

INTEGRATOR

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The Area 4 SCD Cooperative Research Farm: Celebrating 30 Years of Collaborative Research

Recent calls for increased investment in long-term cropping systems research have been prompted by the need to develop productive and resilient agroecosystems in response to multiple challenges associated with producing more food, fuel, and fiber during unprecedented climate change. Established long-term research sites occupy a special role to address this call, as their history of applied treatments and associated data provide unique opportunities to test hypotheses framed in the context of future conditions.

Since 1984, the Area 4 Soil Conservation Districts (SCD) Cooperative Research Farm near Mandan has served as a focal point for improving the sustainability of dryland cropping systems through team-focused, systems-oriented research and technology transfer. This article summarizes the background and accomplishments of the farm over the past 30 years, and looks forward to how it might serve the agricultural community in the future.

Research Farm Background

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The establishment of the Area 4 SCD Cooperative Research Farm (www.area4farm.org) arose from discussions between Mr. Roy Nelson, a local farmer, and supervisors of the Area IV SCD in the early 1980s. Mr. Nelson proposed leasing his

entire farm to the SCD for the purpose of supporting long-term research on conservation tillage and dryland cropping systems. A formal proposal to establish the Cooperative Research Farm was made in June 1983. Later that year the proposal was adopted.



The over arching purpose for the Area 4 SCD Cooperative Research Farm was to provide land for conducting large-scale, long-term research on conservation tillage and dryland cropping systems.

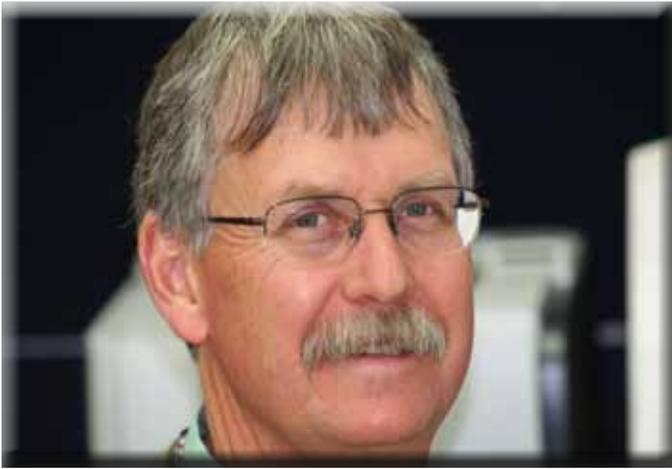
Specific themes originally set forth by the Research Advisory Committee included:

- Conduct research on field-sized plots
- Develop management systems that conserve soil and water resources
- Improve water conservation and soil erosion control technology
- Promote the adoption and use of research findings
- Present research information in understandable terms
- Identify research needs through the advisory committee and agricultural community

The Area 4 SCD Cooperative Research Farm is administered by a Research Advisory Committee comprised of one member from each cooperating Soil Conservation District.

Staff at the USDA-ARS Northern Great Plains Research Laboratory (NGPRL) conduct research and carry out day-to-day operations at the farm. The farm is located approximately 3 miles southwest of

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Message from Matt

Welcome to the summer issue of the INTEGRATOR. I have been looking forward to this issue for two reasons. First, we are celebrating the 30th year of the Area 4 Soil Conservation Districts Cooperative Research Farm.

The Area 4 farm has been a key part of our research program since 1984 and continues to be the focal point of our sustainable cropping systems research. The Area 4 farm is where pioneering studies of no-till farming and dynamic cropping systems originated. Today, the Area 4 farm figures prominently in the new national Long-Term Agroecosystem Research (LTAR) network.

The second reason for my excitement to pen this message is to inform our customers and stakeholders about the new funding we have received. In the fiscal year 2014 budget that was passed in March, the NGPRL received new recurring funding to conduct research as part of the new LTAR network. We look forward to putting new research into place and bringing on new staff to help us conduct this much needed research.

