Northern Great Plains Research Laboratory

USDA 150 YEARS 1862-2012

NORTHERN GREAT PLAINS
INTEGRATOR
For environmentally and economically sound agro ecosystems for the northern Great Plains.

February 2012

NORTHERN GREAT PLAINS RESEARCH LABORATORY 100 YEARS

Crop diversity elicits diverse information

Potential declines in crop diversity across the US have been a subject of scientific debate recently. Sketchy accounts of major changes in crop diversity in some parts of the U.S. have raised concerns about the impacts of crop production on the environment and future sustainability. At a local level, it is not surprising to hear some of the farmers and ranchers noticing significant changes in cropping practices in and around their farms. In agronomic systems, crop diversity is synonymous to biological diversity, which is an important ecosystem service. However, a spatial evaluation of crop diversity and how it has changed over time has not been done.

Scientists at NGPRL, with collaborators at NDSU and USDA-ARS in Morris, MN, and the USDA-National Agricultural Statistics Service (USDA-NASS) are evaluating the characteristics of cropping diversity of the lower 48 states. Using data from the USDA-NASS Agriculture Census over several years, an index was computed for every county to quantify crop diversity. This index, Shannon diversity index, is a popular measure of diversity in ecology and environmental sciences. Presented as effective number of crop species (ENS), maps were generated for the

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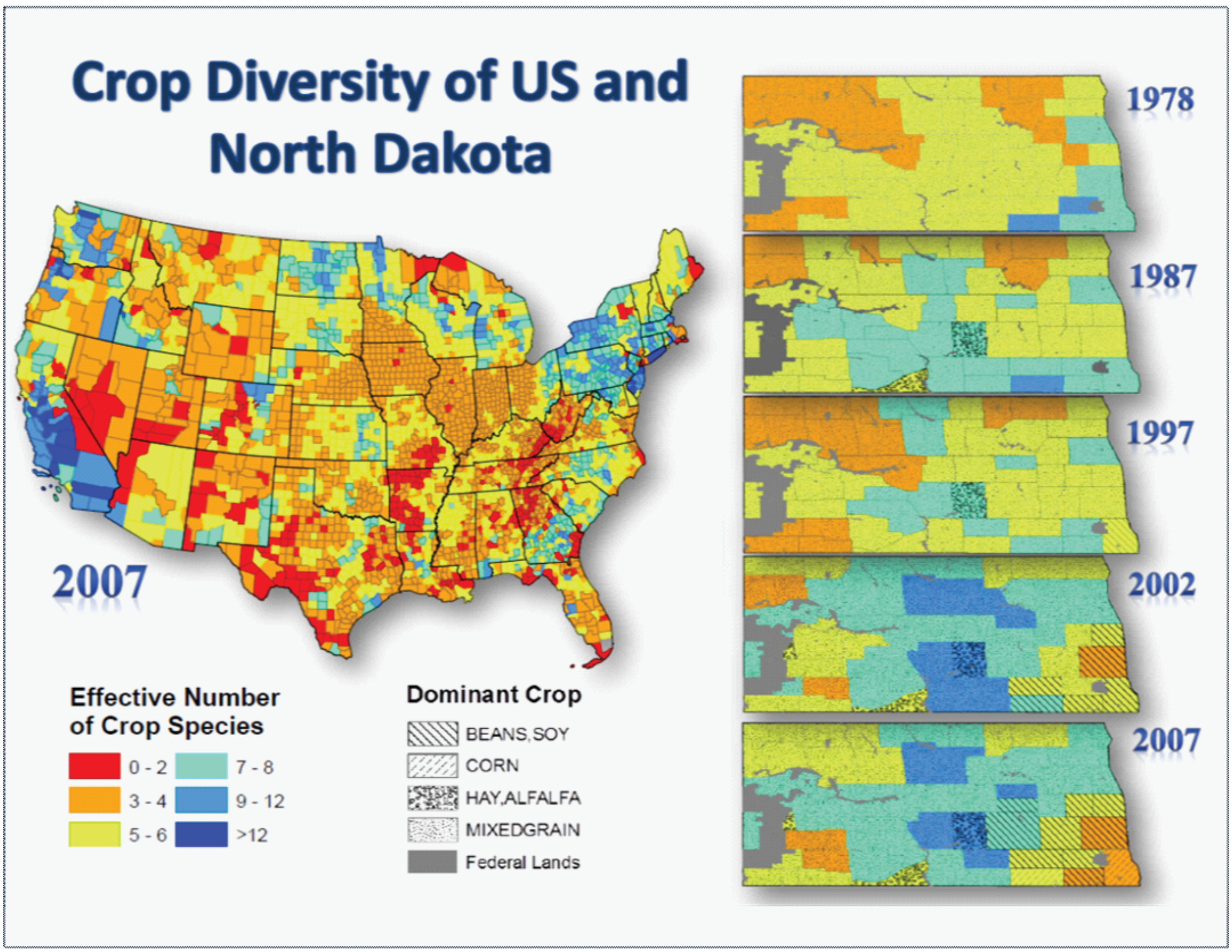

Crop diversity elicits diverse information

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Dr. Jonathan Aguilar

contiguous US (Figure 1). Low ENS (red) means low diversity, and high ENS (blue) denotes high diversity. As a hypothetical example, a county that has 10 crops with relatively even acreage between crops would have an ENS value of about 10, while a county with the same 10 crops but has most acreage dominated by one crop will get an ENS value of about one. The dominant crops, crops that had the highest acreage within a county, were overlaid on a map of North Dakota counties to get a better understanding the cropping systems.

