Request for Information, Long-Term Agro-Ecological Research (LTAR)

Title: Upper Mississippi River Basin LTAR 11/15/2011

A. Summary: The Upper Mississippi River Basin is an important agricultural region. The intense agricultural production in this area causes inherent environmental problems, including nitrate export to the Gulf of Mexico, eutrophication of lakes, soil erosion and greenhouse gas emissions. This Long-Term Agro-Ecosystem Research station consists of a distributed network of research sites, including five watersheds: the South Fork of the Iowa River, Walnut Creek N (Story Co., IA), Walnut Creek S (Jasper Co., IA), Chippewa River in west-central MN, and The Pat's Creek – Galena River watershed in southwest WI. Ancillary field sites are available to support research relevant to agricultural systems. Scientific expertise is provided by several USDA-ARS laboratories: National Laboratory for Agriculture and Environment (NLAE), the ARS North Central Soil Conservation Research Laboratory (NCSCRL) in Morris, MN, the Soil and Water Management Research Unit, St Paul, MN, and the University of Wisconsin-Platteville Pioneer Farm. This proposal describes watersheds and other research that demonstrate the ability to support an LTAR.

B. Introduction and Rationale

Agroecosystems are fundamentally important to society in a variety of ways: production of food, feed and fiber, regulation of water supply and quality, and production and sequestration of greenhouse gasses. Agroecosystems include plant, animal and microbial life forms, soils and water, and atmospheric components. Understanding the flows of carbon, nutrients and water among these components is the key to understanding the provisioning of ecosystem services and resiliency of agroecosystems. Agroecosystems differ from other ecosystems in the degree of human management and influence. Walbridge and Shafer (2010) stated that "Long-term field studies are particularly important for anticipating the environmental effects of shifting agricultural practices, improving the effectiveness of conservation programs, and identifying the broader societal benefits of modern agriculture, such as bioenergy production, carbon sequestration, improved water quality and water-use efficiency, and wildlife habitat."

C. Research Questions and Objectives

Long-term research (LTR) addressing agroecosystems should focus on the exchange of nutrients, carbon, water and gasses among ecosystem components. In addition, LTR should address soil organic structure and composition in relation to biodiversity of crops, animals and soil biota. Agricultural systems are designed to produce food and fiber which is exported outside the ecosystem, while receiving substantial inputs of energy and nutrients from external sources. This LTAR is developed with the goal of integrating information across a range of locations and partners to address these complex research questions through the development of an interactive multidisciplinary and multiscale network.

Research Questions

- How do cropping systems that include perennials, longer rotations and integrated systems of crops with livestock on the land affect soil fertility and in turn water infiltration, water storage in the soil profile or loss to tiles and runoff?
- What water quality improvements can be gained from new conservation practices for tile-drained landscapes?
- What are the economic trade-offs among production systems and conservation practices?
- How are watershed hydrology and water quality responding to changes in climate and agricultural practices?

- How are the fluxes of carbon, water, and nitrogen affected by changes in conservation practices and linked to water quality?
- How can we use LTAR data to estimate ecosystem services?
- How does landscape structure (topography, vegetation, land use) affect the up-scaling of soil and aquatic processes to a regional level?
- From a systems analysis standpoint, what are the key indicators for defining resilience and stability of an agroecosystem? What are the critical factors controlling resilience and stability?

D. LTAR Infrastructure and Capacity

This LTAR seeks to address the dominant agroecosystem of the upper Midwest, the corn-soybean-animal production system. Hydrologically, this is the Upper Mississippi River Basin (Figure 1). A variety of research watersheds, field plot experiments laboratories, and databases are used to assemble relevant data from which inferences can be made about the Upper Mississippi River Basin (UMBR). The proposed LTAR generally lies within the Prairie Peninsula domain of the National Ecological Observatory Network (NEON, http://www.neoninc.org/science/domains). However, the NEON sites within this domain are located in northeast Kansas outside the boundary of this LTAR. The LTAR boundaries coincide with the NRCS boundaries of the Upper Mississippi River Basin. The NSF-funded Critical Zone Observatory network has no agricultural sites and the sole agricultural LTER (Kellogg Biological Station) is located in south-central Michigan.

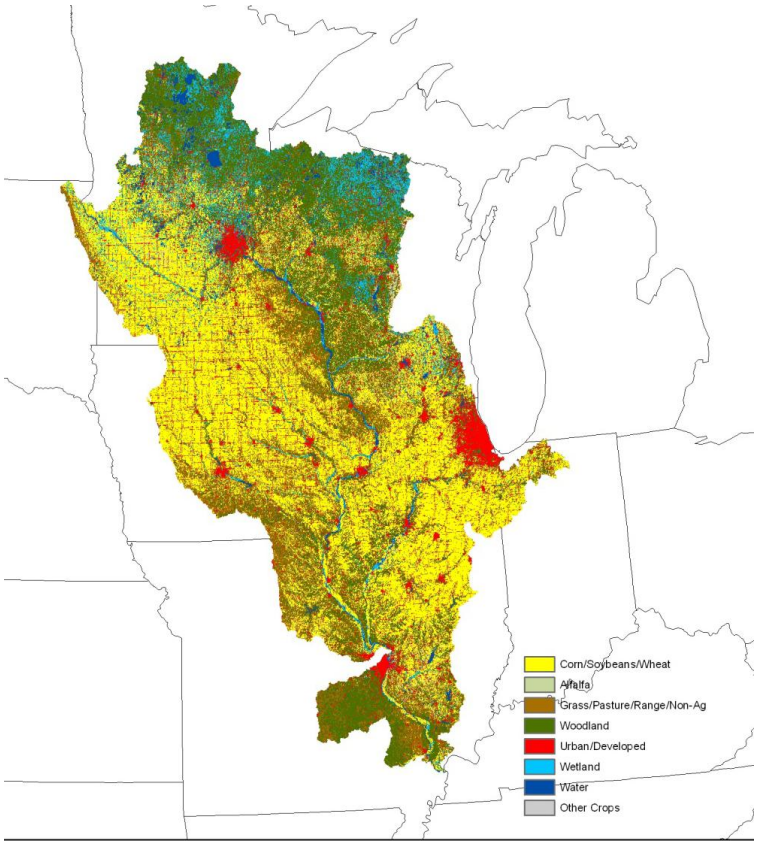


Figure 1. Upper Mississippi River Basin land use (Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Upper Mississippi River Basin. USDA-NRCS)

Watersheds

Walnut Creek North, Iowa

Characteristics: Walnut Creek in Boone and Story counties Iowa drains 5,130 ha in the Central Iowa and Minnesota Till Prairies (MLRA) and Des Moines Lobe physiographic regions (Figure 2).

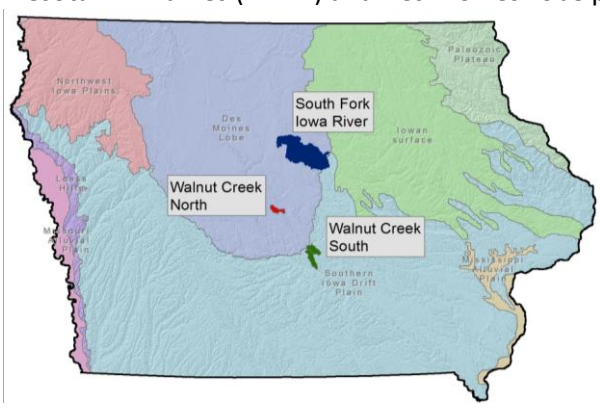


Figure 2. Location of Iowa watersheds in relation to major landforms.

The landscape is underlain by glacial till deposited 10-15,000 years ago (Eidem et al., 1999), with the exception of the driftless region of NE IA, SE MN, and SW WI. The maximum relief on the poorly dissected terrain is generally less than 5 m with internally drained prairie potholes common in the upper parts of the watershed. Aquic soils occupy 60% of the watershed area. The Clarion-Nicollet-Webster soil association dominates the landscape, with Okoboji and Harps soils occupying potholes. Subsurface tile drains and ditches installed over the past 120 years accelerate drainage and transport of several dissolved contaminants. Normal annual precipitation is 818 mm with 52% falling during May through August in relatively short, but intense events. Annual base flow, which includes tile flow, constitutes 75% of the total stream discharge. Much of the remaining runoff is derived from inlets into the subsurface drain system. About 80% of the watershed is under corn and soybean rotation; 3% in forage crops, 3% in pasture; 4% in woodland; and the remainder in small grains, transportation, and farmsteads. The only animal production operations in the watershed are a seasonal beef pasture area and a small horse farm. The hydrologic data record extends back to 1992, with precipitation, temperature and other weather data. The monitoring network is shown in Figure 3.

