farms are supplying local communities with food and aesthetic, yet functional, landscapes. While some barriers to greater adoption of well-managed pasture-based farming systems are real, surveys suggest that many barriers are perceived and could be overcome with education.

Grazing networks and on-farm demonstrations are separating what is real from perceived. Local, state, and federal programs to support well-managed grazing systems need to be organized into coordinated action. New comprehensive research investigations need to be designed so that ecologically sound, pasture-based farming systems can be adopted and adapted using a firm scientific basis for greater understanding of the broad biogeochemical and socioeconomic considerations.

New and existing policy options should be further developed to encourage adoption of well-managed pasture-based livestock production as one of several agroecological approaches to meet the current and future demands of a robust production system without harming the ecosystem that supports it. This perspective has broad implications for how agriculture might be practiced throughout the eastern U.S., especially through ecologically sound pasture-based management.

*Franzluebbers, A.J., Paine, L., Winsten, J., Krome, M., Sanderson, M.A., Ogles, K., Thompson, D. 2012. Well-managed grazing systems: a forgotten hero of conservation. Journal of Soil and Water Conservation. 67:100A-104A. <http://www.jsowonline.org/content/67/4/100A.full.pdf+html>*

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## Extent of Kentucky bluegrass and its effect on native plant species diversity and ecosystem services in the Northern Great Plains of the USA

David Toledo, Matt Sanderson, John Hendrickson

The geographic spread of Kentucky bluegrass in rangelands of the United States has increased significantly over the past three decades. Preliminary analysis indicates that Kentucky bluegrass occupies over half of all ecological sites across the Northern Great Plains.

Kentucky bluegrass has served as nutritious forage during certain times of the year. It is a widely used turf grass, and has been used as a soil stabilizer against erosion. However, the consequences of the rapid Kentucky bluegrass expansion on native plant species diversity and ecosystem services have received little attention.

The invasion and expansion of Kentucky bluegrass in the Northern Great Plains has contributed to the decrease of native prairie community integrity and plant diversity and has altered plant community structure and function.

We reviewed available research related to Kentucky bluegrass and evaluated its effects on native plant diversity and ecosystem services. Invasion of Kentucky bluegrass may bring serious negative consequences to ecosystem services and restoration of native rangelands.

Greater native landscape connectivity is needed to maintain the flow of ecosystem goods and services from these rangeland ecosystems.

*Toledo, D., Sanderson, M., Spaeth, K., Hendrickson, J., & Printz, J. 2014. Extent of Kentucky bluegrass and its effect on native plant species diversity and ecosystem services in the Northern Great Plains of the USA. In Society for Range Management Meeting Abstracts. 7*

## Tannins in soil *continued from page 1*

nitrogen in some desert soils from arid regions of the western U.S.

Non-tannin phenolic compounds had little impact on soil CEC while tannins resulted in net increases. Like nitrogen, the increases in CEC, which were linearly related to retained treatment carbon, were most strongly demonstrated in western U.S. soils.

This study showed tannins produce effects, associated with soil quality and function, on a broad range of soil types. Their initial retention in the soil, together with associated decreases of soluble nitrogen and increased CEC suggests tannins may be part of management strategies.

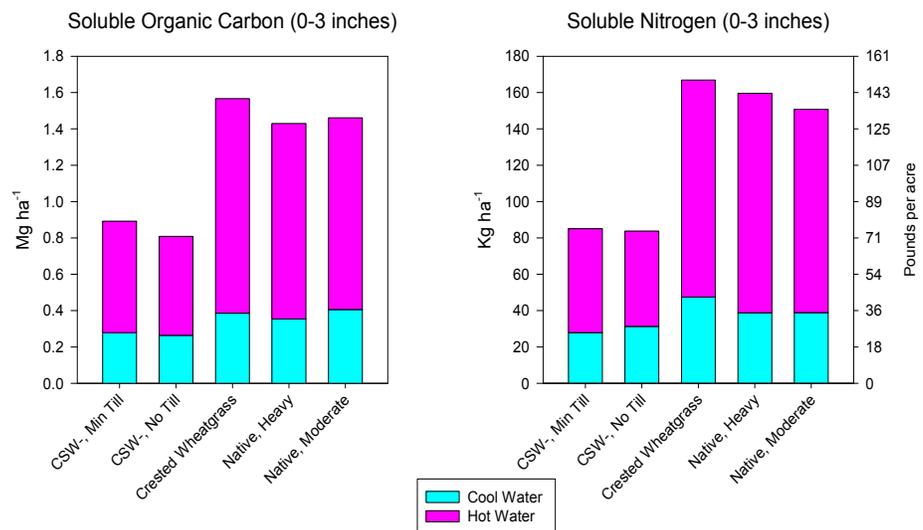
Halvorson is also interested in how phenolic compounds produced by plants can affect the activity or population characteristics of soil microorganisms. Another recent study, in collaboration with Miami University, focused on a class of microorganisms related to nitrogen cycling (ammonia oxidizers) and examined how three phenolic compounds, of increasing complexity, affected microbial respiration (activity) and population characteristics. Soil microorganisms metabolized the simplest compound (Methyl gallate) more efficiently than complex compounds but not as efficiently as the control (glucose). While none of the treatment compounds resulted in larger population size, the simple and intermediate complexity compounds resulted in genetic or physiological changes to soil microbial populations compared to the control. However, the compounds did not affect ammonia oxidizers.