Initial results show that there are indeed shifts in U.S. crop diversity but these shifts are regionally dependent. These data suggest that crop diversity has declined in the US Corn Belt. These decreases seem to coincide with increases in the predominance of corn as a major crop. On the other hand, many counties in the South Atlantic region show gains in crop diversity. Much of North Dakota has become more diverse between 1978 and 2007. This may be in part due to the persistent promotion of crop diversification in the state.

Understanding the pattern of cropping diversity could also raise interesting questions. Counties with low crop diversity seem to be expanding in the Midwest. What is driving the expansion? On the other hand, what could be happening in the South Atlantic region that drives up crop diversity? Could we speculate that corn production drives down crop diversity in the county, such as the case of the southeast corner of North Dakota? Is the conversion of wheat to soybean production a precursor to corn production? These are some questions that resource managers and policy makers could possibly be asking when shown the maps.

Crop diversity reflects several important ecological and social aspects of agriculture. Below are some the aspects and issues that will be considered as the research progresses.

1) Susceptibility to pest and disease – monoculture or low crop diversity is more susceptible than a very diverse cropping practice, thus these maps could be used to identify areas with high potential for pest and disease problems.

2) Technological advancement – the invention and adaptation of certain technologies could shift cropping management for an area or region. For example, the dawn of pivot irrigation systems have dramatic influence on the cropping management in the Northern and Central Great Plains, which influenced crop diversity depending on the land managers and location.

3) Farmer's management paradigm –individualism of farmers influences diversity in crop production, or the lack thereof. Individual farmers or ranchers could influence overall crop diversity of the county depending on their management standard and the extent of influence of their neighboring farmers , extension personnel, or other private and government entities.

4) Impact of government programs – in general, farmers respond to programs if the programs provide benefits that they value (economic, social, or environmental). The conservation reserve program, for example, may have transformed the crop diversity of some counties, but maybe not for other counties.

5) Economic policies and product markets – a major factor in decision making on the farm is economic return. Changes in commodity and input prices could change the crops planted on the farm to whatever is economically favorable.

6) Climatic shifts and weather patterns – droughts and floods are possible drivers for shifting from one cropping practice to another which could be based on the farmer's recent experience or on medium- to long-term weather forecasts.

7) Environmental soundness – land managers may adopt a different cropping system if environmental problems are eminent. For example, the extensive use of crops tolerant to glyphosate raises the concern of possible effects on weed resistance. Land managers could have differing responses to this concern.

Part of the research is to solicit insights from land managers with regards to the different drivers of crop

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AREA 4 SCD Cooperative Research Farm USDA ARS

Research Results & Technology Conference

NORTHERN GREAT PLAINS RESEARCH LABORATORY 100 YEARS

Featuring
Dr. David Parker
US Meat Animal Research Center
Clay City, NE
Management of Manure For Increased Ag Production & Water Quality Protection

Tuesday, February 21

Seven Seas Inn
Mandan, ND
12:00 Noon (CT)

NO COST

www.mandan.ars.usda.gov
701 667 3001

CCA CEUs

Registration & Complementary Lunch @ 11:30 AM
Luncheon Speaker: Dr. Don Tanaka, USDA-ARS Soil Scientist (retired)
"Taming the Prairie: *A Century of Ag Research*"

Area 4 SCD Research Farm 2011 Outcome — Dr. Mark Liebig, USDA-ARS Soil Scientist
Crop Yield Summary

Menoken Farm Cover Crops — Ken Miller, Burleigh County Soil Conservation
Amazing things we learned again this year!

Cover Crop Research — Dr. Dave Archer, USDA-ARS Agricultural Economist
What we learned in 2011

Manure Management at Destiny Dairy — Ole Johnson, Destiny Dairy, Stanton, ND
Maximizing the Asset

Efficient Bale Collection Strategies — Dr. Igathi Cannayen, NDSU Biofuels Engineer
Save time, effort, and money

Integrated Systems Project — Dr. John Hendrickson, USDA-ARS Rangeland Management Scientist
You tell us your research needs

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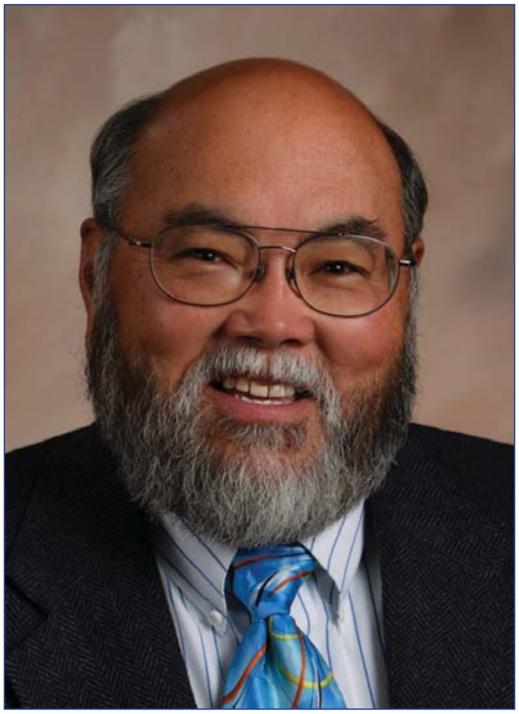
Tanaka Retires

Dr. Don Tanaka, Research Soil Scientist at the USDA-ARS Northern Great Plains Research Laboratory, has announced his retirement at year's end. His thirty-one year career helped change the future of agriculture.



