Northern Great Plains Research Laboratory

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Northern Great Plains

Integrator

For environmentally and economically sound agro ecosystems for the northern Great Plains.

July 2008

Cattle and Beef Production with Less Grain

High oil and grain prices are creating a challenging environment for cattle and beef production. This environment is likely to become more challenging in the future especially for cow-calf producers.

To increase sustainability of cow-calf producers in the northern Great Plains, Dr. Scott Kronberg, NGPRL Animal Scientist, says even more production costs must be driven out, or more value derived from production. With the frugal nature of cattlemen, little unproductive expense remains to be excised. For cattlemen to improve ranch profitability, they may need to raise calves to much closer to slaughter weight than they have in the past to realize profit normally gained by finishing feedlots.

The current thinking by many in the cattle industry is that there may be a significant cost advantage to grow cattle with more forage and less grain. Mainstream cattle producers interpret this to mean that the stocker sector will become more important and cattle will enter feedyards at heavier weights and spend less time on high-concentrate rations before slaughter. A much smaller segment of the industry, the grass-finished producers, interpret this to mean business as usual. However, there is a third way to grow and finish yearlings that requires much less concentrate feeding. Only small amounts of concentrate supplement diets primarily composed of high-quality forage. These diets can grow yearling steers at two to three pounds per day at a lower cost than high-concentrate rations, which typically grow yearlings at three to four pounds per day.

The more yearlings harvest their own feed via grazing, the lower the cost of gain may be. Cattleman increase ownership cost by holding cattle longer, but also reduce cost per pound of gain through less expensive feeds consumed.

How does one turn weaned calves into finished yearlings (i.e., from about 600 to 1200 or 1300 pounds and grading high select or choice) with high quality forage and only small amounts of concentrate? Select cattle that fatten easier and provide them with high-quality forage to graze during the growing season (May into September), high quality swaths of forage to graze during fall, and feed them high quality haylage or hay the rest of the year. Concentrates can be supplemented at 0.2 to 0.4% of the animal's body weight without reducing forage digestion by rumen microbes and thus reducing nutrition derived by cattle from high quality forage.

Forage should be 60 to 80% digestible at all times, and with higher crude protein levels (10 to 16%) when the cattle are smaller and growing rapidly, but with lower crude protein levels (8 to 11%) when their growth has slowed considerably, but they still require fattening.

Forage quality levels can be met in spring and early summer by turning cattle on to pastures that are dominated by native or common introduced cool-season grasses and using good grazing management practices. Rotate cattle to a new pasture after they have grazed about 50% of the vegetation. Do not force cattle to eat older, lower quality vegetation that is typically closer to the soil.

In mid- to late-summer, cattle can consume high-quality forage from pastures after regrown from earlier grazing or mowing of cool-season grasses. High quality forage can also occur in pastures that have significant amounts of warm-season grasses such as big bluestem or switchgrass (eastern Dakotas) or blue grama (western Dakotas and eastern Wyoming and Montana), or grazing mixtures of alfalfa and grasses if bloat-prevention management is adequate.

If these strategies are not practical, annual crops may be utilized to grow yearlings at two to three pounds per day. Strip-grazing annual forages such as proso millet and sudangrass has been proven to be an economically viable option.

Strip grazing uses electric fence to limit cattle to only a day or two of forage at a time. They will stomp down some forage regardless of your grazing management. Most crop fields may benefit from the incorporation of this organic matter into the soil. Some may also be carried in the wind if not held tight in stubble.

Kronberg says that growing a legume such as hairy vetch along with an annual grass will improve future soil health and productivity, and enhance the quality of cattle diet.

Late summer and fall can be challenging to provide high quality forage grazing. For semi-arid areas in the northern Great Plains, a mix of warm-season annual grasses and a short-lived legume or two is unsurpassed. This mixture may be cut and windrowed in late September and used for strip grazing into late fall or early winter.