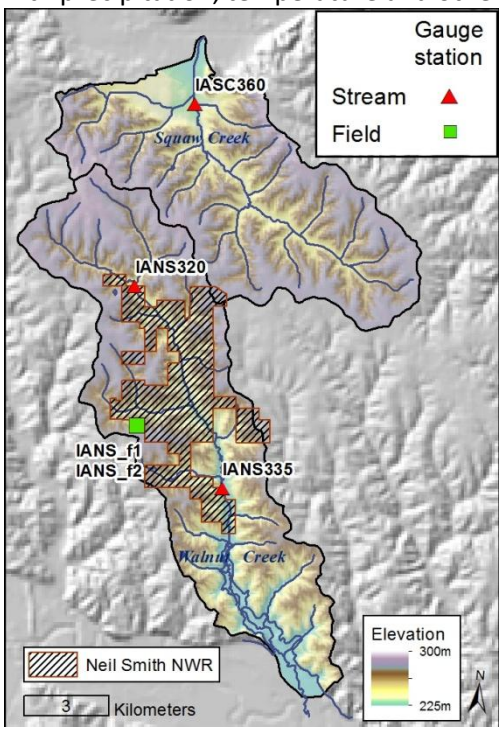
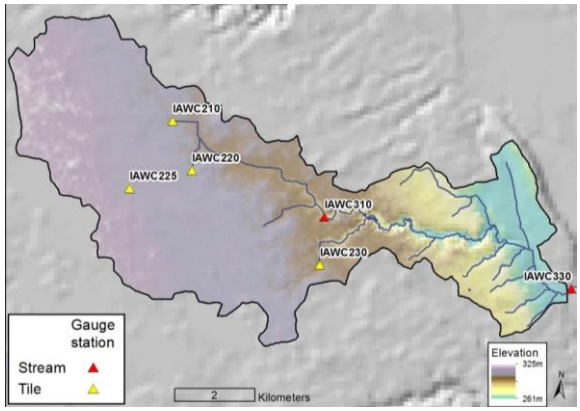


Figure 3. Maps of Walnut Creek South / Squaw Creek (left) and Walnut Creek North (right) with gauged monitoring sites. Sites mapped, but not listed in the table below have data in STEWARDS, but are no longer active.



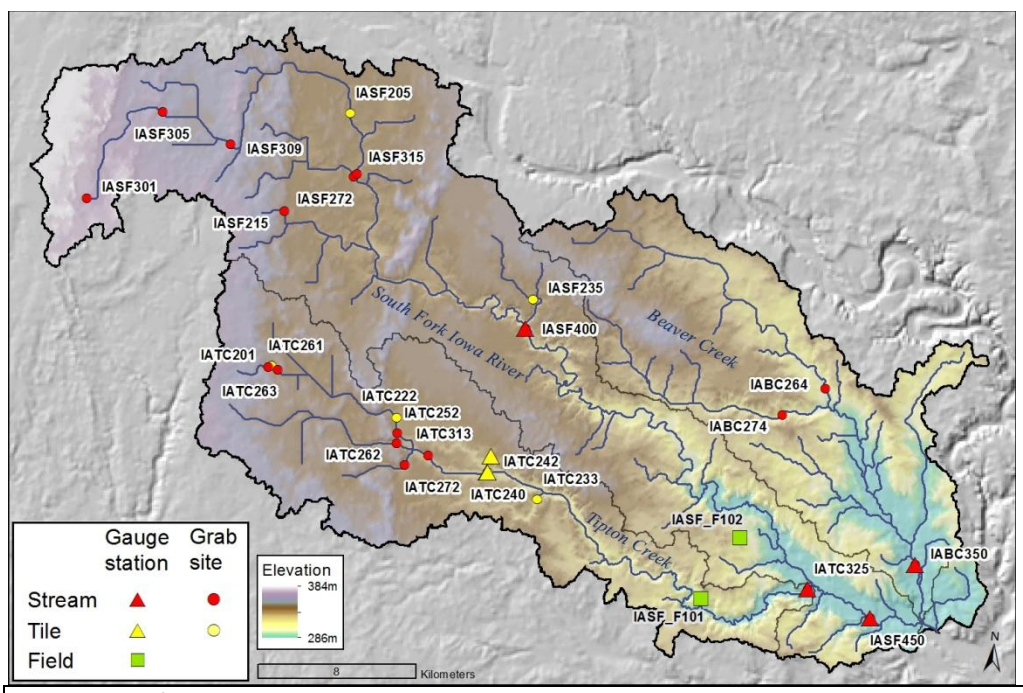
Watershed	Sites	Gauging	Sampling
Walnut Cr S – Stream	NS320, 335	Yes	event and weekly grab
Walnut CR S- Field	NS-f1, f2	Yes	event – field runoff
Squaw Cr – Stream	SC360	Yes	event and weekly grab
Walnut Cr N – tile	WC210, 220, 230	Yes	event and weekly grab
Walnut CR N- stream	WC310, 330	Yes	event and weekly grab

Discharge from the watershed is dominated by base flow (tile-drainage) in all years and all months. Average monthly discharge is greatest during the March-July period and runoff is the largest percentage of total discharge in March due to snowmelt and rainfall on frozen ground. Atrazine and metolachlor have been detected at concentrations > 0.2 µg L^{-1} in about half of all surface water samples, while alachlor and metribuzin have been seldom detected. Atrazine and metolachlor concentrations have rarely exceeded health advisory limits and mean yearly concentrations have been below 2 µg L^{-1} for all locations within the watershed (Jaynes et al., 1999). In contrast, nitrate concentrations have often exceeded 10 mg N L^{-1} during April - July. Total nitrate losses from the watershed have ranged from 1 to 66 kg N ha^{-1} yr^{-1} which is equivalent to 1.5 to 115% of the fertilizer N applied in any year. Thus, nitrate is the primary pollutant of concern related to agricultural activities within the watershed.

South Fork of the Iowa River, Iowa

Characteristics

The South Fork of the Iowa River watershed (Hardin and Hamilton Counties, Iowa) has a total drainage area of 78,000 ha, with about 76,250 ha of this area contributing stream flow to gages being monitored by USDA/ARS/NLAE. The major sub-basins of Tipton Creek (19,850 ha), Beaver Creek (18,200 ha), and the upper South Fork (25,600 ha) are instrumented with separate gage stations. Monitoring was established in 2002. In addition to flow, the data record include precipitation, weather data, nitrate and ammonia, total P, *E. coli*, *Enterococcus*, and some soil properties data (Stott et al., 2011).



Watershed/Tributary	Sites	Gauging	Sampling
South Fork: tile	SF 205, 235	no	monthly – grab

South Fork: stream	SF301, 305, 309, 315, 272	no	monthly – grab
South Fork: stream	SF400, 450	yes	event and weekly grab
South Fork: field flume	SF101,102	yes	event – field runoff
Tipton Creek – tile	TC201, 222	no	monthly – grab
Tipton Creek – tile	TC240,242	yes	event and weekly grab
Tipton Creek – stream	TC252, 262, 263, 272, 313	no	monthly – grab
Tipton Creek – stream	TC325	yes	event and weekly grab
Beaver Creek – stream	BC264, 274	no	monthly – grab
Beaver Creek – stream	BC350	yes	event and weekly grab

Figure 4. Maps of Walnut Creek South / Squaw Creek (left) and Walnut Creek North (right) with gauged monitoring sites.

The Clarion-Nicollet-Webster soil association (Typic Hapludolls – Aquic Hapludolls –Typic Haplaquolls) dominates the landscape, with Harps soils (Typic Calciaquolls) occupying glacial potholes with the Webster soil. The landscape is composed of glacial till deposited 10-15,000 years ago, mostly on the Des Moines Lobe (Figure 4). The terrain is poorly dissected and internally drained "prairie potholes" are common in the upper parts of the watershed. The low relief creates poor drainage conditions, and hydric soils occupy 54% of the watershed area. The drainage network accelerates transport of several dissolved contaminants. Normal annual precipitation is 750 mm with 60% falling during May through August often in relatively short, but intense events. Annual baseflow constitutes about 75% of the total stream discharge; most of this (60-65% originating from tile drainage). Much of the surface runoff is conveyed to ditches and streams via surface drainage inlets connected to subsurface drainage mains. About 85% of the watershed is under corn and soybean rotation, and about 6% in grass (CRP) and pasture. Most of the remainder is roadways and developed land cover, only about 1% is forest or wetland. There are about 100 confined swine-feeding operations, most of which are located in Tipton Creek and the upper South Fork.

Nitrate loads from subsurface drainage systems, phosphorus, and sediment in runoff, and pathogens and veterinary pharmaceuticals in stream flow are major water quality concerns (Tomer et al., 2008a). In addition, stream banks are a contributing source of sediment. Conservation practices include conservation tillage (329A and 329B), riparian buffers (391), nutrient management (590), waste utilization (633), constructed wetlands (656), grass waterway (412), and subsurface drainage (606). The distribution and potential effectiveness of conservation practices was discussed in Tomer et al. (2008b).

Walnut Creek South, Iowa

Characteristics

Published literature shows that water quality often responds slowly to land use change, but long-term observational data are needed to better determine the extent and rate of water quality response. Changes in land use and conservation cover are seldom under experimental control in large agricultural watersheds. However, we have the opportunity to study a rare exception in WC-S, where a large-scale ecosystem restoration project is underway at the Neal Smith National Wildlife Refuge (NSNWR - located within WC-S), and a neighboring reference watershed (Squaw Creek, SC) is available as a baseline comparison (Figure 3). Land above site NS320 is primarily agricultural and below this site is NSNWR's restored prairie. Schilling and Spooner (2006) showed nitrate concentrations declined slowly as prairie reconstructions were established during the refuge's first 13 years. Expansion of the prairie reconstructions has since continued at a slower pace, and the focus of NSNWR is shifting from prairie establishment to management issues including invasive species, establishing the role of prescribed fire in long-term management, and maintaining herds of bison (*Bison bison L.*) and elk (*Cervus canadensis*).

As watershed monitoring continues, the opportunity exists to document long-term water quality response to land cover change, climate, and management of the refuge.