Tanaka began his career with the USDA Agricultural Research Service in Sidney, Montana in 1980 and has been a significant leader in the team-centered research the Northern Great Plains Research Laboratory for over two decades.

In his leadership with the multi-disciplinary research team at Mandan, he pioneered no-till crop sequencing research to take advantage of soil/crop ecology interactions and improve soil moisture management. His efforts led to an evolution in cropping systems where production synergies enabled increased crop production, lower input requirements, and enhancement of natural resources.

His research led Tanaka to advocate integrated crop and livestock systems for improved family farm sustainability.

In addition to his research reporting in numerous scientific journals worldwide, Tanaka has been routinely interviewed by the farm press and featured in countless popular press articles. He has been a proficient, authoritative speaker throughout the Northern Plains and Canada.

His two decades of research and promotion of sustainable cropping systems supported North Dakota farmer's reducing reliance on wheat, barley, and oats by 31%, 82%, and 93% respectively. Acres of soybeans, corn, and canola grew 648%, 239%, and 4650% to increase crop sequence synergy. Tanaka's encouragement of including dry pea and lentil in the crop rotation assisted their growth by 437 fold and 50 fold from 1989 to 2010. His research and promotion of sustainable continuous cropping also led to the means to reduce fallow acres in the state by 84%.

Tanaka's research helped significantly improve sustainability of family farming and ranching. His impact has been recognized by selection as a Fellow of the American Society of Agronomy, receiving the Conservation Research Award from the International Soil and Water Conservation Society and Professional Award from the North Dakota Soil and Water Conservation Society. He was also named the Zero-Till Non-Farmer for the United States by the Manitoba-North Dakota Zero-Tillage Farmers Association.

Crop diversity elicits diverse information *continued from page 2*

diversity. In one instance a cooperator told us that having larger farm encourages him to diversify his crops. But in similar cases, farmers tend to focus on planting one crop out of convenience and availability of equipment. The research team is researching answers to these dynamics, especially with regards to some important local or even regional drivers. We encourage you to contact us if you have some helpful insights on this matter. Team members from NGPRL are Drs. Jonathan Aguilar, John Hendrickson (john.hendrickson@ars.usda.gov), Dave Archer (david.archer@ars.usda.gov), and Mark Liebig (mark.liebig@ars.usda.gov).

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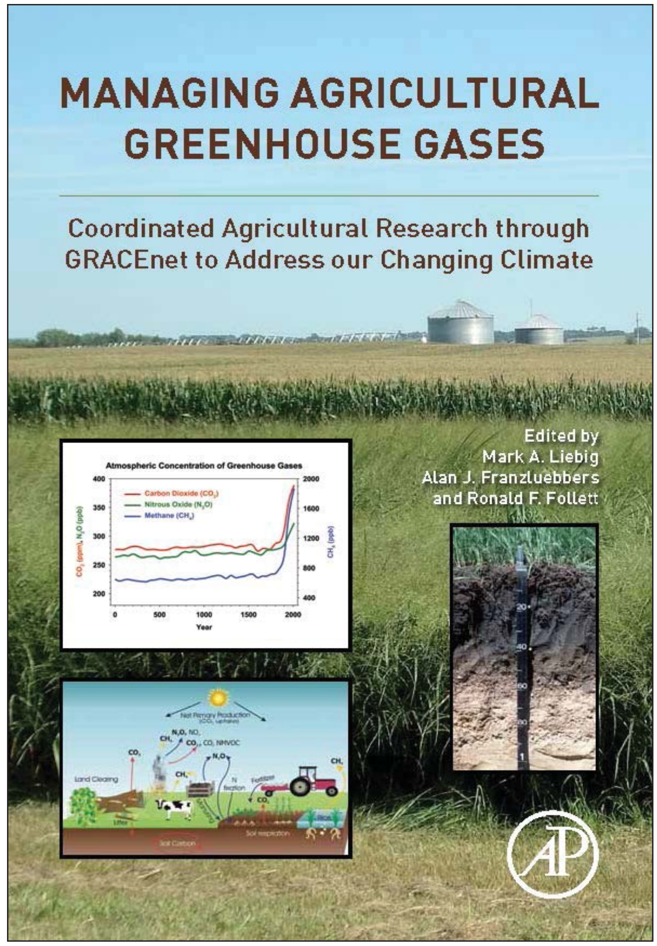
Feel free to pass on this issue of Northern Great Plains Integrator to others interested in agricultural research in the northern Great Plains. Northern Great Plains Integrator is published and distributed by the USDA-ARS, Northern Great Plains Research Laboratory, PO Box 459, 1701 10th Avenue S.W., 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

NGPRL scientists contribute to forthcoming book

Over the past 10 years scientists at NGPRL have been actively involved in a national research project within USDA-ARS called GRACEnet (Greenhouse gas Reduction through Agricultural Carbon Enhancement network). Since its inception, GRACEnet has sought to provide information on soil carbon dynamics and greenhouse gas emissions in agricultural systems in different agroecological regions throughout the United States, and evaluate how conservation management practices in these regions could reduce net greenhouse gas emissions. Collectively, GRACEnet scientists (numbering about 70 at 32 locations) have published over 250 research articles, and in doing so, have significantly expanded greenhouse gas mitigation science.