The staff continues to change at NGPRL and we bid a reluctant farewell to Dr. Kris Nichols, Larry Renner, and Faye Kroh. Dr. Nichols is leaving to become the Research Director at the Rodale Institute in Kutztown, PA.

Kris has been at the forefront of soil health research and is internationally recognized as a leading authority on mycorrhiza and glomalin in the soil ecosystem. We wish Kris the best of luck in her new role and hope to collaborate with her and the Rodale Institute in the future.

Both Larry Renner and Faye Kroh are retiring after several decades of dedicated service to the NGPRL. We wish them well as they enter a new phase of their life and engage in new and exciting adventures.

As always, we appreciate the support and cooperation of our customers and stakeholders as we work on solutions to challenges in agriculture.

A handwritten signature in black ink that reads "Matt Sanderson". The signature is fluid and cursive.

Matt Sanderson
Research Leader

USDA Friends & Neighbors Day

The Northern Great Plains Research Laboratory hosts a major open house each year to showcase the USDA-ARS research and allow our friends and neighbors to enjoy their local federal facility. The public is invited to come visit us on July 17.

The Area 4 SCD Cooperative Research Farm with over 90 supporters sponsor the activities of the 2014 Friends & Neighbors Day. This year we will be highlighting the results of the 30-year partnership between the soil conservation districts and USDA-ARS.

Activities and campus presentations begin at 2:00 p.m. NGPRL's Dave Archer, Nic Saliendra, and David Toledo will share their research on campus, while

the research tour that departs at 3:00 p.m. will highlight much more. Guest speakers on campus will be Susan Liebig (NRCS; "Unlocking the secrets of soil"), Linda Jones (Sitting Bull College; "Edible plants on the prairie"), Rob Hanna (ND Historical Society; "6 strange and wonderful things about ND agriculture"), Jackson Bird (Bismarck City Forester; "Stump the tree guy"), and Lena Bohm (NRCS; "Pollinator buzziness"), and others.

There will be activities for 'future scientists' (children), exhibits, posters, antique and modern equipment displays, etc. throughout the 15-acre research campus. The afternoon will conclude with a public barbecue and evening entertainment.

Friends & Neighbors Day

South of the Heart River on Highway 6

1701 10th Avenue SW

Mandan

July 17, 2014

2-8 PM CDT



Enjoy the park-like campus filled with Children's Activities, Presentations, Exhibits, Demonstrations, Tours, Evening Barbecue & Entertainment

- Learn about:
- Local Ag research
 - Master gardeners
 - Stump the tree guy
 - Edible prairie plants
 - Oilseeds to jet fuel
 - Pollinator buzziness
 - ND Ag Dept. exhibits
 - Unlocking soil secrets
 - Know your grazing land
 - Environmental research
 - much more...

FREE and Open to the Public

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Sponsored by:

Research farm pioneer Al Black inducted into Agriculture Hall of Fame

Al Black, was inducted into the North Dakota Agriculture Hall of Fame in Valley City in March 2014.

Black worked as a scientist for 40 years. He was research leader of the Northern Great Plains Research Laboratory in Mandan from 1979-93.

Black was instrumental in the founding of the Area 4 SCD Cooperative Research Farm, which conducts farm field-size agricultural research. He was pioneering in recognizing the need for large scale research and private-public partnerships.

Black died in July 2013 in Colorado. He is survived by his wife and two daughters and his brainchild, the research farm, is now in its 30th year of long-term research on dryland cropping systems.

The farm south of Mandan is on land leased from the family of the late Roy Nelson. Income generated by the farm goes into a revolving fund used for payment of the lease, farming expenses and promotion.

“The establishment of the farm set a foundation for long-term research, which really has a generational impact by providing research opportunities for scientists two or three decades later,” said Mark Liebig, a soil scientist at the Northern Great Plains Research Laboratory.