Our watershed monitoring program has operated stream gauges located up-stream and down-stream of NSNWR since 2007, extending the record from the first ten years of stream monitoring. We based our monitoring scheme on that described by Schilling and Spooner (2006), but expanded the weekly manual sampling to include automated collection of a flow-paced composite sample during each rainfall-runoff event. Samples are analyzed for nitrate-N, total P, and sediment (total suspended solids) using standard methods. Our intent is to extend results from Schilling and Spooner (2006) to determine if the slow rate of decline in nitrate-N concentrations during the first decade (0.6 mg NO_3-N L^{-1} yr^{-1}) is accelerating as prairie reconstructions expanded and became fully established. These watersheds are not on the Des Moines lobe, but consist of loess-derived soils over glacial till. Predominate soils include the Tama, Otley and Ladoga series. NLAE has soil data at selected locations, largely within the reconstructed prairie dating back to 1993 (Cambardella et al., 2003).

Watershed Support. All NLAE watersheds gauge sites are equipped to measure flow and to obtain flow-weighted water samples. Precipitation and weather data are gathered at multiple sites within the watershed. Most stream monitoring sites are instrumented with multi-parameter sensor systems that continuously measure dissolved oxygen, turbidity, temperature, pH, and conductivity. The specific locations and descriptions of equipment and site locations can be found in STEWARDS (www.nrrig.mwa.ars.usda.gov/stewards/stewards.html). The NLAE hydrology team is comprised of a support scientist, two research technicians, plus two part-time student employees, with expertise in data management, programming of field systems, surveying, and data acquisition systems involved in gauging. This group maintains field systems, conducts channel profiling surveys, performs stage-discharge rating curve analysis, collects and processes samples for further analysis, conducts sediment analysis of samples, performs QA/QC of sample and flow data, and processes data towards upload to the STEWARDS database, that is publicly available on the internet.

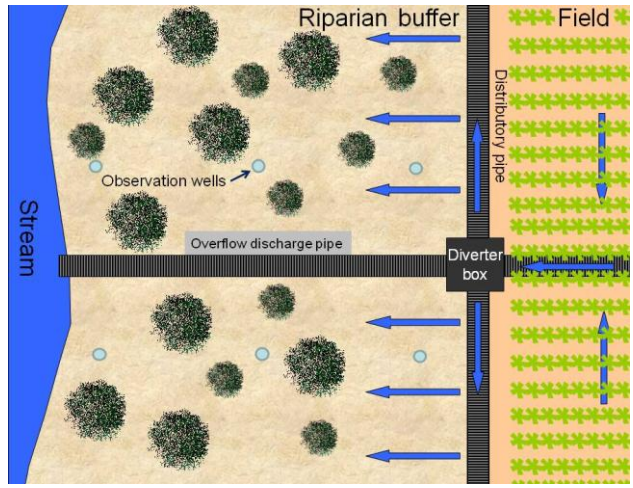
NLAE maintains an analytical laboratory that supports watershed and plot research. Laboratory staff includes a full-time manager, Amy Morrow, an analytical chemist with 22 years of experience (13 years as laboratory manager), and four permanent physical science technicians that specialize in soil and water assays and collectively have 82 years of analytical expertise. This team is responsible for operating, maintaining, and following the Quality Assurance/Quality Control principles governing the lab. The geographic information systems and database development are supported by expertise of David James, who also supports STEWARDS database.

Field Research Sites - Iowa Watersheds

REAP (Renewable Energy Assessment Project. The NLAE conducts several plot-scale studies on land in Story and Boone counties to address the issues of sustainable bioenergy production. The REAP project coordinates research addressing these topics across the United States. Work focuses on biomass harvest strategies, the effect of biomass removal on soils, and management practices (cover crops, living mulches, conservation tillage, biochar and perennial rotations) that allow sustainable biomass production for biofuel (Johnson et al., 2010a, 2010b) . The studies at Ames are conducted on plots in Boone County on soils similar to those in the Walnut Creek and South Fork watersheds.

Subsurface Drainage Field Plots. Field plots with subsurface drainage and equipped for measurement of flow and loads were established in 1999 at Kelly Farm. Water flows and nitrate loads have been measured since 2000 and these data have been used to evaluate the effects of cover crops and denitrification trench bioreactors on reducing nitrate losses (Kaspar et al., 2007, Jaynes et al., 2008, Moorman et al., 2010). These plots are also being used to investigate nitrous oxide fluxes. An additional set of plots equipped with subsurface drainage and monitoring equipment were established in 2011 and

are being used to compare water flow and nitrate loads from organic farming practices. Both sites are in Boone County on soils over glacial till and are generally representative of both the Walnut Creek and South Fork watersheds.



Saturated Buffer – Bear Creek: Redirecting field tile drainage through a distribution pipe into shallow groundwater flowing through riparian buffers, a substantial fraction of the nitrate load will be removed before entering surface waters. To determine how much of the nitrate diverted into the buffer is removed before entering the stream, we will monitor the shallow groundwater introduced to the buffer by the distributory pipe. A series of wells located along four transects between the pipe and stream will be installed. The water table depth at the wells will be monitored and recorded every six hours with Global Water (WL-16) water lever loggers. Water samples will be taken on a bi-weekly basis from the wells and tile and analyzed for nitrate

Brooks Field. This site is a producer field where long term records exist on the field-scale variation in energy, water and CO_2 balances. Turbulent fluxes of sensible and latent heat (H & LE) and CO_2 are measured using the eddy covariance (EC). Each EC system is comprised of a three-dimensional sonic anemometer (CSAT3 Campbell Scientific Inc. Logan, UT1) and a fast response water vapor (H_2O) and CO_2 density open path infrared gas analyzer (IRGA) (LI7500 LICOR Inc., Lincoln, NE). In both the corn and soybean fields EC instrument height is maintained on the 10 m towers at approximately 2 h (where h = canopy height in m) above the surface. An additional fixed height tower at 10 m is located at the boundary of the corn and soybean fields and contains the same instrumentation as the within field towers. Ancillary data include soil moisture, soil heat flux, leaf area, plant productivity, and reflectance measurements.

Remote Sensing – SFIR: Field sites in SFIR have been used to verify efforts to use remote sensing for estimating biomass production and crop residue cover.

Chippewa River Watershed, Minnesota

Characteristics: The Chippewa River Watershed (CRW), with a population of about 41,000 people, drains 5387 km^2 of mixed natural and managed landscapes. The watershed has major public amenities and 3219 km of intermittent and perennial streams. The primary land-use in the CRW is agriculture as corn, soybeans, sugar beets, wheat, dry edible beans and grass-based livestock. Annual crops currently predominate on 81 to 94% of the land in southern sub-watersheds. The northern sub-watersheds are still predominantly agricultural (60 to 68%), but have more grass, forest and water and integrated crop and livestock operations. The watershed is included in the new Minnesota Prairie Plan to expand grass-based working farms around core natural prairie areas.

The CRW is the object of Total Maximum Daily Load (TMDL) assessments for fecal coliform bacteria and ammonia. A third TMDL study for turbidity is underway. In addition, the CRW will be part of a TMDL for sediment for the Minnesota River and part of a TMDL for sediment and nutrients for Lake Pepin, which aggregates pollutants and runoff from the Minnesota River basin, including the CRW (Senjem 2008).

Due to current land-use systems, the CRW faces a number of environmental challenges, including degradation of water quality, threats to biodiversity, and increased flooding, soil erosion and nutrient loss to both surface and underground water (Boody et al. 2005; Nangia et al. 2010). In addition to these environmental challenges, the impact of spatio-temporal climate variability in the watershed is likely to be intensified by climate change, which is predicted to disrupt many ecosystem functions, altering their capacity to provide goods and services and rendering them more susceptible to degradation (Friend, 2010).

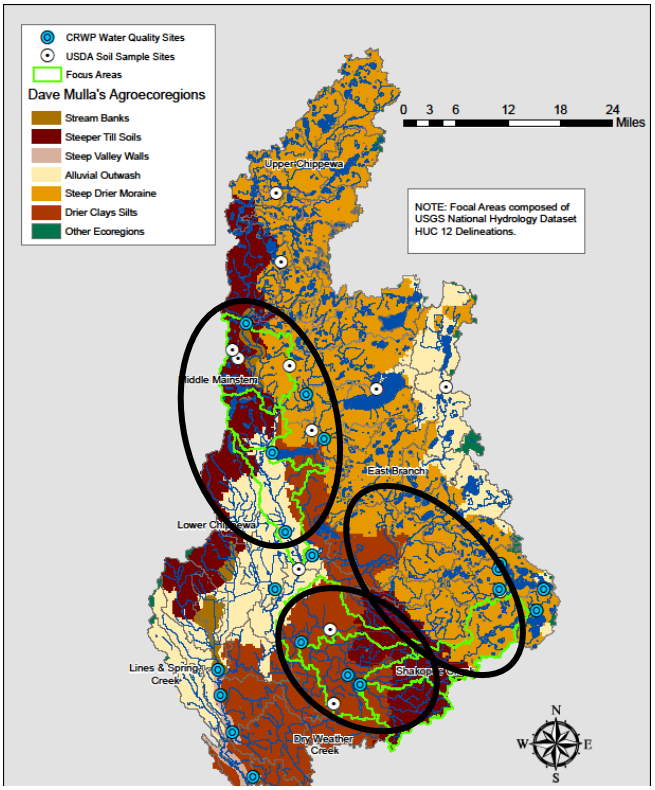


Figure 5. Chippewa River watershed, showing sub watershed areas and land use. Circles indicate focus areas for targeted conservation.

Earlier monitoring efforts in the CRW (Wymar, 2007) resulted in establishing a water quality and quantity baseline, and concluded that increased perennials on the landscape is necessary to enhance environmental and economic agroecosystem services, promote conservation incentives, and develop viable markets for perennials and integrated crop-livestock production systems. Previous modeling predicted that land resources in the CRW can be multifunctional; they can provide a large number of functions related to social, economic and environmental prosperity and sustainability (Boody et al. 2005; Jordan et al. 2007).

