

Area 4 SCD Cooperative Research Farm

A Legacy for the Future



A Legacy for the Future

Area 4 SCD Cooperative Research Farm

Presentation overview...

- Context
- The Area 4 Farm
- An Exciting Future



Pre-1980s Agriculture

- Tillage
- Fallow
- Low crop diversity
- Farm crisis



The Area 4 SCD Cooperative Research Farm

Established from a 'Bottom Up' effort



1950 - Nelson Family farm established southwest of Mandan, ND

June 17, 1983 - A formal proposal to establish a Cooperative Research Farm was made at the annual Area 4 SCD meeting

December 1, 1983 - Original lease was signed between the Area 4 SCD Research Advisory Committee and the Nelson Family

1981 - Mr. Roy Nelson proposes leasing his entire farm to the local Soil Conservation District (SCD) for the purpose of supporting long-term research



Timeline

The Area 4 SCD Cooperative Research Farm

Original purpose and research themes

Provide land for conducting large-scale, long-term research on conservation tillage and dryland cropping systems

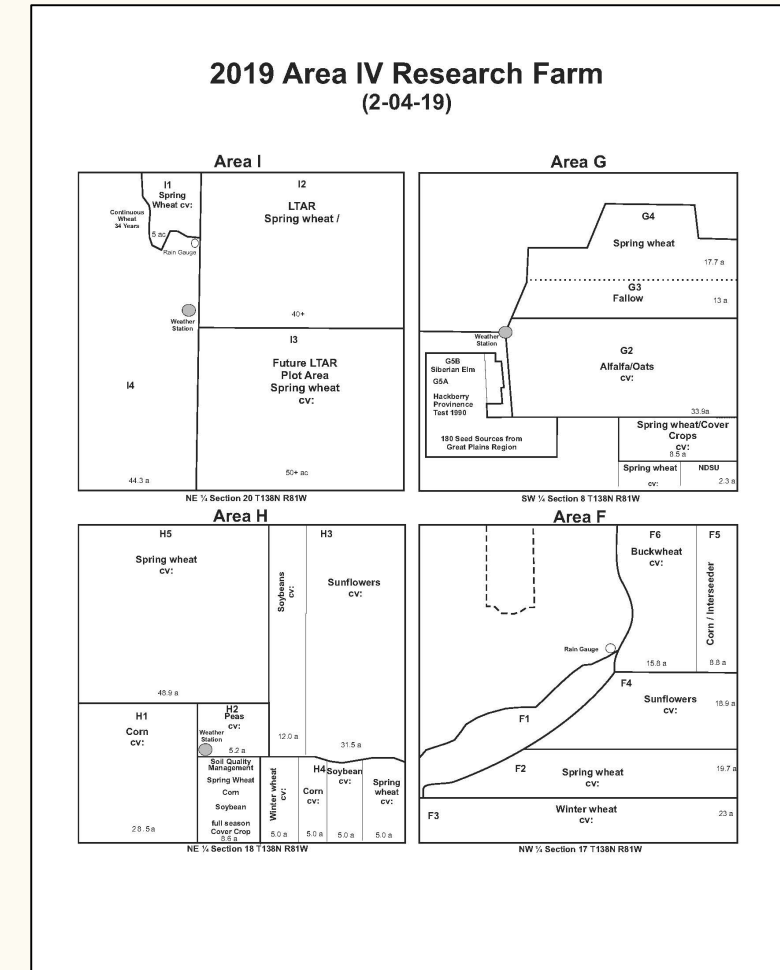
- ✓ Field scale
- ✓ Soil & water conservation systems/technology
- ✓ Promote the adoption
- ✓ Understandable terms
- ✓ Responsive to stakeholders



The Area 4 SCD Cooperative Research Farm

Location, land attributes, and field layout

- Located southwest of Mandan, ND
- Gently rolling landscape
- High quality soils (CPI = 90 for dominant soil series)
- 22 fields (5-50 acres)
- Fields spread across four quarter sections

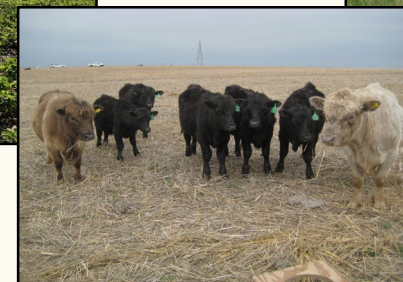


Research Cooperation

Northern Great Plains Research Laboratory

Established by Congress on August 8, 1912 to respond to the needs of farmers and ranchers of the Northern Plains.