A book from Academic Press (Elsevier) will be published later this year synthesizing recent findings from GRACEnet scientists and university researchers throughout the United States. Managing Agricultural Greenhouse Gases: Coordinated Agricultural Research through GRACEnet to Address our Changing Climate (see cover) will consist of 29 chapters providing regional syntheses of soil organic carbon and greenhouse gas dynamics across a broad portfolio of agricultural land uses, as well as summaries addressing key activities central to GRACEnet (e.g., modeling, method development, economic outcomes, adaptation research, and international collaboration).

The book was co-edited by NGPRL soil scientist Mark Liebig, along with Alan Franzluebbers and Ron Follett, who are also ARS scientists. Dave Archer, NGPRL agricultural scientist, contributed a chapter addressing economic outcomes of greenhouse mitigation options. Collectively, the book is envisioned to support ARS's goal of providing knowledge and information to better implement scientifically-based agricultural management practices from field to national policy scales. The book is expected to be published in early summer 2012.

Liebig, M.A., A.J. Franzluebbers, and R.F. Follett (Eds.). 2012. Managing agricultural greenhouse gases: Coordinated agricultural research through GRACEnet to address our changing climate. Academic Press, San Diego, CA.

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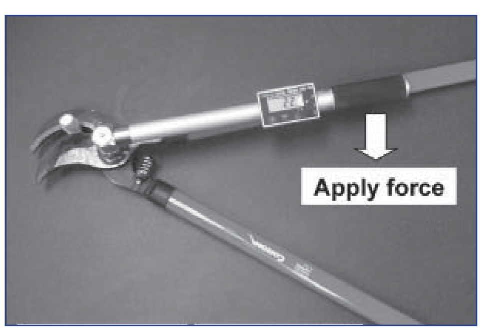
Fast and simple measurement of cutting energy requirement of plant stalk and prediction model development.



A novel idea of utilizing a digital torque wrench (DTW) assembled with a common bypass lopper to determine the cutting energy of corn stalks in combination with a modified Warner–Bratzler device attachment on a standard universal testing machine (UTM) was developed. Peak torque per unit area, peak stress, and net and specific cutting energy were determined. The DTW peak torque and UTM standard net cutting energy, and the DTW torque per unit area and UTM specific energy were strongly correlated ($r \geq 0.95$; $P < 0.0001$). Simple linear models (R2 ≥ 0.91; $P < 0.0001$) of net and specific cutting energy from the DTW readings were developed. The DTW cutting energy measurement method is fast, simple, less expensive, portable, and suitable for on-site measurements.

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Identifying Economic and Environmental Impacts of Harvesting Crop Residues for Biofuel Production

The Energy Independence and Security Act of 2007 set goals for the use renewable energy to meet liquid transportation fuel needs. Biomass has been identified as a large potential source to meet these needs. However, there are questions about the costs of obtaining enough biomass to meet biofuel needs and the impacts of biomass harvest on the environment.

For crop residue harvest to be profitable at the field level, farmers will need to be paid enough to cover the cost of any harvest operations, transportation, and storage costs they will be responsible for, plus the value of any additional fertilizer that would be needed in order to make up for the nutrients lost with the biomass, and any impacts that crop residue harvest will have on future grain production. Using field data and computer simulation modeling, we estimated these costs for each field within a 20-mile radius of Morris, MN to see what price a bioenergy facility would have to pay to get enough material for the plant, knowing that the price would need to be high enough for it to be profitable for the farmer. The analysis looked at harvesting wheat straw and corn stover.

Biomass transportation and handling costs can be substantial, and this will likely affect where biomass will be harvested. Figure 1 shows transportation and handling costs for biomass for crop fields within the 20-mile radius of Morris, MN. Because of the high biomass transportation costs it would be most profitable for fields closest to the bioenergy plant to be harvested (Figure 2). Increasing the price paid for biomass will expand the area where it is profitable to harvest. This increases the amount of biomass supplied. Over 600,000 tons of crop residues could be harvested from existing cropland within the 20-mile radius. However, the bioenergy plant would need to pay almost $75/ton for it to be profitable for farmers to harvest this much (Figure 3). The bioenergy plant would have to pay at least $54/ton before it would be profitable to harvest any crop residue in the area.

Crop residue is also important for protecting the soil against wind and water erosion, and for maintaining soil organic matter. Harvesting crop residue would generally increase soil erosion and decrease soil carbon (Figure 4). At high enough biomass prices, farmers would begin finding it profitable to shift crop rotations to more corn. Because corn produces more residue, the analysis showed this would partially offset the impacts of biomass harvest on water erosion and soil carbon, but not wind erosion. Some of these effects could also be reduced if farmers were willing to adopt less-intensive tillage practices. However, the analysis showed that harvesting residue did not increase the profitability of strip-tillage relative to conventional tillage, so was not likely to encourage producers to change to less intensive tillage systems based on economics alone. However, field research has shown that no-till and strip-tillage are at least as profitable and less risky than conventional tillage systems for corn and soybean production in the area (Archer and Reicosky, 2009). This could help allow for profitable biomass harvest without increasing erosion or degrading soil carbon.