Given the complexity of the agroecosystem, and the spatio-temporal variability of the involved processes, modeling is needed (Hatfield et al. 2008) for assessing the impact of alternative agricultural management strategies, including more permanent plant cover on the landscape, on biophysical (biomass and grain yield of crops, carbon sequestration in the soil, nitrogen loss, runoff, and soil erosion) processes in the watershed. This needs to be an iterative process with implementation of targeted systems and practices. Our partnership-based approach is summarized as follows.

Approach: The Chippewa 10% Project is intended to make voluntary, practical connections between land-use change at the field/farm level and watershed goals for multiple ecosystem services. Water monitoring addresses concentrations and loads for nutrients (nitrate, phosphorus), sediment, *E coli* and other contaminants. Ecologically sensitive fields, areas in grass or wetlands to be maintained, economically marginal lands for row crops or other areas are being identified through GIS, visual inspection and discussions with farmers. HUC 12 focal areas in two areas and a third focal area have been identified to begin one-to-one outreach (Figure 5). Efforts led by Land Stewardship Project (LSP) and CRWP include the "Profits from Perennials" (http://chippewa10.org/) series that recognize the essential link between diversified farming systems that can profit farmers and communities and play a key role in creating a healthy ecosystem.

The Chippewa River Watershed Project (CRWP) has for13 yrs measured water quality and flow at the 8 digit and sub-watershed levels with 19 instrumented sites. From April 1 through September 30 data

loggers are installed to take continuous flow measurements at primary monitoring stations. Water samples are taken during high and low flow conditions and analyzed at a state certified lab for nitrate-nitrogen, total phosphorus, orthophosphorus, total suspended solids, turbidity and *E. coli* bacteria as well as other pollutants. Biomonitoring is also occurring. Monitoring will continue long-term pending resources. (http://www.chippewariver.com/water_quality.aspx)

Field Research Sites – Chippewa:

Cattle and Pasture Research: Two long-term on-farm research projects are being conducted within the Chippewa watershed to assess the impact of beef cattle grazing on biomass, soil quality, wildlife and water quality of perennial pastures., and monitor and analyze C, N, P, ET and sediment in a dairy farm operation.

Long Term Cropping Systems – NCSRL: Databases on weather, GHG emissions, crop, crop rotation and cropping system yield, and soil physical, chemical and biological variables were compiled from long-term ARS research experiments at Swan Lake Research Farm near Morris (Johnson et al., 2010a, 2010b, 2011). These data contribute to the REAP and GRACEnet research. A field experiment established in 2002 compares conventional and organic cropping systems. Long-term datasets at the ARS-NCSCRL (North Central Soil Conservation Research Lab.) and University of Minnesota's West Central Research and Outreach Center are being used for model calibration (Jaradat and Weyers, 2011). Models are being used by NCSCRL to test four scenarios for land use change including perennial livestock products, perennial biomass, best management practices in row crops and conservation lands developed by the Project Team. Economic analyses are identifying costs and returns from markets for perennial crops as compared to row crop commodities, conservation program incentives and possible ecosystem services payments, as well as risk management tradeoffs. Modeling and cost analysis will be iterative after meeting with farmers. Partners intend to monitor and compare attained impacts to goals, rates of implementation and predicted ecosystem impacts for water quality and flow, habitat and community impacts over the next decades as funding allows.

GRACEnet Site - Rosemount, MN: This site is located at the University of Minnesota's Research and Outreach Station in Rosemount, MN (44° 45' N, 93° 04' W). The soil is a Waukegan silt loam (fine-silty over skeletal mixed, superactive mesic Typic Hapludoll) containing 22% sand, 55% silt, and 23% clay. Annual 30-yr mean precipitation is 879 mm, and annual mean temperature is 6.4 ^{o}C. Since 1991, plots have been maintained in a randomized complete block factorial design with tillage and rotation as the main treatments, with each treatment combination replicated three times. The tillage treatments are: (i) Conventional tillage (CT) employing fall moldboard plowing following corn, fall chisel plowing or disk ripping following soybean, with spring pre-plant cultivation prior to both corn and soybean, (ii) Conservation tillage (CsT) employing fall chisel plowing or disk ripping following corn, no fall plowing following soybean, with spring cultivation prior to soybean only, and (iii) No tillage (NT) employing no fall tillage or spring cultivation. Each tillage treatment is maintained under both continuous corn and corn-soybean and rotations, with the corn and soybean phases of the rotation present each year. Each plot is 27.4-m (36 corn rows) wide by at least 30-m long. In addition to the tillage and rotation treatments, starting in 2003, various N fertilizer management treatments have been added by splitting the main plots. Treatment effects on soil organic C and N, inorganic N, grain yields, soil respiration and enzyme activity, and emissions of methane, nitrous oxide, and nitric oxide have been published in multiple studies (Venterea, 2007; Venterea and Baker, 2008; Venterea and Stanenas, 2008; Venterea et al., 2005; 2006; 2010; 2011).

Ameriflux Site – Rosemount: Two fields at the Rosemount Research station have been a part of the Ameriflux program since 2003 (Baker & Griffis, 2005; 2009). Each is fully instrumented with eddy

covariance equipment for measuring CO2 and H2O exchange, incoming and outgoing solar and longwave radiation, and soil moisture and temperature profiles. One field is in corn/soybean rotation with conventional fall tillage, while the other uses reduced (strip) tillage and cover crops in addition to the corn/soy rotation. A variety of additional measurements have been made in these fields, including carbon and water vapor isotope fluxes and nitrous oxide chamber fluxes (Griffis et al., 2004,2005, 2008). The site also is part of the COSMOS program for soil moisture measurement.

Pat's Creek - Galena River, WI

Characteristics

The Pat's Creek – Galena River (PCGR) sub-watershed (figure 6) is a nine-mile long tributary of the Galena River Watershed located on the western end of the Illinois – Wisconsin border which is part of the Northern Mississippi Valley Loess Hills Major Land Resource Area (NMVLH; Major Land Resource Area 105; NRCS, 2006). The NMVLH covers 22,209 square miles, which includes about one-fifth of Wisconsin (including most of the Driftless Area) plus adjacent parts of Minnesota, Iowa, and Illinois. The NMVLH is characterized by rolling to hilly uplands dissected by tributaries of the Mississippi River. Silt loam soils several feet thick cover thick sequences of Paleozoic sandstones and dolostones. Soils are generally well-drained, and artificial drainage is rare. Nitrate exports from watersheds can be large, over 18 lb/ac/yr (Masarik et al., 2007). This is in the uppermost category of the classification scheme of Goolsby et al. (2001) for the Mississippi drainage (13-28 lb/ac/yr).

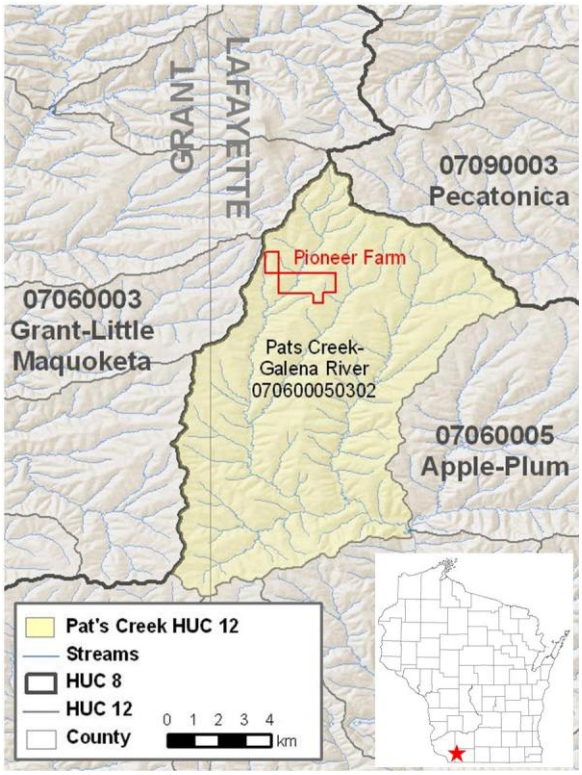


Figure 6. Location of Pat's Creek – Galena River sub-watershed and UW-Platteville Pioneer Farm.

The PCGR sub-watershed is representative of the more agriculturally-intensive portion of the NMVLH, which in Wisconsin lies south of the Military Ridge running across northern Grant and central Iowa Counties. Over 90% of the land cover is agricultural, much of which is in row crops utilizing large inputs of fertilizer and pesticides. Riparian areas are usually grazed or are grass buffers (generally <15 ft) adjacent to row crops and have virtually no tree cover. Stream bank erosion and siltation are prevalent (from Macholl et al., 2010).

Field Research Sites

<u>Pioneer Farm (PF):</u> Located within the PCGR sub-watershed, PF is a 430-acre farm with 330 tillable acres located 5 miles southeast of Platteville, WI. The farm is home to an Angus beef cow herd, Holstein milking herd, and crossbred swine unit. The crop rotation consists of corn, oats, and alfalfa to provide feed and forage for livestock. As part of the University of Wisconsin-Platteville campus community, the primary goals of PF are to conduct systems and applied research, provide on-farm experiences to students, and to communicate education and research to students, agencies, producers, and the public.

PF has been conducting edge-of-field runoff research since 2002 and has gradually increased its capacity since that time by adding more stations and streamlining methods (USGS, 2008). Currently, surface-water runoff is monitored at 22 sites using a paired-basin experimental design (Figure 7). Runoff is monitored from both pasture and cropped land-use areas. Samples are collected year-round with automated equipment using flow-paced methods. Samples are analyzed for sediment and nutrient content.