This initial study provided insight into potential plant-microbial interactions based on the effects of polyphenols, which are plant natural products, on soil microbial communities. It demonstrated that small polyphenols are better substrates for respiration and have larger effects on the diversity of soil microbes than larger polyphenols. It also showed that tannins have

no short term effects on ammonia oxidizing bacteria compared to glucose and the overall bacterial abundance was not increased by short term incubation of polyphenols in soil. Additional studies are yet needed, using a broader range of compounds and soils.

A portion of Halvorson's future research will include evaluation of the role of phenolic compounds in North Dakota agroecosystems especially their interactions with soluble nitrogen. Although soluble carbon and nitrogen are only a small fraction of the total soil pools, they are important because they are linked to plant available nutrients and soil microorganisms. The carbon and nitrogen extracted from soil with cool water are thought to correlate to recent inputs such as fertilizer, lime, manure, or soluble plant residues while carbon and nitrogen recovered after hot water incubation are positively correlated with soil microbial biomass carbon and nitrogen, mineralizable nitrogen and total carbohydrates. Typically, more soluble organic matter can be recovered with hot water than cold and most (80%) of nitrogen recovered in hot water is in unspecified organic forms.

Preliminary data suggest soluble nitrogen may be present in North Dakota soils in significant quantities and that differences associated with management or soil type will be most clearly observed in hot water extracts.



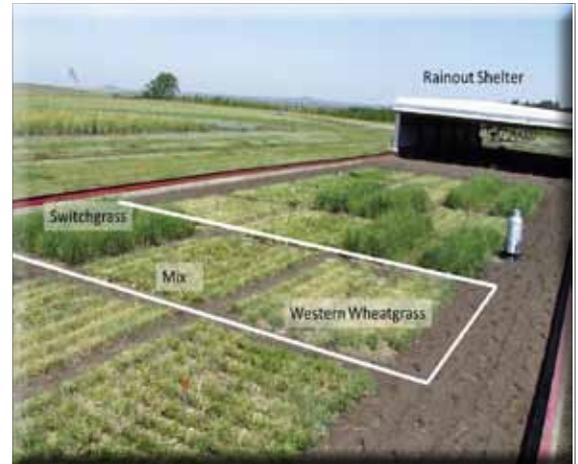
## Water use efficiency for switchgrass, western wheatgrass, and a western wheatgrass alfalfa mixture

John Hendrickson<sup>1</sup>, Marty Schmer<sup>2</sup>, and Matt Sanderson<sup>1</sup>

<sup>1</sup>Northern Great Plains Research Laboratory, USDA-ARS, Mandan, ND and

<sup>2</sup>Agroecosystem Management Research Unit, USDA-ARS, Lincoln, NE

Water and agricultural use of water is becoming a greater concern, especially in western parts of the Great Plains and there are concerns about how biofuel production may affect water quality and quantity. Because of these reasons, it is important to evaluate the water use efficiency (WUE) and soil water deficit of potential biofuel crops as well as other forages. We used a rainout shelter at the Northern Great Plains Research Laboratory at Mandan, ND to evaluate WUE and soil water deficits for switchgrass, western wheatgrass, and a western wheatgrass – alfalfa mixture under an early-season (May-June), a late - season drought (July-August) and a control (normal growing season moisture).



In both drought treatments, approximately 50% of the long-term average May-August precipitation (10.15 inches) was applied as irrigation water. In the early-season drought, only 20% of the 4.5 inches of the irrigation water applied from May through August was applied in May-June while the remainder (80%) was applied in July-August. In the late-season drought a similar approach was used. However, in the late-season drought, 80% of the 4.9 inches irrigation water applied between May through August was applied in May-June, while the remaining 20% was applied in July-August.