NGPRL Mission: To develop adaptive and integrative practices for sustainable crop, livestock, and rangeland systems.

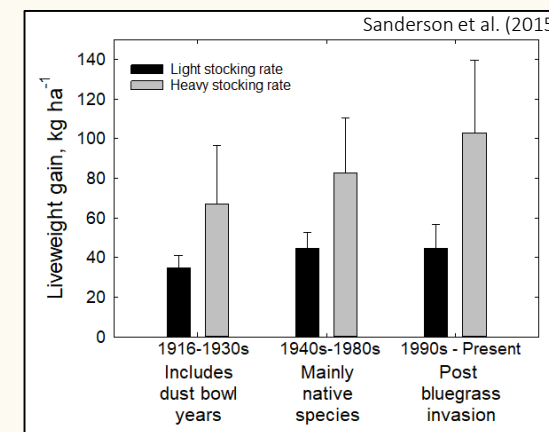
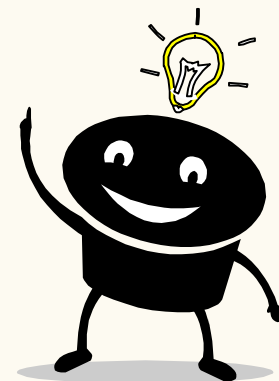


Northern Great Plains Research Laboratory

People, Place, & Purpose

System integration and design...

- Understand the “Why?”
- Quantify long-term system impacts
- Document outcomes following review by producers and the scientific community
- Develop user-friendly tools to help producers manage more sustainably