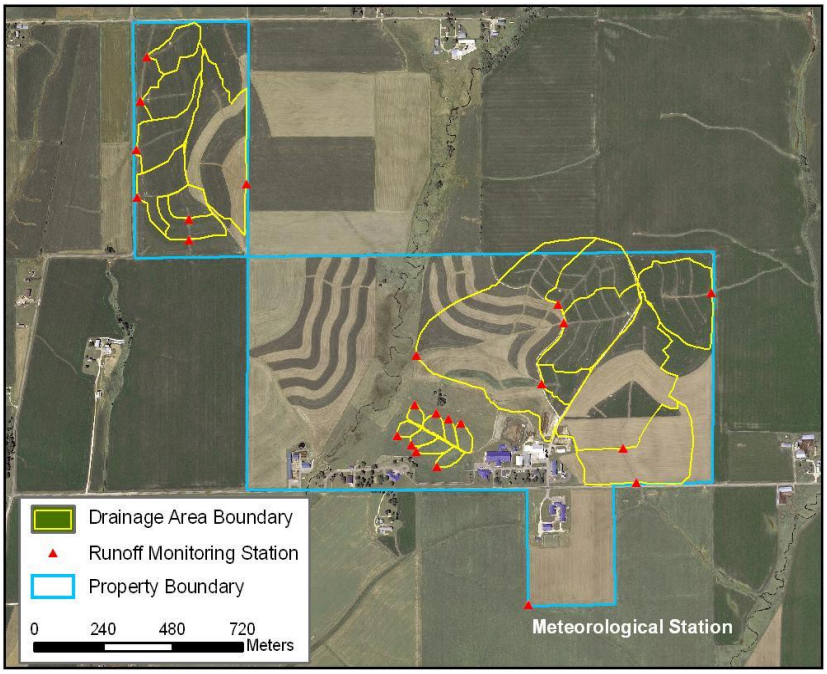


Figure 7. UW-Platteville Pioneer Farm surface-water runoff monitoring infrastructure.

An on-site meteorological station records precipitation, temperature, humidity, wind speed and direction, soil temperature and moisture, and other parameters. Detailed, field-by-field agronomic data is collected and archived.

A series of research projects have been focused on determining the contribution of stream banks to overall sediment export (USGS, 2005 & Panuska et al., 2011). A project to conduct year-round in-stream monitoring at the outlet of the PCGR 12-digit HUC is currently under development. Routine groundwater monitoring has been ongoing since our wells (Figure 8) were installed in 2006. Groundwater data collection includes measurements of water table elevation, temperature, pH, conductivity, nitrate, and chloride.

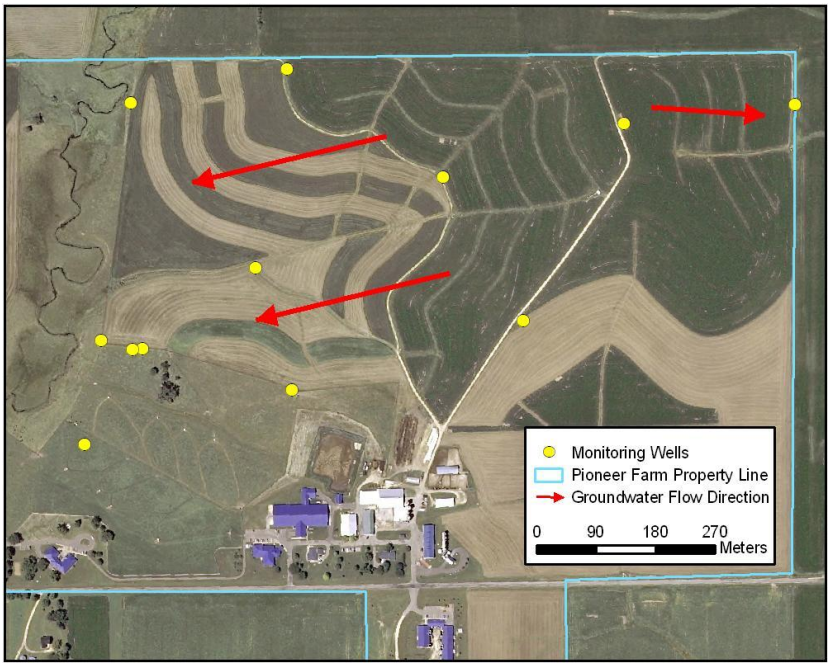


Figure 8. UW-Platteville Pioneer Farm groundwater runoff monitoring infrastructure.

E. Research Projects

Cooperative research projects would be developed across the LTAR based on common objectives which combine the expertise among the participants. This proposed LTAR is consistent with the current broad goals of the participating USDA unit's Project Plans.

F .Data Availability and Sharing

Project Management

The UMRB LTAR will be lead by an **LTAR Oversight Committee** of NLAE, cooperating scientists and stakeholders. The purpose of this committee is to oversee general direction and management of the LTAR. LTAR watersheds will be managed by NLAE., ARS-Morris, ARS-St Paul, and UW-Platteville. Cooperating organizations (e.g. Land Stewardship, Iowa Soybean Association, Environmental Defense Fund, USGS) would be invited to participate on a regular basis. Individual sites will be maintained by the contributing organization (e.g., NLAE). The LTAR Oversight Committee will also be responsible for considering research proposed by outside organizations.

Data Sharing

The proposed LTAR NLAE will contribute data to, and maintain STEWARDS (Sustaining The Earth's Watersheds – Agricultural Research Database System) to support multiple watershed assessments across participating ARS locations www.nrrig.mwa.ars.usda.gov/stewards/stewards.html. This activity is directly tied to long-term strategic goals for ARS of maintaining long-term watershed monitoring with publicly available databases to support watershed modeling and research across the scientific community. The expansion of ARS database capability to support plot studies has received attention and appears to be viable, but functional databases of this type have not been produced.

Data will be available across the LTAR participants to jointly address the research objectives common across watersheds the participants. Methods for sharing data will be accomplished through the data base and determined by the LTAR Oversight Committee.

G. Investigators and Accomplishments

Investigators-NLAE

The NLAE contributes a team of experienced investigators with an array of expertise.
Jerry Hatfield, Ph.D., Laboratory Director NLAE, micrometeorology and climate change
Doug Karlen, Ph.D., Research Leader, Soil quality and agricultural biofuel feedstocks
Tom Moorman, Ph.D., Research Leader, environmental microbiology
Mark Tomer, Ph.D. Soil science and hydrology
David James, Geographic information systems and watershed database operations
Dan Jaynes, Ph.D., Soil science, agricultural drainage and nitrogen management
Sally Logsdon, Ph.D., Soil water flow and soil structure
Cindy Cambardella, Ph.D. Soil cycling of nitrogen and carbon
Tom Sauer, Ph.D., Soil management
Rob Malone, Ph.D., Modeling soil processes and effects of management practices
Tom Kaspar, Ph.D., Soil-plant interactions and cover crops
John Kovar, soil phosphorus in crops and pastures
Tim Parkin, Ph.D., Soil microbiology and greenhouse gas fluxes

Investigators - St. Paul

John Baker, Ph.D., Research Leader, micrometeorology, soil physics
Gary Feyereisen, Ph.D., hydrology
Kurt Spokas, Ph.D., soil physics and soil biochemistry
Rodney Venterea, Ph.D., soil physics and nitrogen cycling

Investigators – ARS Morris and Chippewa River Watershed

Abdullah Jaradat, Ph.D., ARS-Research Leader, modeling and decision tool development
Jane M.F. Johnson, Ph.D., soil science, sustainable biofuels, carbon sequestration, greenhouse gases. Also, member of both REAP and GRACEnet database development
Sharon L. Weyers, Ph.D., soil biology and nutrient cycling
Margaret Kuchenreuther, Ph.D., Univ. Minnesota, Morris, plant ecology, prairie management.
Steve Wagner, electronics engineer, GIS/GPS analysis
George Boody (LSP) Oversee Comprehensive Chippewa 10% Project and nitrogen cycling GIS analysis
Terry VanDerPol (LSP) Oversee project, case study investigator and oversee market development
Kylene Olson**,** assures decision tools and approach are useful for the Chippewa River Watershed Project
Paul Wymar, SWAT simulations and conduct monitoring at Chippewa River Watershed Project
John Westra, Ph.D., Research Leader, build and use integrated economic model and decision tools
Brad Heines Ph.D., and Jim Paulson (UM) Evaluate options for grazing
Bruce Freske, US Fish and Wildlife Service, Assist with landowner outreach

Investigators - Platteville

Dennis Busch, Ph.D., PF Research Manager, Surface-water hydrology and nutrient management
Chris Baxter, Ph.D., Soil science
Adam Hoffman, Ph.D., Surface-water chemistry
Jeffrey Huebschman, Ph.D., Biology: small mammals
Andrew Jacque, Ph.D., Groundwater hydrology and chemistry
Philip Parker, Ph.D., Surface-water hydrology
Michael Penn, Ph.D., Surface-water hydrology
Philip Sealy, Ph.D., Electrical engineer sensor development
Kristopher Wright, Ph.D., Biology: freshwater ecology

Accomplishments- NLAE

Past NLAE accomplishments include field and watershed research on water quality for the Management Systems Evaluation Areas (MSEA), research to support the Conservation Effect Assessment Program (CEAP), participation in GRACENET and REAP, and participation in the Midwest Intensive Project of Ameriflux. NLAE has also hosted multiagency projects to evaluate multiscale methods to quantify energy fluxes and validate microwave methods to estimate soil moisture. NLAE also has a long record of accomplishment in the development and evaluation of conservation practices (cover crops, denitrification reactors, riparian buffers) and in targeting of conservation practices. The NLAE also has substantial expertise in micrometeorology, energy balance analysis and the measurement of greenhouse gases.