From: Archer, D.W. and J.M.F. Johnson. 2012. Evaluating Crop Residue Biomass Supply: Economic and Environmental Impacts. BioEnergy Research (in press) DOI: 10.1007/s12155-012-9178-2.

Additional reference: Archer, D.W., and D.C. Reicosky. 2009. Economic performance of alternative tillage systems in the northern Corn Belt. Agron J 101:296-304

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Igathi Cannayen Recognized

Dr. Igathi Cannayen, NDSU Bioprocess Engineer working in collaboration with the Northern Great Plains Research Laboratory and the National Energy Center of Excellence, Bismarck State College, Bismarck, was presented the Outstanding Reviewer award by "Bioresource Technology" journal. He was also recognized as the American Society of

Agricultural and Biological Engineers (ASABE) Outstanding Reviewer for the "Food and Process Engineering Division." Only 10-11 of over 900 reviewers are recognized each year.

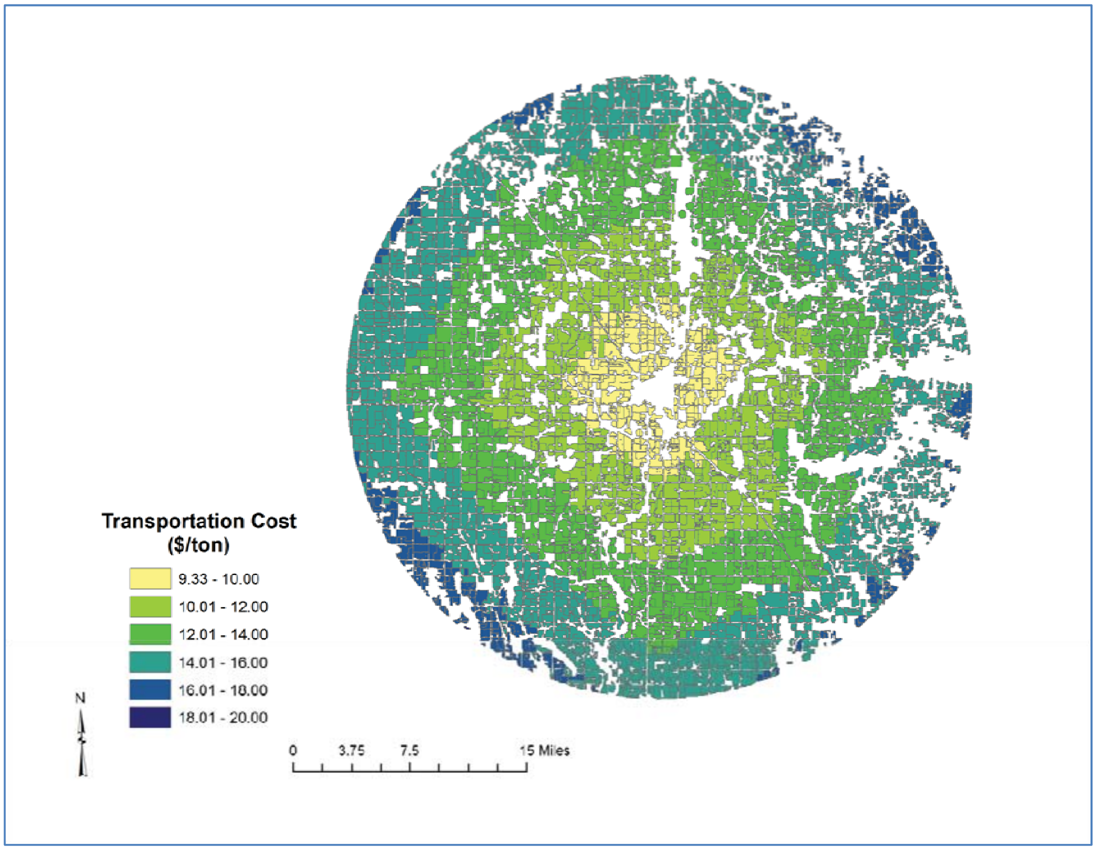


Figure 1. Biomass transportation and handling costs for crop fields within a 20-mile radius of Morris, MN