Biomass production was measured at the end of the growing season in October. In 2006, switchgrass produced 6.3 tons per acre under the control treatment, 3.8 tons per acre under the early-season drought and 4.8 tons per acre under the late-season drought. Under the early-season drought, switchgrass produced almost three times the biomass as western wheatgrass and under the late-season drought, switchgrass produced four times biomass as western wheatgrass and twice as much as the western wheatgrass-alfalfa mixture.

Water use efficiency was strongly influenced by the amount of forage produced. Switchgrass always produced more biomass than the western wheatgrass monoculture and so the WUE for switchgrass was greater than for the western wheatgrass monoculture. The WUE for switchgrass ranged from 0.31 to 0.41 pounds of biomass per inch of water used which was nearly 4 to 5 times greater than the WUE for western wheatgrass (0.06 to 0.11 pound of biomass per inch water). Water use efficiency for the mixture (western wheatgrass and alfalfa) was much more variable. For example, under the early season drought (May-June), WUE for the mixture was similar to switchgrass. However, for a later drought and the control, WUE for the mixture was similar to western wheatgrass. The year after the drought, WUE for the mixture was similar to switchgrass again.

Soil water deficit was also evaluated in the study. Soil water deficit was calculated as the difference between the month with the greatest soil water and the month with the least soil water. Although switchgrass had the greatest WUE it also resulted in the greatest soil water deficit while the water deficit for the mixture was usually the lowest except for the control. The water deficit for the western wheatgrass-alfalfa mixture was 31% and 38% lower than the water deficit for the switchgrass for the early and late drought stress respectively.

The results from this project suggest that switchgrass is an appropriate perennial biofuel to use in the drier areas of the northern Great Plains because of its greater WUE. However, its greater soil water deficit suggests that switchgrass may deplete the soil water more under a multi-year drought than western wheatgrass or a grass alfalfa mixture. This may be especially crucial if switchgrass was used as a perennial phase in a crop rotation. Researchers and producers need to be aware of the benefits and drawbacks for using switchgrass in dry or drought prone areas.

# Glomalin and soil aggregation under six management systems in the northern Great Plains

Kris Nichols and James Millar

The soil environment in range- and crop-land ecosystems is impacted by aboveground management including plant species composition, the length of time a living plant is growing, grazing intensity, and amount of soil disturbance. In other words, soil health is expected to decline with increased disturbance due to grazing or tillage and going from native to introduced plant species. Measurements of soil quality parameters, such as soil aggregation and the activity of arbuscular mycorrhizal fungi (a plant root symbiont) are indicators of soil health.

In this study, soil samples were collected from three range [native grass, rotational grazing (NGRG); tame grass, heavy grazing (TGRG); and tame grass, rotational grazing (TGHG)] and three cropping [conventional till (CT); CT plus manure (CTM); and long term no till (NT)] systems. Glomalin concentration [measured as Bradford reactive soil protein (BRSP)] and the stability of 1 to 2 mm soil aggregates were the parameters used to compare these systems.

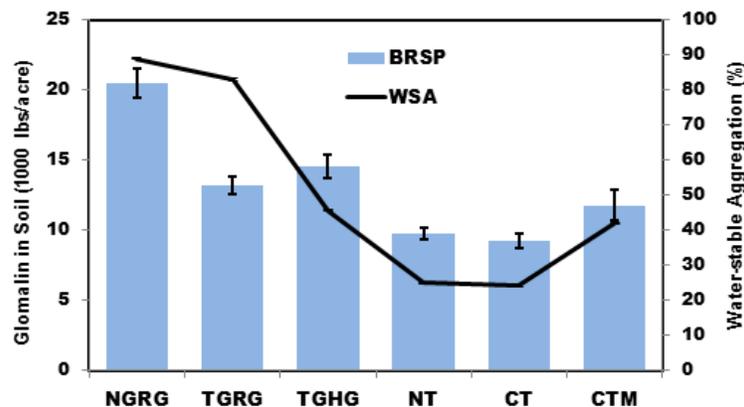


Figure 1. Glomalin, measured as Bradford-reactive soil protein (BRSP) on a 1000 lbs acre<sup>-1</sup> basis, and percentage of water-stable 1-2 mm aggregates in three range [native grass, rotational grazing (NGRG); tame grass, heavy grazing (TGRG); and tame grass, rotational grazing (TGHG)] and three crop [conventional till (CT); CT plus manure (CTM); and long term no till (NT)] systems.