Accomplishments – St Paul

Scientists in the St. Paul Unit have been active participants in both the REAP and GRACEnet multi-location projects since their inception. The Unit was also one of the core groups in the Management Systems Evaluation Areas (MSEA) project. The Rosemount field site has been a part of the NOAA GCIP-GEWEX program (Baker et al, 1999; 2000), and has been an Ameriflux site for many years. It has also been part of a number of research projects funded by NSF, NOAA, NASA, and USDA.

Accomplishments – Morris

As a natural resources conservation research lab, NCSCRL's accomplishments include R&D on a wide range of on-station, on-farm and watershed-scale topics based on farmers' needs and in response to changing rural landscape, including (1) tillage and crop residue management to reduce soil erosion and improve early crop growth, (2) guidelines and methodologies to reduce soil erosion, (3) technologies to

reduce soil compaction, (4) software and recommendations to manage N fertilizer, (5) management practices to reduce runoff and improve water quality, (6) alternative cropping systems including oilseed crops and perennials, (7) guidelines for biomass removal, and (8) metrics to determine how agricultural management practices affect GHG emissions. NCSCRL actively participates in GRACEnet and REAP The Lab participates with LSP and others to model agro-ecosystem services in the Chippewa River Watershed in response to climate and land-use changes. The Lab has expertise in dBase management, modeling, GIS/GPS technologies, soil chemistry, soil biology, energy balance, and GHG measurements.

Accomplishments - Platteville

Accomplishments for PF include the establishment of 22 paired-basins for conducting field-scale research. Data from the surface-water monitoring program has supported the development of the Wisconsin Phosphorus Index, improvements to RUSLE 2, and evaluation of emerging contaminants (Havens et al. 2010). PF is providing leadership in efforts to coordinate of edge-of-field monitoring programs within the Great Lakes Region; and, in cooperation with UW-Platteville Engineering, PF has developed innovative, low-cost methods for monitoring intermittent streams. PF is a producer-driven research program, and all projects are developed with significant producer participation to ensure that research is relevant to the current needs of producers.

The strength of these investigators and their collaborators is shown in the Supporting References section at the end of this document. This section contains references specifically cited within the RFI and also includes other relevant publications.

H. Partnerships

The **Chippewa River Watershed Project, Land Stewardship Project, Louisiana State University Ag Center, Nature Conservancy , University of Minnesota 's West Central Research and Outreach Center, University of Minnesota, Morris** and **US Fish and Wildlife Service** cooperate with the NCSRL on the Chippewa 10% Project . Along with other agencies, NGO and academic partners these entities collaborate in planning and conducting this comprehensive targeting, implementation and monitoring project.

Southfork Watershed Alliance, a local organization, is working to encourage implementation of conservation practices that can protect and improve water quality in the South Fork of the Iowa River.

U.S. Fish and Wildlife Service manages the Neal Smith National Wildlife Refuge (Walnut Creek S watershed) and collaborates with NLAE on water and soil quality research.

NRCS works with NLAE in coordinating with producers and in assessing conservation practice impacts.

USGS maintains continuous discharge stations at two sites in the SFIR where the NAWQA program found nitrate concentrations to be among the highest observed in the US. Measurements of pharmaceuticals, hormones and pathogens have been a subject of recent research.

Iowa State University collaborates with NLAE in a variety of ways, including research on conservation practices, nutrient management and tile drainage, and effective manure management strategies for tile-drained lands. Dr. Tom Isenhart is a PI leading the saturated buffer project.

Iowa Soybean Association collaborates with NLAE on water quality and agriculture issues. ISA maintains some watershed monitoring activities in the Raccoon River Basin.

Environmental Defense Fund collaborates with NLAE on water quality and agriculture issues. EDF maintains some watershed monitoring activities in the Boone River Basin with an effort to expand

conservation practices. Other efforts with NLAE involve using GIS-based mapping tools to facilitate placement of conservation practices.

University of Minnesota collaborates with the ARS-St. Paul Unit at the Rosemount site, particularly on carbon cycle and trace gas research.

Minnesota Corn Growers Association (MCGA) and the **Agricultural Utilization and Research Institute (AURI)** collaborate with the ARS-St. Paul unit on a variety of research projects related to the impact of agriculture on water quality.

Producer Groups collaborate with UW Pioneer Farm by serving on our Steering Committee and participating on Project Advisory Groups. Producers groups currently collaborating with our program include Farm Bureau, National Farmers Organization, WI Pork Association, Poultry and Egg Association, Potato and Vegetable Growers, Crop Production Association, Professional Dairy Producers of WI, WI Farmers Union, Dairy Business Association, WI Milk Marketing Board, WI Cattlemen's Association, WI Soybean Growers Association, and WI Soybean Growers.

Iowa Soybean Association, **Iowa State Extension Service, Minnesota Department of Agriculture, and The Nature Conservancy** collaborate with Pioneer Farm on field-testing of prototype edge-of-field surface-water monitoring equipment.

University of Minnesota, Trout Unlimited, Sand County Foundation, The Nature Conservancy, Discovery Farms, US Geological Survey, USDA-Agricultural Research Service, Michigan State University, and University of Illinois, collaborate with Pioneer Farm on issues related to broader coordination of edge-of-field monitoring efforts within the Great Lakes Region.

Wisconsin State Lab of Hygiene collaborates with PF on identification and evaluation of emerging contaminants in surface-water runoff from agricultural land-use areas.

U of WI-Stevens Point collaborates with PF on analysis of surface-water runoff samples, groundwater monitoring, SWAT modeling, and development of alternative sampling equipment.

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I. Supporting References

Baker, J.M., K.J. Davis, and G.J. Liknes. 1999.The surface energy balance and boundary layer development during snowmelt. J. Geophys. Res. 104 D: 19611-19621.

Baker, J.M., G.N. Flerchinger, and E.J.A. Spaans. 2000. Sensible heat exchange during snowmelt. In "Contaminant Hydrology: Cold Regions Modeling", S.A. Grant (ed). CRC Press, Boca Raton, FL.

Baker, J.M., and T.J. Griffis. 2005. Examining Strategies to Improve the Carbon Balance of Corn/Soybean Agriculture using eddy covariance and mass balance techniques. Agric. Forest Meteorol. 128:163-177.

Baker, J.M., and T.J. Griffis. 2009. Evaluating the potential of winter cover crops in corn-soybean systems for sustainable co-production of food and fuel. Agric. Forest Meteorol. 149:2120-2132.

Baxter, C. A., Ward, L. W. 2006. Sediment, Nitrogen and Phosphorus in Runoff from Single Crop Watersheds on Pioneer Farm 2003-2005. Factsheet 1-500-0807.

Blume, E., M. Bischoff, T.B. Moorman, and R.F. Turco. 2004. Degradation and binding of atrazine in surface and subsurface soils. J. Agric. Food Chem. 52:7382-7388.

Boody, G., D.A. Vondracek, M. Krinke, J. Westra, J. Zimmerman, and P. Welle. 2005. Multifunctional agriculture in the United States. Bioscience 55:27-38.

Busch, D., Mentz, R., Owens, D. 2009. Filter strip attenuation of feedlot runoff contaminates. Poster Presentation at National Water Conference. St. Louis, MO.

Cambardella, C.A., T.M. Isenhart, K.E. Schilling, P. Drobney, and R.C. Schultz. 2003. Soil carbon assessment across a native prairie reconstruction chronosequence. P 49-53. In: S. Fore (ed.) Proc. 18th N. Amer. Prairie Conf., Truman State Univ., Kirksville, MO.

Cambardella, C.A., T.B. Moorman, J.M. Novak, T.B. Parkin, D.L. Karlen, R.F. Turco, and A.E. Konopka. 1994. Field-scale variability of soil properties in central Iowa soils. Soil Sci. Soc. Am. J. 58:1501-1511.

Cambardella, C.A., T.B. Moorman, D.B. Jaynes, T.B. Parkin, W.W. Simpkins, and D.L. Karlen. 1999. Water quality in Walnut Creek watershed: nitrate-nitrogen in soils subsurface drainage water and shallow groundwater. J. Environ. Qual. 28:25-34.

Dinnes, D. L., D.L. Karlen, D.B. Jaynes, T.C. Kaspar, J.L. Hatfield, T.C. Colvin, and C.A. Cambardella. 2002. Nitrogen management strategies to reduce nitrate leaching in tile-drained Midwestern soils. Agron. J. 95:153-171.

Dolan, M. D., C.E. Clapp, R.R. Allmaras, J.M. Baker, and J.A.E. Molina. 2006. Soil organic carbon and nitrogen in a Minnesota soil as related to nitrogen, tillage, and residue management. Soil Tillage Res. 89:221-231

Du, B., Arnold, J.G., Saleh, A., and Jaynes, D.B. 2005. Development and application of SWAT to landscapes with tiles and potholes. Trans ASAE 48:1121-1133.

Du, B., Saleh, A., Jaynes, D.B., and Arnold, J.G. 2006. Evaluation of SWAT in simulating nitrate nitrogen and atrazine fates in a watershed with tiles and potholes. Trans. ASABE. 49(4):949-959.