One of most important parts about long-term research at the farm is that changes in the soil on the Great Plains happen slowly because of the area’s erratic growing seasons, Liebig said.

“Some important properties, like organic matter content, can take up to a decade to be able to detect a measurable change as a result of a new management practice,” he said. “I can’t emphasize enough how useful it (the farm) is to scientists as a resource.”

As a soil scientist, Black was known for his research

with partner Armand Bauer. The two found nutrient availability, not water availability, had a larger effect on yields. They worked to improve water conservation, crop water use and control soil erosion.



Al Black speaking at the Area 4 SCD Cooperative Research Farm during his tenure at the Northern Great Plains Research Laboratory.

In 2010, Bauer was the first soil scientist inducted into the North Dakota Agriculture Hall of Fame. Black is now the second.

The research Black and Bauer did, and other soil scientists now do, at the research farm has applications in the region as well as internationally, in parts of Argentina, Ukraine, Australia and Canada.

“It’s very much a focus on conservation practices that maximize crop diversity while minimizing soil disturbance, which increases crop yields”, Liebig said. “It’s sort of a win,

win, win there.”

The principles developed at the research farm, including no-till and crop rotation, have allowed family farmers to use 100 percent of their crop production acres.

In 1984, nearly 6 million acres were left fallow each year in North Dakota. Since then, fallow acres have been reduced by more than 90 percent.

“I think there’s been a strong adoption of practices that have been developed at the farm,” said Matt Sanderson, research leader at the Northern Great Plains Research Laboratory today.

Because of the farm, scientists have been able to do research on a larger, farmer-size scale, using large farm equipment, instead of small plots.

“That’s what farmers like to see,” Sanderson said. “Once you do things on a real farm, it has more impact. They believe it more ... Without the farm, we would not have been able to verify for actual farm conditions.”

Jessica Holdman, Bismarck Tribune, March 2, 2014

Efficient Infield Bale Collection Strategies - Save Time, Effort, and Money

Collaborative research between North Dakota State University and the Northern Great Plains Research Laboratory

The largest expense in cow-calf beef production is in the over-winter feed of the gestating brood cow. Driving cost out of quality winter feedstuffs is critical. Reducing the expense in hay production (fuel, equipment, time, etc.) is important. In



Fig. 1 Biomass bales dispersed on a field after baling. Inset: Bales brought to field-edge stack.

developing handling procedures for cellulosic biomass raw materials, cattlemen can profit from research focused on efficient biomass handling.

The common adage “Field to Factory” used in connection with biomass logistics sounds like a simple point-to-point transportation of well-packaged biomass. But a closer look at the biomass distribution for collection reveals a different situation. Although, a “factory” can be considered as a point destination, the biomass on the field, even after consolidation into bales, is a dispersed source. Bales need to be collected and transported to a field-edge stack or field storage to be considered a point source of biomass.

Baling is an important postharvest operation because the packing of biomass material helps in collection and preservation of biomass as well as clearing the field for subsequent cropping operations.

Bales can be made, left on field, and transported later, uncoupling the harvest and infield transportation operations, which offer a significant advantage. However, the bales are dispersed (Fig. 1) in the field, and hinder future agricultural operations and potential crop regrowth, if not removed in a timely manner. Bales left on fields too long will damage the plants under them and the bales may lose integrity, become difficult to handle, and lose significant dry matter.

Usually, the bales will be moved to a field-edge stack before being transported to a secured

storage location or transported to other facilities or to a feedlot for local consumption. Thus, an efficient aggregation of bales with the least total distance involved is a goal of forage producers and bale handlers.