Residue Management



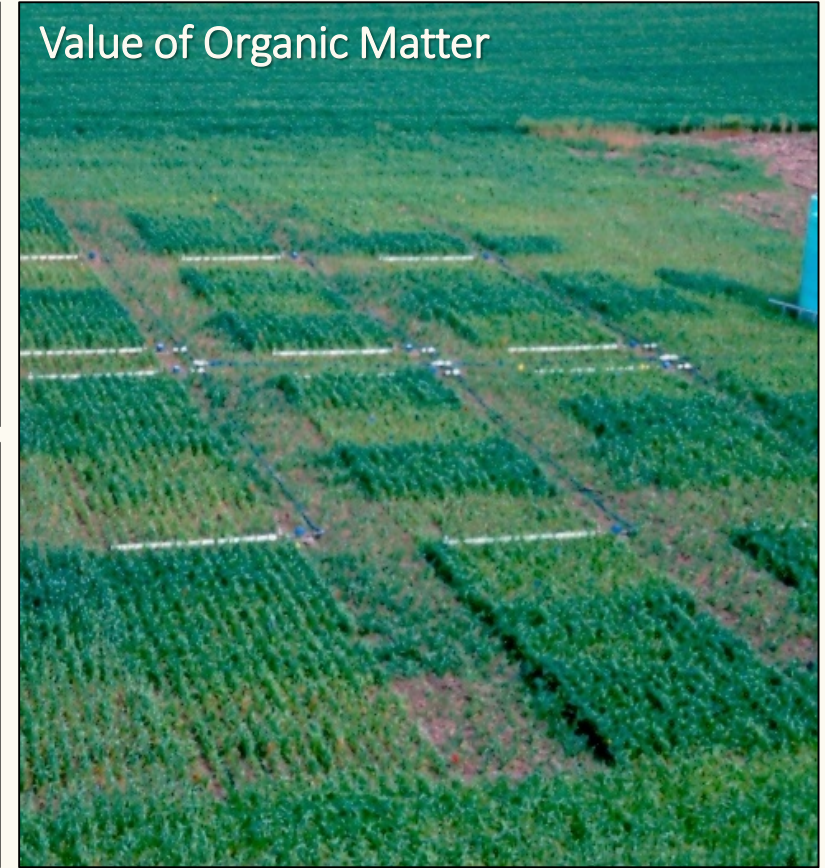
Rotations & Tillage



Crop Sequencing



Value of Organic Matter



Precision Agriculture



The Area 4 SCD Cooperative Research Farm

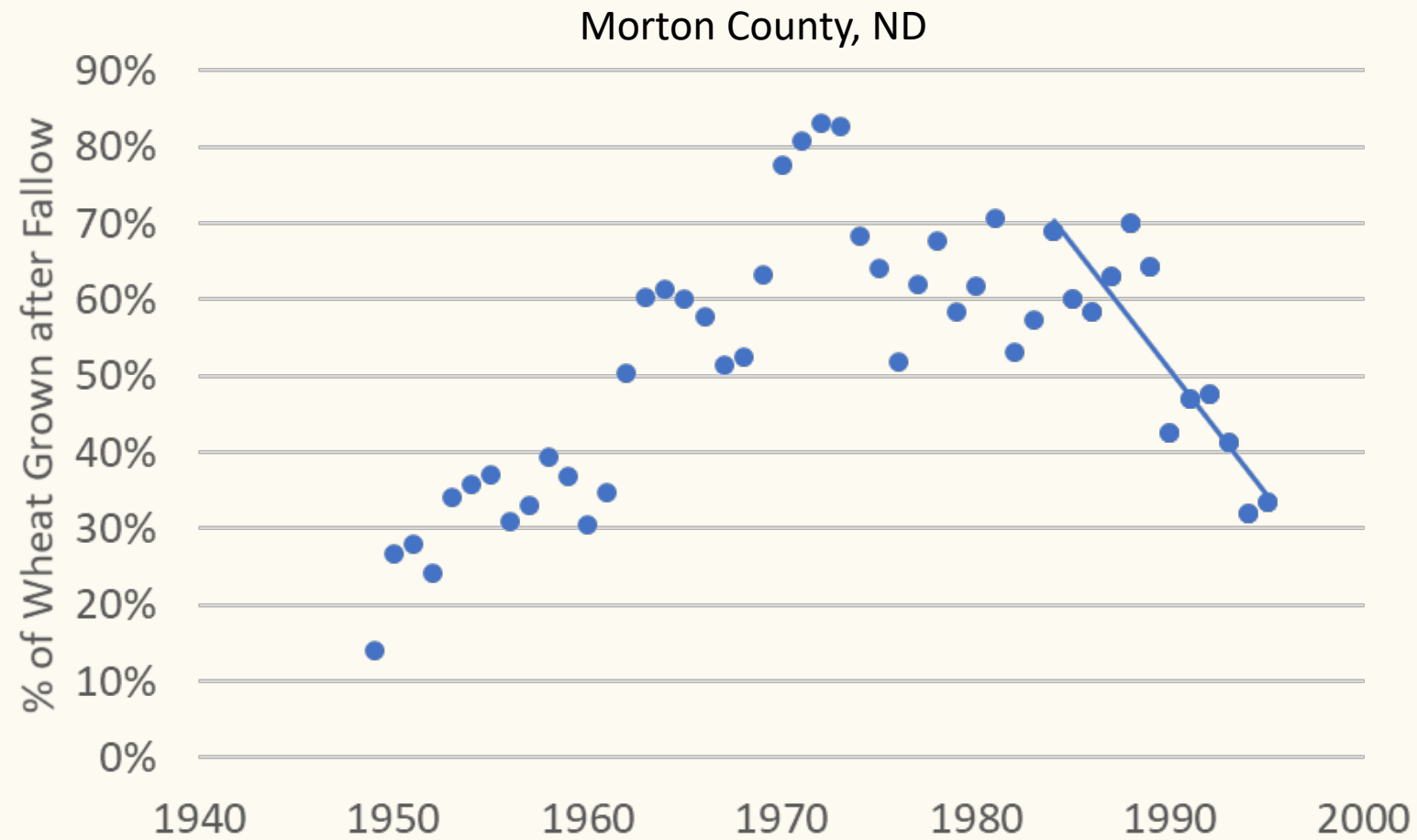
Previous research

Recognition of the Value of Soil

- **1 ton/ac Soil Organic Matter = 31.4 lb/ac spring wheat grain yield**



Decreased Fallow

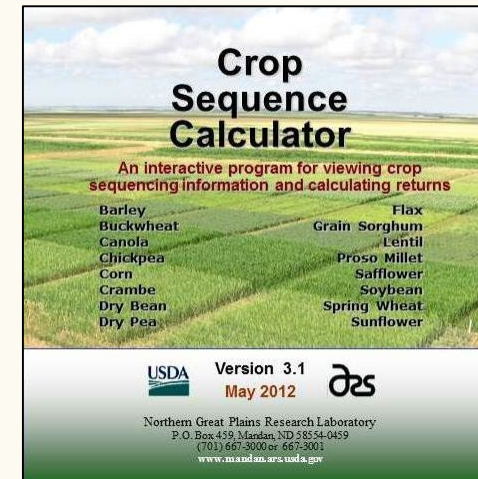


The Area 4 SCD Cooperative Research Farm

Developing practical decision tools

Crop Sequence Calculator

- Designed to help plan profitable crop rotations.
- >14,000 copies distributed worldwide.