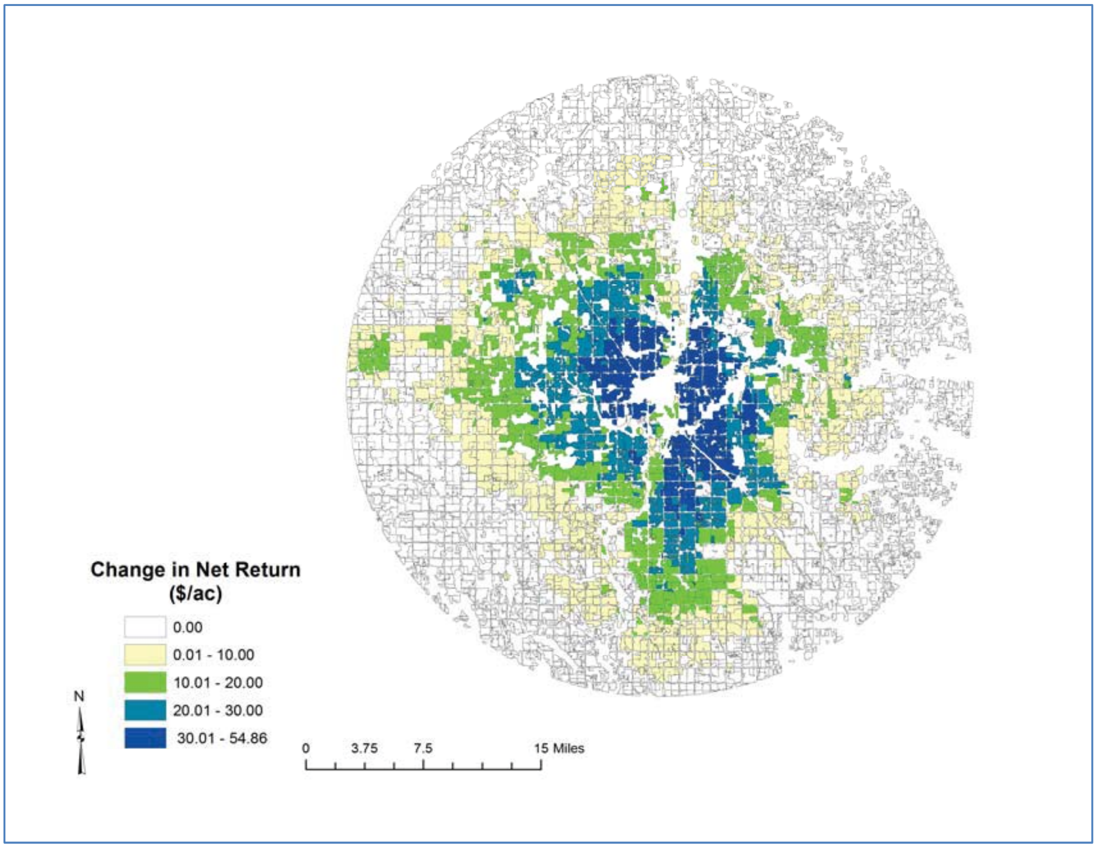


Figure 2. Annual net returns for fields where harvesting and selling crop residues at a price of $58/ton would be profitable.

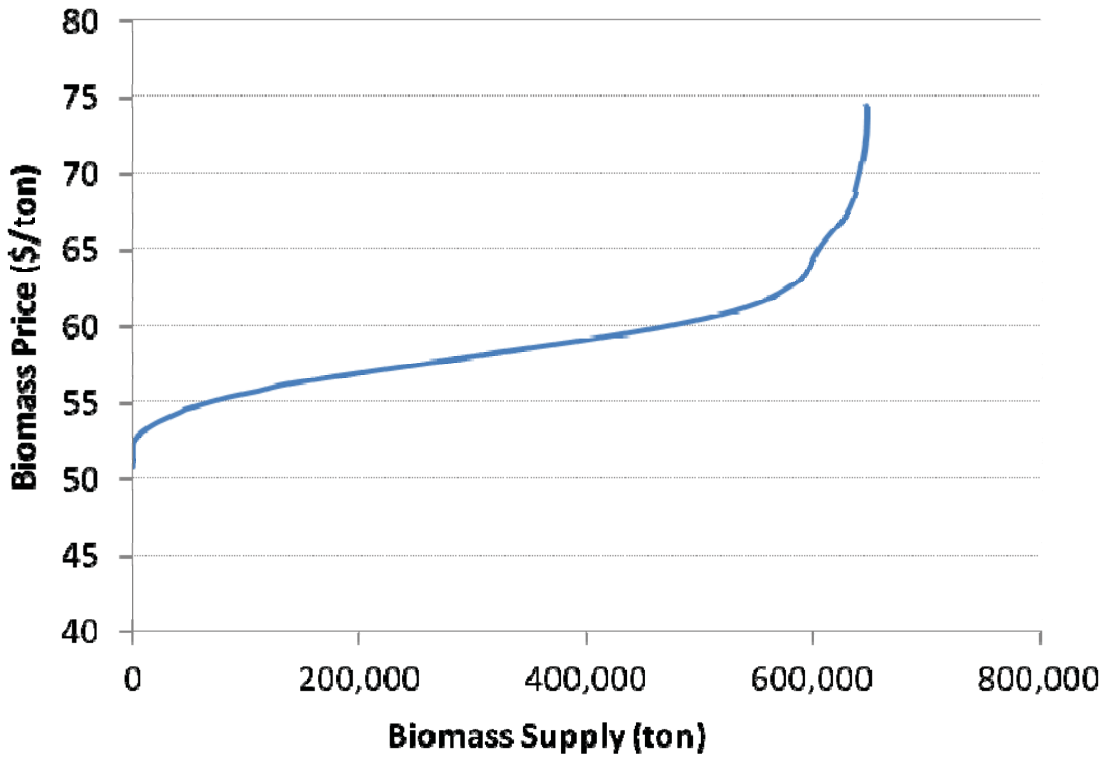


Figure 3. Relationship between farm-gate biomass price needed for profitable crop residue harvest at the field level and the amount of biomass supplied.