Most of the biomass logistics analyses have concentrated on transporting biomass from the field to proposed processing facilities, considering “field” as a point source of biomass with biomass made into several forms (e.g., pellets, briquettes, bales). Elaborate logistics models of the biomass supply to a biorefinery have been developed and implemented. As these models address biomass supply to a processing facility as a whole, detailed infield bale aggregation was beyond their scope

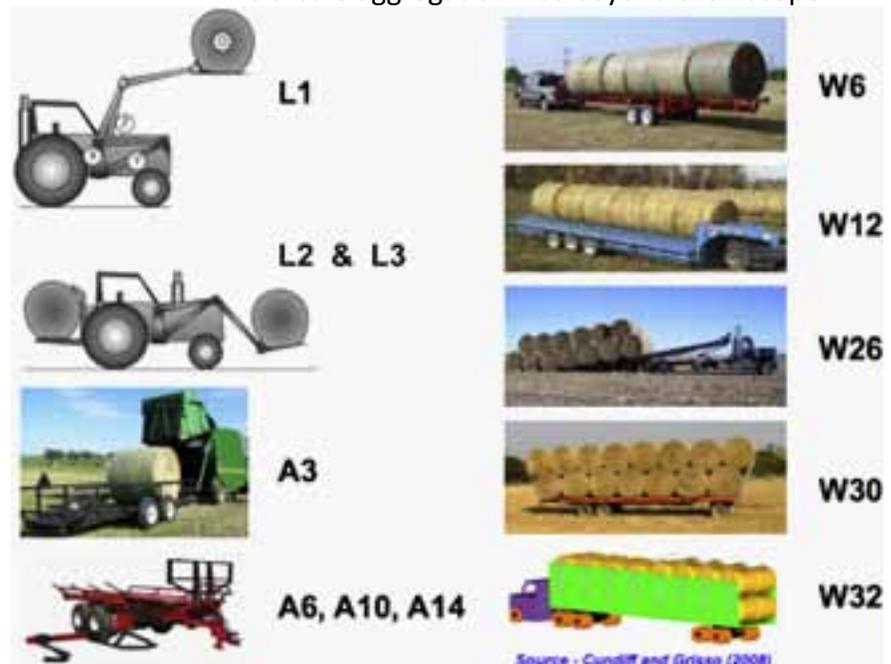


Fig. 2 - Types of bale loaders, transporting wagons, and advanced bale handling equipment; L, W, and A represent loader, wagon, and advanced bale handling equipment respectively, and the numerals indicate the number of bales handled; source of some inset pictures is Googleimages.

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Crop Residue Harvest Economics

Crop residues have been identified as a potential biomass source for bioenergy production. However, as a farmer, it does not make sense to harvest residue if you lose money doing it. Similarly, for the bioenergy industry, it does not make sense to build a biorefinery without knowing how much biomass farmers would be able to economically supply over the long term. If harvesting biomass is to be profitable at the farm level, the income from selling the biomass must be able to cover all of the harvesting and handling costs, but also needs to account for any impacts on current and future grain crop production. However, the costs of producing crop residues, including effects on grain production, can vary between sites with different soils, weather, and crop production systems.

As part of the Renewable Energy Assessment Project (REAP) and Sun Grant Regional Partnership collaboration, a coordinated effort was undertaken to conduct field experiments at multiple sites across the USA and to assemble the data collected at those sites into a common database, known as REAPnet, for use in evaluating biofuel feedstock production alternatives. The REAPnet database is publicly accessible through the ARS data portal (<http://nrrc.ars.usda.gov/arsdataportal/#/Home>).