High quality hay or haylage can be made from many annual crops including corn. Cattlemen must carefully evaluate relative feed value and production expense. Corn silage may be excellent for feed production and quality, but cost per ton must be evaluated to optimize cost of production for each unique set of feed production opportunities and operating conditions.

At the Northern Great Plains Research Laboratory, yearling steers gained an additional 1/3 to 3/4 lbs. per day when forage diets were supplemented with concentrates. In 2007, Angus steers that grazed Proso millet in August and September, then grazed cool-season perennial grasses in late September and October, had average unsupplemented daily gains (ADG) of 1.83 lbs., 2.3 lbs. if they were supplemented with about 2 lbs. of ground flaxseed (0.2% of body weight) per day, and 2.39 lbs. (0.28% of body weight) if they were supplemented with a mixture of ground corn and soybean meal that had equivalent levels of crude protein and digestible energy as the flaxseed. There were not statistically significant differences in ADG between the two supplemented groups of steers, but the group of steers that were not supplemented gained significantly less.

Cattle that fatten easily can be finish to high select or choice with high quality forage that is grazed on pastures, fields of windrowed forage, and fed as silage or hay. Rates of gain derived from primarily high-quality forage diets can be improved with small amounts of supplemental concentrates.

Dr. Scott Kronberg - scott.kronberg@ars.usda.gov - 701.667.3013

Switchgrass May Mean Better Soil

In a study at two locations, Dr. Kris Nichols, a microbiologist with the Northern Great Plains Research Laboratory, found that soils with native grasses such as switchgrass have higher levels of glomalin than soils planted to non-native grasses.

Glomalin is a sugar-protein compound that might assist in formation. The more glomalin in a given soil, the better and less erosion-prone that soil probably is.

In 2004, Nichols collected soil from under grass plots established between 1987 and 2002. The amount of glomalin in the soil increased as the degree of interdependence between plants and the arbuscular mycorrhizal fungi--which produce glomalin and live inside plant roots and the surrounding soil increased. That interdependence is greatest in warm-season native grasses such as switchgrass, blue grama, big bluestem and indiangrass.

Further evidence that soils underneath native grasses are higher in glomalin came from another study on rangeland areas at Mandan and near Platte, S.D.


Switchgrass

In an earlier study, Nichols analyzed samples from undisturbed soils with native vegetation in Maryland, Georgia, and Colorado. According to her analysis, glomalin stored a large percentage of the carbon found in those soils and contributed greatly to soil fertility. On average, glomalin stored 15 percent of the soil carbon, with the highest amount, 30 percent, in a Colorado soil and the lowest amount, nine percent, in a Georgia soil. These results are similar to those from other soil samples taken around the world.

The increased glomalin and underground carbon storage observed with switchgrass adds to its value as a potential source of cellulosic ethanol.

Nichols uses glomalin measurements as a quick guide to evaluate how "soil friendly" farming or rangeland practices actually are.

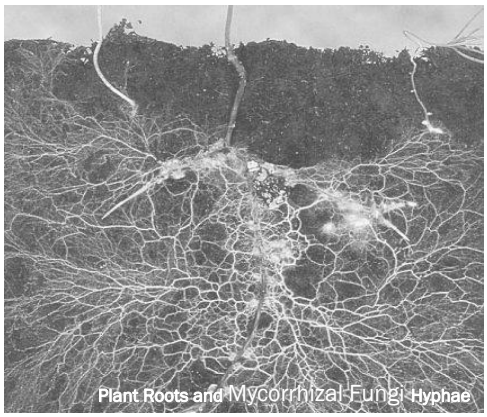
Prior to joining the USDA-ARS staff at Mandan, Nichols worked with USDA-ARS soil scientist Sara Wright, who identified and named glomalin in 1996.