Rangeland systems had higher glomalin content – BRSP - and water stable aggregation (WSA) than cropland systems with the native grass treatment having the highest values (Fig. 1). The NGRG and TGRG systems had similar WSA values and the TGHG system having higher BRSP than the TGRG which was unexpected. In addition, the NT and CT treatments had similar values, while the CTM treatment had the highest values for the cropland systems. Despite these results, regression analysis showed strong relationships ( $R^2 = 0.6787$ ) between BRSP and WSA showing that these parameters provided consistent results.

The interacting biological, chemical, and physical processes occurring in the soil, particularly in the rhizosphere, control the majority of soil functions, but it may be difficult to assess these processes. Therefore, indicators of good functioning soils, such as aggregate stability, may provide mechanisms for understanding soil health and how it relates to aboveground management. This study showed a strong relationship between glomalin and WSA and the differences between management systems. More research exploring the soil environment and how it relates to aboveground management, especially in rangelands, will help to model above- and belowground relationships.

Nichols, K.A., Millar, J. Glomalin and soil aggregation under six management systems in the northern Great Plains, *Open Journal of Soil Science*, 2013, 3, 374-378 [http://file.scirp.org/Html/6-1660152\\_41596.htm](http://file.scirp.org/Html/6-1660152_41596.htm)

## North Dakota begins 'energy beet' process study

The first beet-to-ethanol pilot plant in the nation recently was announced for construction in California. Meanwhile, North Dakota researchers are moving forward on studies to determine if a similar idea will be feasible there.

"If all goes as expected, North Dakota's beet-to-ethanol commercialization might start in two years", says Maynard Helgaas of West Fargo, president of Green Vision Group. "I feel optimistic that once we get the research done, our financial (situation) is going to look pretty good."

A single plant is projected to cost up to \$65 million. Some of that will depend on positive results from scientific studies.

"One key North Dakota study is just starting", Helgaas says. In this storage and processing study, the energy beets are crushed and not sliced in refined sugar production.

Lead researcher Igathi Cannayen, a North Dakota State University assistant professor of agricultural and biosystems engineering, is located at the Northern Great Plains Research Laboratory at Mandan, N.D., which is part of the U.S. Department of Agriculture's Agricultural Research Service.

Cannayen says 10 tons of beets were provided by American Crystal Sugar Co. for the study. Some were repacked into plastic 18-gallon totes and placed in a 10-by-10-by-7 foot walk-in freezer, recently acquired for the purpose. Some were left in bulk.

"Each tote will hold about 50 pounds of beets," Cannayen says. "Each will be taken out and will pass through the equipment."

The equipment is expected to arrive in early May and will include a crusher, which can be used with different screen sizes, and a press. The crusher is essentially a hammer mill that will push the beet material through different screen sizes, producing different particle sizes. Among other things, Cannayen will study how much energy it takes to push the beets through the screens, as well as the optimal combination of processing and juice recovery.

Crushed beets will go through a basket- or wine-press, similar to what is used in wine-making. Once the pulp has been pressed, it will be mixed with hot water for a second, third or fourth washing to extract as much sugar as possible. Eventually, the scientists will be studying the optimal speed of processing.

"Collaborating scientists are working on separate aspects of the process", Cannayen says. For example, Dennis Wiesenborn, an NDSU chemical engineer in Fargo is studying the effects of storing whole beets at various temperatures, controlling and monitoring them for gaseous output. Some of those beets will be shipped to Mandan for secondary testing.

Helgaas says other studies are ongoing on the agronomic side of the energy beet potential.

NDSU scientists are studying how energy beets can be used on saline soils, for example, as well as irrigated and nonirrigated conditions. A new plot for yield data will be added in Cando, N.D. Plot results were favorable across the state last year, despite the drought.

"Meanwhile, California is on a similar path", Helgaas says. He says that project involves year-round ethanol production with beets that are planted and harvested in stages.

At Five Points in California's Central Valley, farmers who once grew 330,000 acres of sugar beets for Spreckles Sugar Co., are trying to revive the crop for ethanol production. All but one beet sugar mill has been closed in the Imperial Valley, according to news reports.

The farmers have formed Mendota (Calif.) Bioenergy LLC, a company to build the energy beet demonstration plant, which will turn 250 acres of beets into 285,000 gallons of ethanol per year - a small plant by commercial standards. If successful, the farmers would push for development of a larger, commercial-scale plant.