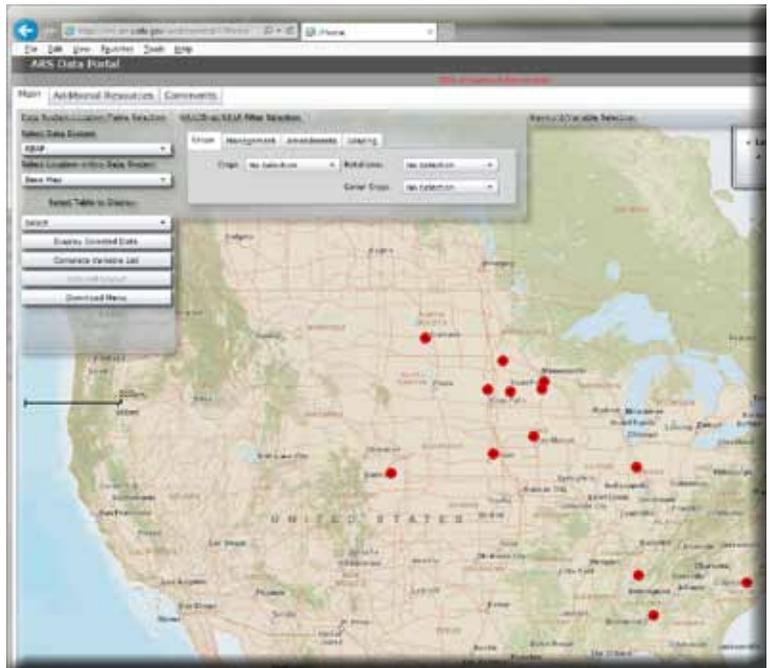
A tool was built to retrieve data from the web site to generate production cost information from REAP



Baling dry pea residue at the Mandan, ND research site.

field studies and compare the profitability of crop residue harvest strategies at the different locations.

For the initial analysis, the tool was used to retrieve data from two sites, one near Ames, Iowa and one



REAPnet data access web page.

near Mandan, North Dakota. The initial analysis looked at residue harvest impact over three years at each of the sites, thereby included only short-term impacts on grain yields and input use. Production alternatives analyzed at each site included different tillage, crop rotation, input use, and biomass harvest rate options specific to each location.

Results showed that harvesting biomass at low removal rates had little short-term impact on crop productivity. Results also showed that, even though direct biomass harvest costs were higher at lower harvest rates, breakeven biomass harvest prices were lower at the lower harvest rates since the lower harvest rates had less impact on crop productivity. However, it will be important to monitor longer-term changes to see if grain profitability decreases. Results showed that biomass could be profitably produced in the short-term at prices in the field of \$24-38 per dry ton at the Iowa site, and \$49-66 per dry ton at the North Dakota site. These results provide farmers and the biomass industry cost information, and provide a tool for future use in analyzing biomass production costs and comparing production methods at other sites.

Archer, D.W., Karlen, D.L., Liebig, M.A. 2014. Crop residue harvest economics: An Iowa and North Dakota case study. *BioEnergy Research*. 7(2):568-575. <http://link.springer.com/article/10.1007/s12155-014-9428-6>

Soil Properties and Long-Term Grazing

Studies evaluating grazing management influences on soil properties within growing seasons and across consecutive years are limited, yet such studies may provide insight into ecosystem resilience, particularly if the study period encompasses extreme weather conditions.

A study was conducted to evaluate near-surface soil property dynamics in three long-term grazing management systems at the Northern Great Plains Research Laboratory. Evaluations were conducted three times during the growing season over three consecutive years, with the last year (2006) during a drought.

Grazing treatments evaluated in the study included two permanent vegetation pastures and one seeded forage pasture.

The permanent pastures included a moderately grazed pasture and heavily grazed pasture, both established in 1916 on native rangeland and managed without the application of tillage, fertilizer, herbicides, or fire. The seeded forage was a crested wheatgrass pasture, established in 1932 by planting into previously tilled native range. The crested wheatgrass pasture was fertilized each fall beginning in 1963 at a rate of 40 lb. N ac⁻¹.

Results from the study found near-surface soil

properties exhibited strong responses to not just grazing management, but also year and season. High stocking rate and fertilizer N application within the crested wheatgrass pasture contributed to increased soil bulk density and extractable N, and decreased soil pH and microbial biomass compared to permanent pastures.