Eidem, J.M., W.W. Simpkins, and M.R. Burkart. 1999. Geology, groundwater flow, and water quality in the Walnut Creek watershed. J. Environ. Qual. 28:60–69.

Freihoefer, A.T. 2007 Linking Field-Scale Phosphorus Export to a Watershed-Scale Model. A Thesis, College of Natural Resources, University of Wisconsin, Stevens Point

Friend, A.D. 2010. Terrestrial plant production and climate change. J. Exp. Bot. 61:1293-1309.

Goolsby, D.A., W.A. Battaglin, B.T., Aulenbach, and R.P. Hooper, 2001. Nitrogen input to the Gulf of Mexico. J. Environ. Qual. 30(2): 329-336.

Gowda, P., Mulla, D.J., Jaynes, D.B. 2008. Simulated long-term nitrogen losses for a Midwestern agricultural watershed in the United States. Agric. Water Manage. 95:616-624.

Green, C.H., M.D. Tomer, M. DiLuzio, and J. Arnold. 2006. Hydrologic calibration of the Soil and Water Assessment Tool for a large tile-drained watershed in Iowa. Trans. ASABE. 49:413-422.

Greenan, C.M., Moorman, T.B., Kaspar, T.C., Parkin, T.B., and Jaynes, D.B. 2006. Comparing carbon substrates for denitrification of subsurface drainage water. J. Environ. Qual. 35:824-829.

Greenan, C., Moorman, T.B., Parkin, T.B., Kaspar, T.C., Jaynes, D.B. 2009. Denitrification in wood chip bioreactors at different water flows. J. Environ. Qual. 38:1664-1671.

Griffis, T.J., J.M. Baker, S.D. Sargent, B.D. Tanner, and J. Zhang. 2004. Measuring field scale isotopic CO2 fluxes with tunable diode laser absorption spectroscopy and micrometeorological techniques. Agric. Forest Meteorol. 124:15-29.

Griffis, T.J., J.M. Baker, and J. Zhang. 2005. Seasonal dynamics of isotopic CO2 exchange in a C3/C4 managed ecosystem. Agric. Forest Meteorol. 132:1-19.

Griffis, T.J., S.D. Sargent, J.M. Baker, X. Lee, B.D. Tanner, J. Greene, E. Swiatek, K.C. Billmark. 2008. Direct measurement of biosphere-atmosphere isotopic exchange using the eddy covariance technique. JGR-Atmospheres. J. Geophys. Res., 113, D08304.

Hatfield, J.L., D.B. Jaynes, M.R. Burkart, C.A. Cambardella, T.B. Moorman, J.H. Prueger, and M.A. Smith. 1999. Water quality in Walnut Creek watershed: setting and farming practices. J. Environ. Qual. 28:11-24.

Hatfield, J.L., J.H. Prueger, and D.W. Meek. 1999. Spatial variation of rainfall over a large watershed in central Iowa. Theor. Appl. Climatol. 64:49-60.

Havens, S,., Hedman, C., Hemming, J., Mieritz, M., Shafer, M., and Schauer, J. 2010. Stability, preservation and quantification of hormones and estrogenic and androgenic activities in surface water runoff. Environ. Toxicol. Chem. 29(11): 2481-2490.

Havens, S.M. 2011. Assessing the Occurrence of Steroid Hormones and Hormone Metabolites from Cattle and Dairy Animal Feeding Operations. Ph.D. Thesis. University of Wisconsin-Madison. Madison, WI.

Jaradat, A.A., and S.L. Weyers. 2011. Statistical modeling of yield and variance instability in conventional and organic cropping systems. Agron. J. 103:673-684.

Jaynes, D. B., D.L. Dinnes, D.W. Meek, D.L. Karlen, C.A. Cambardella, and T.S. Colvin. 2004. Using the late spring nitrate test to reduce nitrate loss within a watershed. J. Environ. Qual. 33:669-677.

Jaynes, D.B., Colvin, T.S., and Kaspar, T.C. 2005. Identifying potential soybean management zones from multi-year yield data. Computers and Electronics in Agriculture 46:309-327.

Jaynes, D. B., T.S. Colvin, D.L. Karlen, C.A. Cambardella, and D.W. Meek. 2001. Nitrate loss in subsurface drainage as affected by nitrogen fertilizer rate. J. Environ. Qual. 30:1305-1314.

Jaynes, D. B., J.L. Hatfield, and D.W. Meek. 1999. Water Quality in Walnut Creek Watershed: Herbicides and nitrate in surface waters. J. Environ. Qual. 28(1):45-59.

Jaynes, D.B., Kaspar, T.C., Moorman, T.B., and Parkin, T.B. 2008. In situ bioreactors and deep drain-pipe installation to reduce nitrate losses in artificially drained fields. J. Environ. Qual. 37:429-436.

Jaynes, D.B. 2011. Confidence bands for measured economically optimal nitrogen rates. J. Prec Ag. 12:196-213.

Jaynes, D.B., Kaspar, T.C., Colvin, T. 2011. Economically optimal N rates of corn management zones delineated from soil and terrain attributes. Agron. J. 103:1026-1035.

Johnson, J.M.F., and N.W. Barbour. 2010. Crop yield and greenhouse gas responses to stover harvest on glacial till Mollisol. pp. 36-39 19th World Congr. Soil Sci.: Soil solutions for a changing world. 1-6 August 2010, Brisbane, Australia.

Johnson, J.M.F., D.W. Archer, and N.W. Barbour. 2010a. Greenhouse gas emission from contrasting management scenarios in the Northern Corn Belt. Soil Sci. Soc. Am. J. 74:396-406.

Johnson, J.M., W.W. Wilhelm, D.L. Karlen, D.W. Archer, B.J. Wienhold, D.T. Lightle, D.L. Laird, J. Baker, T.E. Ochsner, J.M. Novak, A.D. Halvorson, F. Arriaga, and N.W. Barbour. 2010b. Nutrient removal as a function of corn stover cutting height and cob harvest. Bioenergy Research. 3(4):342-352.

Johnson, J.M.-F., D.W. Archer, S.L. Weyers, and N.W. Barbour. 2011. Do mitigation strategies reduce global warming potential in the northern U.S. Corn Belt? J. Environ. Qual. 40:1551-1559.

Johnson, J.M.F., D.W. Archer, D.L. Karlen, S.L. Weyers, and W.W. Wilhelm. 2011b. Soil management implications of producing biofuel feedstock. p. 371-390. *In* J. Hatfield and T. Sauer (eds.) Soil management: Building a stable base for agriculture. ASA Series. ASA and SSSA, Madison, WI.

Johnson, J.M., S.K. Papiernik, M.M. Mikha, K.A. Spokas, M.D. Tomer, S.L. Weyers. 2010a. Soil Processes and Residue Harvest Management. p. 1-44. In: Lal, R., Stewart, B.A., (eds.) Soil Quality and Biofuel Production. Advances in Soil Science. CRC Press. Boca Raton, FL.

Johnson, J.M., W.W. Wilhelm, D.L. Karlen, D.W. Archer, B.J. Wienhold, D.T. Lightle, D.L. Laird, J. Baker, T.E. Ochsner, J.M. Novak, A.D. Halvorson, F. Arriaga, and N.W. Barbour. 2010b. Nutrient removal as a function of corn stover cutting height and cob harvest. Bioenergy Res. 3(4):342-352.

Jordan, N, G. Boody, W. Broussard, J.D. Glover, D. Keeney, B.H. McCown, G. Mclsaac, M. Muller, H. Murray, J. Neal, C. Pansing, R.E. Turner, K. Warner, and D. Wyse. 2007. Sustainable development of the agricultural bio-economy. Science 316:1570-1571.

Karlen, D.L., Dinnes, D.L., Jaynes, D.B., Hurburgh, C.R., Cambardella, C.A., Colvin, T.S., Rippke, G.R. 2005. Corn response to late-spring nitrogen management in the Walnut Creek watershed. Agronomy Journal. 97:1054-1061.

Karlen, D.L., Tomer, M.D., Neppel, J., Cambardella, C.A. 2008. A preliminary watershed scale soil quality assessment in North Central Iowa USA. Soil & Tillage Res. 99:291-299.

Kaspar, T.C., Parkin, T.B., Jaynes, D.B., Cambardella, C.A., Meek, D.W., and Jung, Y.S. 2006. Examining changes in soil organic carbon with oat and rye cover crops using terrain covariates. Soil Sci. Soc. Am. J. 70:1168-1177.

Kaspar, T.C., D.B. Jaynes, T.B. Parkin, and T.B. Moorman. 2007. Rye cover crops and gammagrass strip effects on NO3 concentration and load in tile drainage. J. Environ. Qual. 36:1503-1511.

Lewandowski, A., Anderson, J., Birr, A., Montgomery, B., Busch, D. 2008. Feasibility of an On-Farm Water Quality Program in Minnesota. Report prepared by the University of Minnesota Water Resources Center for the Minnesota Department of Agriculture. Available Online [http://wrc.umn.edu/outreach/onfarmresearch].

Li, L., Malone, R.W., Ma, L., Kaspar, T.C., Jaynes, D.B., Saseendran, S.A., Thorp, K.R., Yu, Q., Ahuja, L.R. 2008. Winter cover crop effects on nitrate leaching in subsurface drainage as simulated by RZWQM-DSSAT. Trans. ASABE. 51:1575-1583.

Ma, L., Malone, R.W., Heilman, P., Jaynes, D.B., Ahuja, L.R., Saseendran, S.A., Kanwar, R.S., Ascough II, J.C. 2007. RZWQM simulated effects of crop rotation, tillage, and controlled drainage on crop yield and nitrate-N loss in drain flow. Geoderma 140 (3):260-271.