Dr. Kris Nichols - kristine.nichols@ars.usda.gov - 701.667.3008

Glomalin Is Key to Locking Up Soil Carbon

A soil constituent known as glomalin provides a secure vault for the world's soil carbon. That's according to Dr. Kris Nichols, a microbiologist at the Northern Great Plains Research Laboratory.

Glomalin is a sticky substance secreted by


Plant Roots and Mycorrhizal Fungi Hyphae

the fungal hyphae that funnel nutrients and water to plant roots. It acts like little globs of chewing gum on strings or strands of plant roots and fungal hyphae. Into this sticky "string bag" fall the sand, silt, and clay particles that make up soil--along with plant debris and other carbon-containing organic matter. The sand, silt, and clay stick to the glomalin, starting aggregate formation, a major step in soil creation.

On the surface of soil aggregates, glomalin forms a lattice-like waxy coating to keep water from flowing rapidly into the aggregate and washing everything, including carbon, away. As the builder of the formation "bag" for soil, glomalin is vital globally to soil building, productivity and sustainablilty--as well as to carbon storage.

Nichols uses glomalin measurements to gauge which farming or rangeland practices work best for storing carbon. Since glomalin levels can reflect how much carbon each practice is storing, they could be used in conjunction with carbon credit trading programs.

In studies on cropland, Nichols has found that both tilling and leaving land idle--as is common in arid regions--lower glomalin levels by destroying living hyphal fungal networks. The networks need live roots and do better in undisturbed soil.

When glomalin binds with iron or other heavy metals, it can keep carbon from decomposing for up to 100 years. Even without heavy metals, glomalin stores carbon in the inner recesses of soil where only slow-acting microbes live. This carbon in organic matter is also saved--like a slow-release fertilizer--for later use by plants and hyphae.

Evaluation of Perennial Herbatious Biomass Crops in North Dakota

North Dakota has over seven million acres of highly erodible and saline cropland. Perennial herbaceous crops may achieve long-term sustainability on this land by reducing erosion and greenhouse gas emissions, and adding organic soil matter. With oil prices exceeding $100 per barrel, bioenergy production from these biomass crops would provide economic stability for the producer and the community.

A 10-year bioenergy crop study initiated in 2006 by the North Dakota Natural Resources Trust, NDSU, Northern Great Plains Research Laboratory, ND Game and Fish Department, ND Department of Commerce, ND Farmers Union, Dakota West RC&D, Dakota Prairie RC&D, Jamestown/Stutsman Development Corporation, and NRCS will determine the appropriate plant species or species mix, harvest methods, and practices to maintain productive perennial biomass stands. Plant species or species mixes including switchgrass alone; tall wheatgrass alone; intermediate wheatgrass alone; a CRP mix of intermediate and tall wheatgrasses; a CRP mix of intermediate and tall wheatgrasses, alfalfa, and sweetclover; a switchgrass and tall wheatgrass mix; a switchgrass and big bluestem mix; a switchgrass and altai wildrye mix; and a basin and altai wildryes mix were seeded at six locations in May 2006.


Big Bluestem

Baseline soil samples, taken prior to planting by Drs. Mark Liebig and Kris Nichols from NGPRL were evaluated for gravimetric water content, soil bulk density, EC, pH, total carbon, nitrogen, inorganic carbon, particulate organic matter, extractable nitrate and phosphorus, soil aggregation, water-stable aggregation, and glomalin concentration. No differences were seen between samples collected from the same location, but differences were seen across locations. Higher glomalin and aggregate stability values were found at locations with higher overall precipitation rates. Similar analyses will be conducted on 5-year intervals to determine the impacts of plant species or species mix and crop production practices on soil organic matter and carbon storage.