Soil nitrate-N tended to be greatest at peak aboveground biomass, whereas soil ammonium-N was greatest in early spring. Drought conditions during the third year of the study contributed

to nearly two-fold increases in extractable N under the crested wheatgrass pasture and heavily grazed permanent pasture, but not the moderately grazed permanent pasture.

Regression analyses found select soil properties to be modestly related to greenhouse gas fluxes. Among soil properties, electrical conductivity was

included most frequently in stepwise regressions, and accordingly, may serve as a useful screening indicator for greenhouse gas 'hotspots' in grazing land.

For more information, please refer to Liebig, M.A., S.L. Kronberg, J.R. Hendrickson, and J.R. Gross. 2014. Grazing management, season, and drought contributions to near-surface soil property dynamics and greenhouse gas flux in semiarid rangeland. Rangeland Ecol. Manage. 67: 266-274. <http://srmjournals.org/doi/abs/10.2111/REM-D-13-00145.1>

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Retirements



Larry Renner, NGPRL Electronics Technician at NGPRL, will retire after 32 years of service. In July, he will begin a new adventure supporting the Rafiki Children's Orphanages in Africa.



Faye Kroh, NGPRL Biological Technician at NGPRL, will retire after 38 years of service in July. She has supported numerous research programs and scientists for over a third of the history of the Northern Great Plains Research Laboratory. Her extensive garden, fish pond and 'fabric stash' will now appreciate her full attention.

The Area 4 SCD Cooperative Research Farm: Celebrating 30 Years of Collaborative Research

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Mandan, ND on gently rolling land with fertile soil (Temvik-Wilton silt loams). Prior to establishment of the research farm, the land was intensively tilled and cropped to wheat and corn or left fallow.

Research Accomplishments

The Area 4 SCD Cooperative Research Farm has fostered an evolution of cropland conservation in the northern Plains. Over the past 30 years, NGRPL scientists - and their collaborators - have conducted research on five broad themes (Figure 1) resulting in over 80 peer-review journal articles and book

for agricultural clientele has been a central component of the Area IV SCD Cooperative Research Farm since its establishment. Over the 30 year farm history, NGRPL scientists and staff have been engaged in a broad range of outreach and technology transfer activities that have served to meet this goal.

Traditional outreach activities have included conferences and field tours.

A 'Research Results & Technology Conference' has been held every winter, and provides NGRPL scientists an opportunity to share research findings from the

Research Theme	1984	1987	1990	1993	1996	1999	2002	2005	2008	2011	2014
Applying conservation tillage and crop residue management to reduce soil erosion											
Developing improved management recommendations for wheat production											
Improving precipitation-use efficiency of dryland cropping systems											
Developing resilient and adaptable crop rotations											
Quantifying soil ecosystem services											

Figure 1. Major research themes addressed at the Area 4 SCD Cooperative Research Farm.

chapters. Major research themes addressed during the farm's history include applying conservation tillage and crop residue management to reduce soil erosion, developing improved management recommendations for wheat production, improving precipitation-use efficiency of dryland cropping systems, developing resilient and adaptable crop rotations, and quantifying ecosystem services.

Important Role of Outreach

Translating research findings into usable information

Area 4 farm with local farmers. In July, NGRPL hosts a 'Friends & Neighbors Day', which typically attracts 800-1000 attendees. A significant component of the day is an afternoon field tour, where NGRPL scientists and staff review current projects and demonstrate crop and soil measurements in a field setting.