Cover Crop Chart

- Information resource to help select cover crops for crop and forage production systems.
- Used throughout the U.S. and in over 50 countries.

USDA Northern Great Plains Research Laboratory Agricultural Research Service

COVER CROP CHART

AREA 4 SCD Cooperative Research Farm

GROWTH CYCLE		PLANT ARCHITECTURE		RELATIVE WATER USE	
A = Annual	B = Biennial	U = Upright	S = Spreading	L = Low	M = Medium
P = Perennial		U = Upright	S = Spreading	L = Low	M = Medium
COOL					
ANNUAL PERENNIAL	LEGUME	LEGUME	LEGUME	LEGUME	LEGUME
BARLEY	CAMELINA	MUSTARD	BALANSA CLOVER	CHICKPEA	WEDG
QAT	PHACELIA	CANOLA	BERSEEM CLOVER	PEA	LUPIN
WHEAT	FLAX	RADISH	CRIMSON CLOVER	LENTIL	TARA BEAN
CRISPA	KALE	TURNIP	RED CLOVER	LEPIDESEA	SWED CLOVER
TRITICALE	SPINACH	BEET	WHITE CLOVER	WINDROOST	TERFOIL
SAUNIE	CHARD	CARROT	KURA CLOVER	VETCH	SAINFOIN
WARM					
AMARANTH	FOXTAIL	PEARL	PROSO	GRAIN	SORGHUM
BUCKWHEAT	QUINOA	CHICKPEA	VELVET	BEAN	CHICKPEA
CLUSTER	JACK	BEAN	MUNG	BEAN	CUCURBITA
SOYBEAN	SOYBEAN	SAFFLOWER	TEFF	CORN	

V 3.0 February 2018

Additional Information

Stubble Height Effect on Winter Wheat in the Northern Great Plains: I. Soil Temperature, Cold Degree-Hours, and Plant Population

Armand Bauer* and A. L. Black

ABSTRACT

Soil temperatures at the crown-depth of winter wheat (*Triticum aestivum* L.) that effect winterkill are generally known. In contrast, estimates of the effect that duration of the low temperature has on winter survival have not been published for winterhardy cultivars. Objectives were to relate temperature at the 4-cm soil depth to winter survival and develop capability to estimate survival based on accumulated cold degree-hours. Field trials were conducted during a 4-yr period on Williams loam (fine-loamy, mixed Typic Argiborolls) at Mandan, ND. Soil temperature at the 4-cm depth was measured

Fowler (1977) and terkill temperature growth chambers hardiest cultivars fall hardening contributed to variation, Freyman (and 'Winalta' grown were harder than kernels (44 mg)

Stubble Height Effect on Winter Wheat in the Northern Great Plains: II. Plant Population and Yield Relations

A. L. Black and Armand Bauer*

Soil coverage by residue as affected by ten crop species under no-till in the northern

D.L. Tanaka, and R.L. Anderson

by residue protects soil and land resources from erosion, conserves soil quality. No-till and chemical weed control are management coverage by residue. On the other hand, crop diversification in

High Quality, Impactful Science > 100 Journal Papers

Conservation Tillage Affects Root Growth of Dryland Spring Wheat under Drought

S. D. Merrill,* A. L. Black, and A. Bauer

ABSTRACT

In dryland cropping, no-tillage can increase small grain crop growth compared with conventional tillage. Because root systems develop ahead of aboveground growth and are affected by soil environment, observation of root growth will show the mechanisms by which enhances crop growth. Wheat (*Triticum aestivum* L.) was grown in spring wheat-winter wheat-sunflower (*Helianthus annuus* L.) begun in 1984 on Temvik-Wilton silt loam (fine-loamy, mixed and Pachic Haploborolls) under conventional till (CT: spring minimal till (MT: spring undercutting) and no-till (NT). Root growth (RLG) was measured by microvideo camera in pressurized minirhizotrons, and soil water was measured by neutron meter. Relative to CT, NT generally enhanced RLG more aboveground growth; RLG averaged 65, 130, and 145 km

residues reduces the impacts of drought periods on crop production. Black (1973) found that soil water storage was positively correlated with residue levels established

d with the smallest plant population spikes/m² to plants/m², grain rain yield (kg/ha) to plants/m², R² of 0.94, 0.97, and 0.95. The relation of grain yield kg/ha (Y) to 0.18x² + 0.00021x². This algorithm yield potential when postwinter