Friends & Neighbors Day 2008
NORTHERN GREAT PLAINS RESEARCH LABORATORY

1701 10th Ave. SW, Highway 6 South, Mandan, ND

July 17th
The World Down Under

The Future Starts With the Soil

More info @ www.mandan.ars.usda.gov or 701.667.3000

Campus Activities

Begin @ 2 PM CDT

- Urban Gardening & Landscaping
- Native American Ethnobotany
- Soils for Gardening
- Rain Gardening
- Birds of Your Backyard
- Trees of North Dakota
- Children's Activities
  - Soil Tunnel
  - Kid Crafts
  - Buggy Rides
- Ice Cream and Hot Dogs

Ag & Environmental Tours

Depart @ 4 PM CDT

- Plant Root Growth & Carbon Sequestration
- Cover Crops
- Bioenergy Crops
- Remote Sensing Range Mgmt
- Corn Production
  - Varieties
  - Sequencing
  - Fertility

Free Evening Barbecue & Missouri River Boys Bluegrass

Organic Price Premiums Make Organic Cropping Systems Profitable

Reducing tillage and increasing crop diversity offer many environmental benefits. While organic farmers recognize the need to protect natural resources, management decisions are often driven by concern for economic survival.

An interdisciplinary research team led by Dr. Dave Archer, compared 16 different cropping system treatments including combinations of system type (organic, conventional), tillage (conventional, strip-tillage), rotation (corn-soybean, corn-soybean-wheat/alfalfa-alfalfa), and fertility (no fertilizer/manure, fertilizer/manure applied at recommended rates).

Reducing tillage intensity and increasing crop diversity reduced annual production costs by $10 to $47/acre within the conventional systems and by $6 to $43/acre within the organic systems.

Production costs were $3 to 21/acre higher for organic systems due to manure handling costs as well as higher fuel, labor, and machinery ownership costs.

Corn, soybean, and wheat yields were over 15% lower when using organic practices due to higher weed pressures.

There were significant reductions in short-term profitability of organic systems, but with organic price premiums, profits for several organic cropping system alternatives were competitive with conventional systems.

The full results of the study are available in the November-December 2007 issue of *Agronomy Journal*.

Dr. Dave Archer - david.archer@ars.usda.gov - 701.667.3048

NDSU BioEPIC Agroecosystems Research Group

Dr. D.C. Coston, NDSU Vice President for Agriculture and University Extension, and Dr. Jon Hanson, Research Leader at the USDA-ARS Northern Great Plains Research Laboratory, have announced the creation of the NDSU Bio Energy and Product Innovation Center (BioEPIC) Agroecosystems Research Group on the USDA-ARS campus in Mandan, North Dakota.

At NDSU in Fargo, BioEPIC offers its stakeholders a reliable, high-quality, targeted research, education and technology transfer related to biomass production, harvesting, transportation, and conversion.

More than 60 faculty and staff from 15 NDSU departments and research extension centers are already involved in BioEPIC, and the program is continuing to grow. The research involves evaluating biomass species for quality and quantity under different environmental and agronomic conditions to determine appropriate bioenergy crops for biofuel production, and developing ways for farmers to add bioenergy crops to their operations.

The Northern Great Plains Research Laboratory currently collaborates with NDSU researchers in several research programs.

The current major initiative of the Mandan Agroecosystems Research Group is building conceptual awareness of long-term sustainable farming systems. "The USDA-ARS Northern Great Plains Research Laboratory is committed to developing environmentally and economically sound Agroecosystems for the northern Great Plains," says Jon Hanson, Laboratory Director. "This endeavor is too big for a single institution and for that reason our partnership with NDSU provides an outstanding means to maintain and enhance agriculture throughout this region."

The North Dakota Agricultural Experiment Station (NDAES) also will be involved. The NDAES is conducting research at its centers throughout the state, in conjunction with the Northern Great Plains Research Laboratory (see Evaluation of Perennial Herbatious Biomass Crops in North Dakota on Page 2), to develop dedicated energy crops. NDSU scientists who office at the USDA-ARS in Mandan will be committed to also work with and at the NDAES Research Extension Centers throughout the state while accessing USDA scientific expertise for NDSU research collaboration.