Decision support tools arising from Area 4 farm projects have played an important role in transferring research findings to the agricultural community. The Crop Sequence Calculator (CSC), a farmer-friendly,

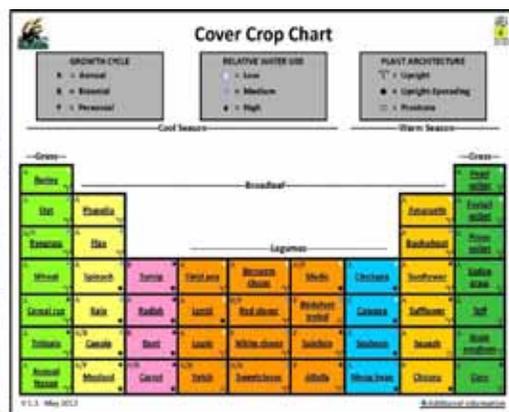
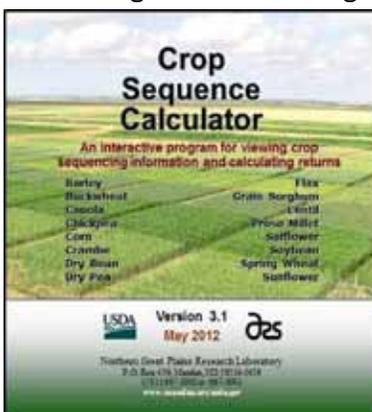


Figure 2. The Crop Sequence Calculator and Cover Crop Chart have facilitated increased adoption of more sustainable cropping practices.

interactive software program to design productive and profitable crop sequences, was developed in the early 2000s using results from crop rotation research conducted on the Area 4 farm. In 2009, the Cover Crop Chart (CCC) was developed by NGRPL scientists and staff in response to the growing demand for user-friendly cover crop information. Together, the CSC and CCC have been distributed to over 15,000 users in the U.S. and abroad (Figure 2; both available at www.ars.usda.gov/npa/ngprl/).

Looking to the Future

There are significant challenges associated with meeting future demand of food, fuel, and fiber while protecting environmental quality and sustaining rural communities. Trends in climate change and non-renewable resource use make these challenges all the more daunting, and underscore the need to develop cropping systems that are adaptable and resilient to external stressors, but are also productive, profitable, and environmentally benign. An emerging emphasis on ecosystem services from agricultural landscapes portends additional roles for farms, where cropland is managed to provide clean water, biodiversity benefits, climate stabilization and long-term soil fertility.

The Area 4 SCD Cooperative Research Farm is poised to provide practical solutions to these forthcoming challenges. Long-term, multi-disciplinary research - a defining attribute of the Area 4 farm - will serve to develop the necessary understanding across a continuum of biophysical and socioeconomic metrics for fostering the development of more sustainable dryland cropping systems. This role was formalized nationally in 2012 with the selection of NGRPL

as the Northern Plains site within the Long-Term Agroecosystem Research (LTAR) Network (Figure 3). The LTAR Network aims to ensure sustained crop and livestock production and ecosystem services from agro-ecosystems, and to forecast and verify effects of environmental trends, public policies, and emerging technologies. Previous and on-going research activities at the Area 4 farm are consistent with the focus of the LTAR Network.

Given the convergence of past investment and future opportunity, the Area 4 SCD Cooperative Research Farm should serve to guide the evolution of dryland cropping systems in the northern Great Plains for the next 30 years by continuing to provide practical, science-based information and decision support tools.

Text adapted from Liebig, M.A., D. Archer, J. Hendrickson, K. Nichols, M. Sanderson, D. Tanaka, S. Merrill, L. Harner, and D. Olsen. 2014. The Area IV Soil Conservation Districts Cooperative Research Farm: Thirty years of collaborative research to improve cropping system sustainability in the Northern Plains. *J. Soil Water Conserv.* doi: 10.2489/jswc.69.4.99A *Journal of Soil and Water Conservation* July/August 2014 vol. 69 no. 4 99A-103A <http://www.jswconline.org/content/69/4/99A.extract>.

Additional information about the Area 4 SCD Cooperative Research Farm can be found at www.area4farm.org.