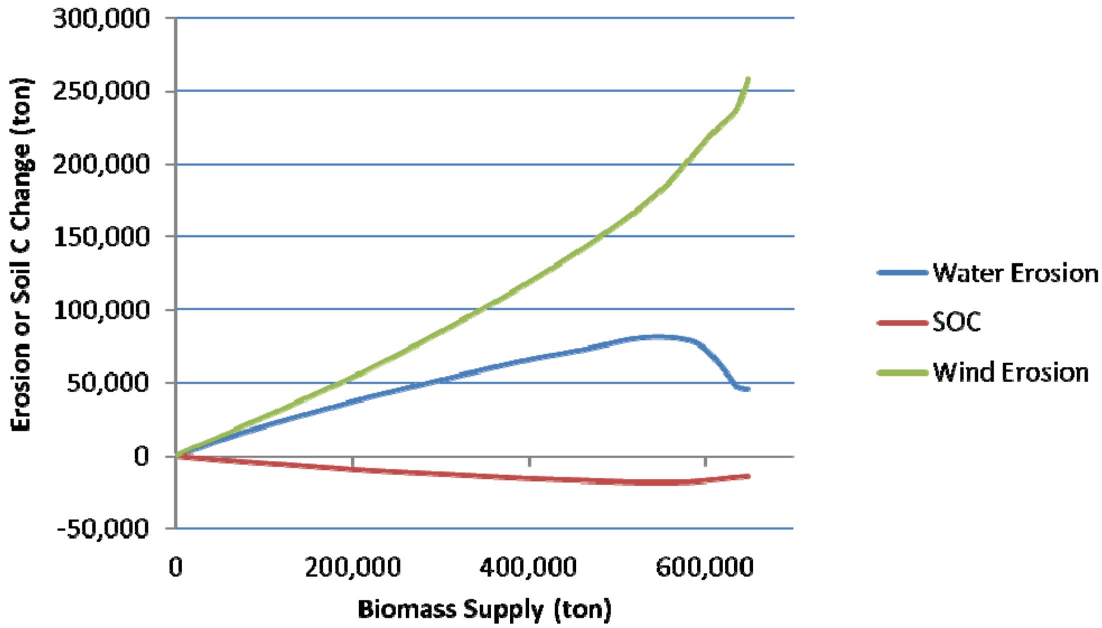
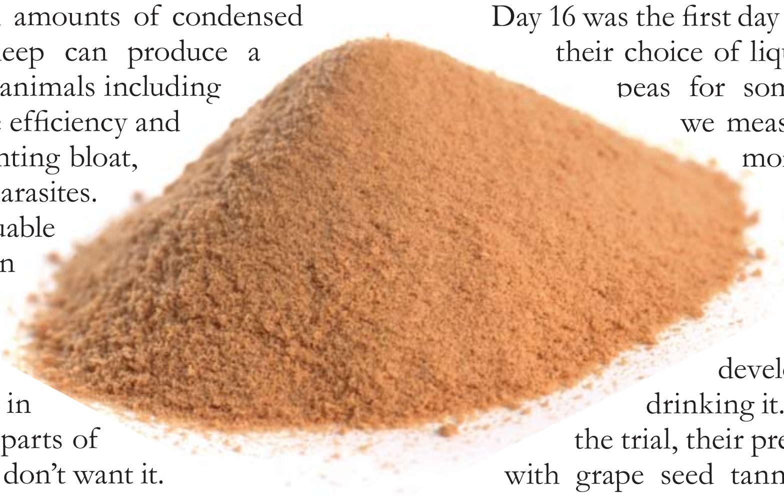


Figure 4. Change in annual water erosion, wind erosion, and soil organic carbon (SOC) as a function of the amount of biomass harvested.

Voluntary intake of small amounts of condensed tannins in water can be beneficial to cattle and our environment



Condensed tannins are a group of related compounds that occur naturally in many species of broadleaf plants. Ingestion of small amounts of condensed tannins by cattle and sheep can produce a variety of benefits to these animals including improving their protein use efficiency and their rate of growth, preventing bloat, and reducing internal parasites. In addition to these valuable things, tannin ingestion can reduce the amount of urea nitrogen that cattle excrete in their urine and this may result in less nitrogen escaping into parts of our environment where we don't want it. However, putting small amounts of condensed tannins into livestock can be difficult especially when the animals are grazing high quality pasture and may not be interested in eating supplements. One way to put small amounts of condensed tannins into grazing cattle and sheep may be via their drinking water and this may also turn out to be a useful way to put them into penned animals too. Consequently, we have been studying this potential for several years an recently evaluated the willingness of cattle to voluntarily drink water with small amounts of grape seed tannin in it when tap water was also available. The graph below indicates combined daily ingestion of water (in liters with a liter being just a little more volume than a quart) with various concentrations of grape seed tannin in it as well as ingestion of tap water for 5 yearling heifers that were simultaneously offered 4 concentrations of grape seed tannin in tap water (0.5, 1.0, 1.5, and 2.0% of their daily dry matter intake) or pure tap water. For days 1 to 14 of the trial the heifers were fed alfalfa pellets at 3.1% of body weight that were 17% crude protein and 92% dry matter. Then starting on day 15 we substituted 8.8 lbs per day of dry peas (22% crude protein) for 8.8 lbs of alfalfa pellets in order to see if the heifers would drink more tannin water if we increased the amount of crude protein in their diet. Day 16 was the first day we would see a response in their choice of liquid intakes after swapping peas for some alfalfa pellets because we measured liquid intakes in the morning as they were eating their morning rations. As we expected, the heifers required several days of sampling the tannin water before they developed a preference for drinking it. During the last 5 days of the trial, their preference for drinking water with grape seed tannin in it became stronger when we increased the amount of crude protein in their diet by substituting alfalfa pellets with dry peas, and we speculate that they did this because condensed tannin binds to plant protein and prevents microorganisms in the rumen forestomach of cattle from degrading plant protein to ammonia (a toxic substance that cattle have limited tolerance for) and allows more plant protein to pass to the true stomach where it be converted to high quality amino acids for beneficial uses by various tissues in the body of cattle.