"This project will strengthen and enhance ongoing research efforts on dedicated energy crop production," says Coston. "This agreement continues our effort to pull together the full set of capabilities within NDSU and position ourselves to be partners with others, such as the USDA-ARS's Northern Great Plains Research Laboratory, to develop and grow biobased production."

The initial collaboration has two main objectives: (1) Determine appropriate crops to maximize biofuel production; and (2) Develop economically feasible management systems for transitioning in and out of bioenergy crop production.

“Thoughts of an Agroecosystem involve disciplines beyond production agriculture including the social sciences”, says Tim Faller, Assistant Director of NDSU Agricultural Experiment Stations and Director of the BioEPIC Agroecosystems Research Group at Mandan. “A current stimulus to this way of thinking would be the emphasis being put on production of crops as feed stocks for energy generation. It is easy to envision many needs of producers as they consider this transition from food production to energy. It becomes even more dramatic when you think of all conversations currently going on over a cup of coffee someplace. That conversation is by no means over and will require much more input from science before change occurs.”

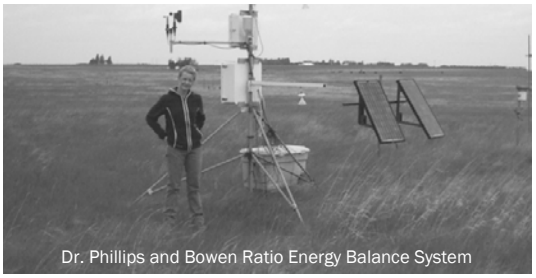
According to Faller, North Dakota’s northern climate lends itself to the production of many forage crops that can contribute to reduction of United State’s energy dependency on petroleum from foreign sources. No one is even sure what the crop will be at the present time. “This is a huge challenge to our mindsets and to North Dakota agriculture.” Our current thinking would primarily involve wheat and cattle”, he adds. “We will need preparation to make this transition to being energy producers.” NDSU and USDA actively collaborating and making rapid progress will positively position North Dakota and the northern Great Plains to help create this industry for family farmers and the economy throughout this region.

Tim Faller - timothy.faller@ndsu.nodak.edu - *701.667.3020*

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

CRP a Major Carbon Sequestration Benefit

Organizations worldwide are asking how agricultural management practices, such as those specified under the Conservation Reserve Program (CRP), influence plant carbon uptake under variable climatic conditions. CRP contracts were written for millions of acres in North Dakota over the last two decades. CRP acres offer important environment benefits with respect to wildlife, but the environmental benefit associated with carbon uptake was previously unknown. Using data available from satellites and field stations, recent results indicate CRP acres in North Dakota represent a significant carbon sink.


Dr. Phillips and Bowen Ratio Energy Balance System

Net carbon uptake for fields planted under the CRP would be expected to remove more carbon from the atmosphere, compared to annual crops, because they are not mechanically disturbed by tillage or chemically amended with fertilizers that release greenhouse gases, such as nitrous oxide.

To determine actual carbon uptake, Dr. Rebecca Phillips, Environmental Scientist at the USDA-ARS Northern Great Plains Research Laboratory, used field and satellite-based data to determine plant properties associated with carbon uptake on a year-by-year basis during a 10 year CRP contract (1997-2006).

Field data were collected with a Bowen Ratio Energy Balance System (see photo), which measures net carbon gains or losses every 20 minutes for a 40-acre field.

Satellite optical data were collected monthly from the Landsat sensor between April and September.

Data representing wide variations in spatial and temporal variability were analyzed over 10 years using over 1450 CRP fields located in both Morton and McLean Counties. Carbon uptake observed during the 1997-2006 growing seasons vacillated with drought and deluge and ranged from -3000 to 6000 lb of carbon per acre per growing season. An average of 2000 lbs of carbon per acre per year was removed from the atmosphere over a 10-year period. Carbon uptake was greatest in 1999 and lowest in 2006.