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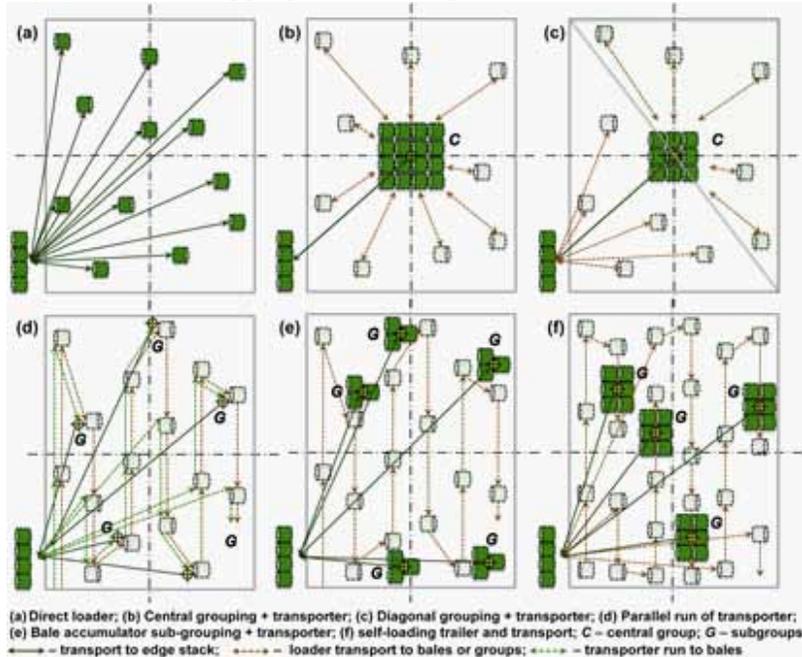
Figure 3. Long-term Agroecosystem Research Network sites and Farm Resource Regions, June 2014 (additional LTAR information available at www.ars.usda.gov/ltar/).

Efficient Infield Bale Collection Strategies - Save Time, Effort, and Money

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or simplistic methods were assumed for this minor subcomponent.

Several logistics scenarios for aggregation involving equipment and aggregation strategies were modeled



and evaluated. Three types of bale collection and transport strategies considered in the study were: (1) Direct collection and transport to the field-edge stack using collection equipment, (2) Centralized grouping using collection equipment and transport to the field-edge stack using transport equipment, and (3) Sub-grouping using collection equipment and transport to the field-edge stack using transport equipment.

The strategies, other than direct transport, use either the loader or bale accumulator to make subgroups of bales that were transported back to a field-edge stack by bale wagons. With the parallel run method, the loader loads the bales on to a parallel running self-propelled truck/wagon, or bales were hauled by the loader-tractor itself. Bales are usually loaded on bale wagons using the

loaders. However, the self-loading bale picker picks up bales and transports them to the field-edge stack, eliminating the necessity of the bale loader. To learn about the commercially available equipment and commonly used aggregation methods, interviews were conducted with local Ag producers in North Dakota.

Application of a single-bale loader that aggregated bales individually was considered the “control” scenario with which others were compared. A computer simulation program determined bale coordinates in ideal and random layouts that evaluated aggregation scenarios. Statistical analysis revealed that the effect of field shape, swath width, biomass yield, and randomness on bale layout did not affect aggregation logistics, while area and number of bales handled had significant impact.

A self-loading bale picker and parallel transport of loader and truck were ranked the most efficient, and single-bale central grouping the ranked lowest among 19 methods studied.

Simplistic methods, namely a direct triple-bale loader or a loader and truck handling six bales running parallel were highly efficient.

Great savings on cumulative distances that directly influence time, fuel, and cost were realized when the number of bales handled was increased or additional equipment was utilized.

Igathinathane, C., D. Archer, C. Gustafson, M. Schmer, J. Hendrickson, S. Kronberg, D. Keshwani, L. Backer, K. Hellevang, and T. Faller. "Biomass round bales infield aggregation logistics scenarios." *Biomass and Bioenergy* 66 (2014): 12-26. <http://www.sciencedirect.com/science/article/pii/S0961953414001317>

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