Macholl, J.A., Kraft, G.J. 2010. Hydrogeology and Groundwater Quality of the UW-Platteville Pioneer Farm and Vicinity. Report for UW-Platteville Pioneer Farm. Center for Watershed Science and Education.

Malone, R.W., Jaynes D.B., Ma, L., Nolan, T.B., Meek, D.W., Karlen, D.L. 2010. Soil-test N recommendations augmented with PEST optimized RXWQM simulations. J. Environ. Qual., 39:1711-1723.

Marr, J., Johnson, S., Busch, D. 2010. Performance assessment of H Flumes under extreme approach flow conditions. University of Minnesota, St. Anthony Falls Laboratory, Project Report No. 538.

Masarik, K.C., G.J. Kraft, D.J. Mechenich, and B.A. Browne, 2007. Groundwater Pollutant Transfer and Export from a Northern Mississippi Valley Loess Hills Watershed. Report to the Wisconsin Department of Natural Resources, DNR Project 181. College of Natural Resources, University of Wisconsin – Stevens Point. Available at www.uwsp.edu/cnr/watersheds/Reports_Publications/Reports/fever_07.pdf.

Mentz, R., Peppler, M., Komiskey, M., Busch, D., Prill-Adams, A., and C. Steiner. 2010. Cattle Crossings in Riparian Pastures: Costs, Benefits and Performance. Poster presentation at the 34th Annual Meeting of the Wisconsin Section of the American Water Resources Association, Madison, Wis.

Moorman, T.B., D.B. Jaynes, C.A. Cambardella, J.L. Hatfield, R.L. Pfeiffer, and A.J. Morrow. 1999. Water quality in Walnut Creek watershed: herbicides in soils, subsurface drainage and groundwater. J. Environ. Qual. 28:35-45.

Moorman, T.B., Parkin, T.B., Kaspar, T.C., Jaynes, D.B. 2010. Denitrification activity and wood loss over nine years in a wood chip bioreactor for treatment of nitrate in drainage water. Ecol. Eng. 36:1567-1574.

Nangia, V., P. Wymar, and J. Klng. 2010. Evaluation of a GIS-based watershed modeling approach for sedeiment transport. Int. J. Agric. Biol. Eng. 3:43-53.

Novak, J.M., T.B. Moorman, and C.A. Cambardella. 1997. Atrazine sorption at the field scale in relation to soils and landscape position. J. Environ. Qual. 26:1271-1277.

Panuska, J.C., Good, L.W., Vadas, P.A. and Busch, D.L. 2009. Phosphorus Content and Particle Size of Sediments in Grassed Waterways Draining Corn and Alfalfa Fields in Southwest WI. Poster Presentation at National Water Conference. St. Louis, MO.

Panuska, J.C., Good, L.W., Vadas, P.A. and Busch, D.L., Ozkaynak, A. 2011. Sediment and particulate phosphorus characteristics in grasses waterways from row crop corn and alfalfa fields collected by manual University of Exeter samplers and automatic sampling. Hydrological Processes 15:2329-2338.

Parkin, T.B., T.C. Kaspar, Z. Senwo, J.H. Prueger, and J.L. Hatfield. 2005. Relationship of soil respiration to crop and landscape in the Walnut Creek Watershed. J. Hydrometeorol. 6:812-824.

Penn, M.R., Mentz, R., Busch, D. 2010. Snowmelt and agricultural runoff: Load quantification and event timing. Watershed Management. ASCE 2011.

Radatz, T.F. 2009. Soil Moisture and Rainfall-Runoff Response of Agricultural Basins in Southwestern Wisconsin During Non-Frozen Ground Periods. Thesis: UW-Madison.

Reungsang, A., T.B. Moorman, and R.S. Kanwar. 2001. Transport and fate of atrazine in midwestern riparian buffer strips. J. Am. Water Res. Assoc. 37:1681-1692.

Saleh, A., E. Osei, D.B. Jaynes, B. Du, and J.G. Arnold. 2007. Economic and environmental impacts of selected BMP's for nitrate-nitrogen reduction in Walnut Creek Watershed, Iowa, using FEM (farm economic model) and enhanced SWAT (soil and water assessment tool) models. Trans. ASABE. 50 (4):1251-1259.

Schilling, K.E., and J. Spooner. 2006. Effects of watershed-scale land use change on stream nitrate concentrations. J. Environ. Qual. 35:2132-2145.

Schipper, Louis A., Robertson, Will D., Gold, Arthur J., Jaynes, Dan B., Cameron, Stewart C. 2010. Denitrifying bioreactors — An approach for reducing nitrate loads to receiving waters. Ecological Engineering 36:1532-1543.

Schroeder, P.D., and J.L. Kovar. 2008. Comparison of the phosphorus sorption characteristics of a conservation reserve buffer and an adjacent crop field. Commun. Soil Sci. Plant Anal. 39:2961-2970.

Singer, J.W., R.W. Malone, D.B. Jaynes, and L. Ma. 2011 Cover crop effects on nitrogen load in tile drainage from Walnut Creek Iowa using Root Zone Water Quality Model. Agric. Water Manag. 98:1622-1628.

Stott, D.E., C.A. Cambardella, R. Wolf, M.D. Tomer, and D.L. Karlen.2011. A Soil quality assessment within the Iowa River South Fork watershed. Soil Sci. Soc. Am. J. 75:2271-2282.

Stuntebeck, T.D., Komiskey, M.J., Peppler, M.C., Owens, D.W., and Frame, D.R., 2011, Precipitation-runoff relations and water-quality characteristics at edge-of-field stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003-8: U.S. Geological Survey Scientific Investigations Report 2011-5008, 46 p.

Thorp, K.R., D.B. Jaynes, R.W. Malone. 2008. Simulating long-term performance of drainage water management across the Midwestern United States. Trans. ASABE. 51(3):961-976.

Tomer, M.D., D.E. James, and T.M. Isenhart. 2003. Optimizing the placement of riparian practices in a watershed using terrain analysis. J. Soil & Water Conserv. 58(4):198-206.

Tomer, M.D., and D.E. James. 2004. Do soil surveys and terrain analyses identify similar priority sites for conservation? Soil Sci. Soc. Am. J. 68:1905-1915.

Tomer, M.D., Locke, M.A. 2011. The challenge of documenting water quality benefits of conservation practices: A review of USDA-ARS's Conservation Effects Assessment Project watershed studies. Water Science and Technology. 64(1):300-310.

Tomer, M.D., D.W. Meek, D.B. Jaynes, and J.L. Hatfield. 2003. Evaluation of nitrate-N fluxes from a tile-drained watershed in central Iowa. J. Environmental Quality. 23:642-653.

Tomer, M.D., T.B. Moorman, C.G. Rossi. 2008a. Assessment of the Iowa River's South Fork watershed. 1. Water quality. J. Soil Water Conserv. 63: 360-370.

Tomer, M.D., T.B. Moorman, D.E. James, G. Hadish. 2008b. Assessment of the Iowa River's South Fork watershed. 2. Conservation practices. J. Soil Water Conserv. 63: 371-379.

Tomer, M.D., C.G. Wilson, T.B. Moorman, K.J. Cole, D. Heer, and T.M. Isenhart. 2010. Source-pathway separation of multiple contaminants during a rainfall-runoff event in an artificially drained agricultural watershed. J. Environ. Qual. 39(3):882-895.

United States Geological Society (USGS). 2008. Methods of Data Collection, Samples Processing, and Data Analysis for Edge-of-Field, Streamgaging, Subsurface-Tile and Meteorological Stations at Discovery Farms and Pioneer Farm in Wisconsin, 2001-7. Open File Report 2008-1015.

United States Geological Society (USGS). 2005. Methods for Monitoring the Effects of Grazing Management on Bank Erosion and Channel Morphology, Fever River, Pioneer Farm, Wisconsin, 2004. Fact Sheet 2005-3134.

Venterea, R.T. 2007. Nitrite-driven nitrous oxide production under aerobic soil conditions: Kinetics and biochemical controls. Global Change Biology 13, 1798–1809.

Venterea, R.T. and J.M. Baker. 2008. Effects of soil physical nonuniformity on chamber-based gas flux estimates. Soil Sci. Soc. Am. J. 72:1410-1417.

Venterea, R.T., J.M. Baker, M.S. Dolan and K.A. Spokas. 2006. Soil carbon and nitrogen storage are greater under biennial tillage in a Minnesota corn-soybean rotation. Soil Science Society of America Journal. 70: 1752-1762.

Venterea, R.T., M. Burger, and K.A. Spokas. 2005. Nitrogen oxide and methane emissions under varying tillage and fertilizer management. Journal of Environmental Quality. 34:1467-1477.

Venterea, R.T., M. S. Dolan, and T.E. Ochsner. 2010. Urea decreases N_2O emissions compared with anhydrous ammonia in a Minnesota corn cropping system. Soil Sci. Soc. Am. J. 74:407-418.

Venterea, R.T., B. Maharjan and M.S. Dolan. 2011. Fertilizer source and tillage effects on yield-scaled nitrous oxide emissions in a corn cropping system. J. Environ. Qual. 40:1521–1531.

Venterea, R.T. and A.J. Stanenas. 2008. Profile analysis and modeling of reduced tillage effects on soil nitrous oxide flux. J. Environ. Qual. 37:1360-1367.

Yan, B., M.D. Tomer, and D.E. James. 2010. Historical channel movement and sediment accretion along the South Fork of the Iowa River. J. Soil Water Conserv. 65(1):1-8.