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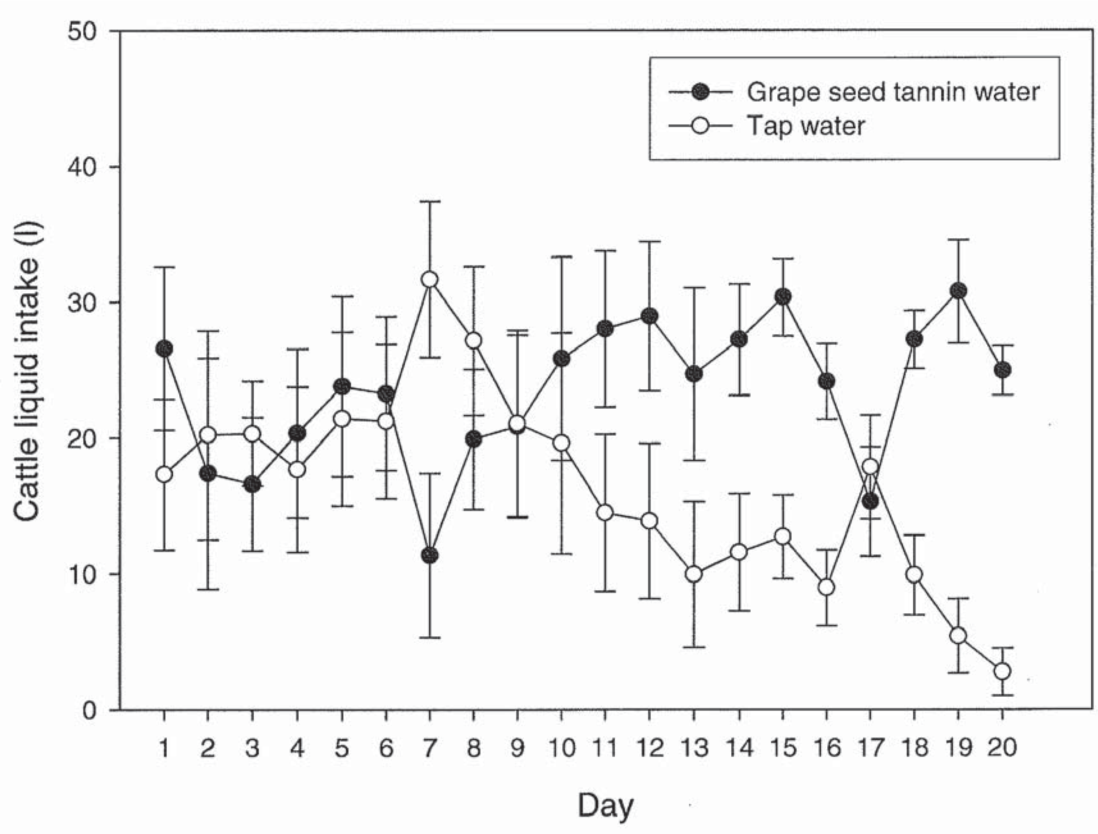

Dr. Rebecca Phillips returns from research in Australia

Dr. Rebecca Phillips, NGPRL Research Plant Physiologist, recently returned from a four month research project in Australia developing new environmental research instrumentation. In Australia, Dr. Phillips assisted a scientific team from the University of Wollongong who are experts in atmospheric measurements. The team worked onsite at facilities of the Manildra Group, the largest user of wheat for industrial purposes in Australia.

Over the last 50 years Manildra has vertically integrated and as a result diversified the product range to include flour, pre-mixes and products derived from flour such as modified starches, glucose syrups, maltodextrine, gluten, specialty protein products and ethanol.

AIS-AU, stands for Agriculture, Industry and Science in the Australia.

The field site pictured processes wheat grain into starch products. The process yields a highly organic waste bi-product that is fractionated into products used for ethanol and cattle feed. The remaining effluent is irrigated onto several hundred acres of grass fields for cattle to consume.

The scientific team which Phillips collaborated with are studying this area to determine the effects of effluent on soil-plant-water-atmosphere relationships in this tidal floodplain region where acidity and salinity must be carefully managed. Collaboration with Dr. Phillips helped them advance knowledge of mechanisms controlling production of trace gases and associated linkages with soil carbon.

The back of the instrument Dr. Phillips is working on in the lab.

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The FTIR is the full scale Fourier transform infrared spectrophotometer.