Results indicate assessment of conservation practices on grassland carbon uptake during the growing season can be estimated at field and landscape scales under variable environmental conditions.

A video of this project can be viewed at: http://www.ars.usda.gov/Main/docs.htm?docid=16721. The audio of an interview with NPR is available at: http://www.earthsky.org/radioshows/52522/grasslands-soak-up-carbon-to-slow-climate-change

Dr. Rebecca Phillips - rebecca.phillips@ars.usda.gov - 701.667.3002

The NGPRL Soil Sample Archive

Sustaining highly productive and environmentally sound agricultural management systems will be a major challenge over the next several decades given projections for human population growth and global climate change. Because of these conditions, long-term agricultural experiments will play an important role in understanding how management systems affect soil attributes – and, in turn – how changes in soil attributes impact the broader environment.


NGPRL Soil Archive

Documenting management effects on soil attributes requires not only well-managed long-term experiments, but also carefully cataloged soil archives. Archived soil samples provide 'time capsules' for determining changes in soil attributes over time, and are particularly valuable as new analytical capabilities are developed.

In the 1940s, a soil archive was initiated at the Northern Great Plains Research Laboratory (NGPRL) to provide the opportunity for evaluate the effects of long-term grazing and cropping management practices on soil attributes over time. The NGPRL soil archive includes over 5000 samples ranging in age from 4 to 90 years. Most of the samples in the archive come from evaluations of the historical pasture treatments at NGPRL or from a multi-state cropping system evaluation conducted by Howard Haas in the early 1950s. The Haas samples included cropping treatments under various crop sequences and fertility regimes (e.g., manure, no manure), as well as native vegetation. These samples were used to by Haas to document the extent of soil carbon loss caused by converting native vegetation to dryland cropping throughout the U.S. Great Plains.


SCS Building at NGPRL

The sample archive is housed in a building south of the NGPRL main campus. The building was built in the 1940s to support regional soil studies by the USDA Soil Conservation Service (now NRCS).

There are numerous opportunities for research using the NGPRL soil archive, opportunities that include detailed characterizations of soil organic matter fractions, analyses of micronutrient content, and evaluations of soil acidity (just to mention a few examples). Overall, collaborative research projects using the NGPRL soil archive should provide a more in-depth understanding of long-term cropping and grazing effects on soil. This is particularly valuable for the region associated with the archive's domain (semiarid Great Plains), as changes in soil properties resulting from management often take decades to be expressed.

Dr. Mark Liebig - mark.liebig@ars.usda.gov - 701.667.3079

Retired Scientists Continue Their Passion for Science

The Northern Great Plains Research Laboratory is blessed by committed scientists who elect to continue their research after their official retirement begins. These scientists have continued in official status as "Collaborators" with the Agricultural Research Service. They maintain offices and administrative support at the Northern Great Plains Research Laboratory in Mandan and remain active, contributing scientists long into retirement.

John Berdahl, Research Plant Geneticist
Retired in 2006
701.667.3004
john.berdahl@ars.usda.gov

Rich Cunningham, Research Plant Geneticist
Retired in 1995
701.667.3016
rich.cunningham@ars.usda.gov

Al Frank, Research Plant Physiologist
Retired in 2004
701.667.3007
al.frank@ars.usda.gov

Jim Karn, Research Animal Scientist
Retired in 2003
701.667.3016
jim.karn@ars.usda.gov

Joe Krupinsky, Research Plant Pathologist
Retired in 2007
701.667.3011
joe.krupinsky@ars.usda.gov

Steve Merrill, Research Soil Scientist
Retired in 2006
701.667.3016
steve.merrill@ars.usda.gov

NORTHERN GREAT PLAINS

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Technology Transfer Product of the
Northern Great Plains Research Laboratory
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USDA-ARS-NGPRL
1701 10th Avenue SW PO Box 459
Mandan, ND 58554-0459
Phone: 701 667-3018 Fax: 701 667-3077