Soil Wind Erosion Hazard of Spring Wheat-Fallow as Affected by Long-Term Climate and Tillage

Stephen D. Merrill,* Alfred L. Black, Donald W. Fryrear, Ali Saleh, Ted M. Zobeck, Ardell D. Halvorson, and Donald L. Tanaka

ABSTRACT

that drought accelerates wind erosion by increasing factors of erodibility together, compounding the ability factors measured in biennial spring wheat-fallow Typic Haploborolls soil were (i) soil-inherent (WE) by rotary sieving, (ii) surface roughness by methods, (iii) standing residue profile, and (iv) topographically. Four tillage treatments ranged from no-till (NT). The erodible fraction of surface changed from 53% during a dry period (1989-1991) to 26% during a wet period (1992-1994). Median values calculated from flat and standing residue

culture in semiarid regions (Smika, 1983). The Great Plains region of the USA is subject to weather cycles, which include multi-year droughts approximately every 10 to 25 yr (Cannel and Dregne, 1983). Drought enhances wind erosion, and mechanical tillage greatly increases wind-erosion hazards of the widely used wheat-fallow system. In spring wheat-fallow, poor crop growth under drought reduces the amount of crop residue available for soil protection during the 21-mo fallow period. To what extent can conservation tillage, either no-till or minimal till, reduce the vulnerability of wheat-fallow

Tillage and cropping effects on soil quality indicators in the northern Great Plains

M.A. Liebig^{a,*}, D.L. Tanaka^a, B.J. Wienhold^b

^a USDA-ARS, Northern Great Plains Research Laboratory, P.O. Box 459, Mandan, ND 58554, USA
^b Water Conservation Research Unit, 120 Keim Hall, Department of Agronomy, University of Nebraska, Lincoln, NE 68583, USA

Published August 28, 2015

Agronomy, Soils & Environmental Quality

Short-Term Soil Responses to Late-Seeded Cover Crops in a Semi-Arid Environment

M. A. Liebig,* J. R. Hendrickson, D. W. Archer, M. A. Schmer, K. A. Nichols, and D. L. Tanaka

ABSTRACT

Cover crops can expand ecosystem services, though management recommendations for their use within semiarid systems is currently constrained by a lack of information. This study was conducted to determine agroecosystem responses to late-summer seeded cover crops under no-till management with particular emphasis on soil attributes. Short-term late-summer seeded cover crops on soil water, available surface soil quality, and residue cover were investigated three consecutive years on the Area IV Soil Conservation Research Farm near Mandan, ND. Mean annual

the Great Plains of North America requires cropping systems to possess a resilient soil. This paper summarizes the interactive effects of tillage, crop sequence, and cropping intensity on long-term cropping system experiments in the northern Great Plains. The experiments, established in 1984 and 1993 on a Wilton silt loam (FAO: Calcic Siltic Chernozem),

Dynamic Cropping Systems: An Adaptable Approach to Crop Production in the Great Plains

D. L. Tanaka,* J. M. Krupinsky, M. A. Liebig, S. D. Merrill, R. E. Ries, J. R. Hendrickson, H. A. Johnson, and J. D. Hanson

ABSTRACT

Research to integrate the vast array of information needed by

market conditions, input prices, government programs and new technology and information represent broad

Crop Sequencing to Improve Use of Precipitation and Synergize Crop Growth

D. L. Tanaka,* R. L. Anderson, and S. C. Rao

ABSTRACT

Cropping systems will not be sustainable without change. Broad-scale problems associated with developing sustainable cropping systems are how to choose and sequence crops in cropping systems. Our objectives were twofold: (i) evaluate impacts of crop sequencing on precipitation use and (ii) show how crop sequencing can accentuate synergistic interactions among crops. Crop-fallow systems that developed in the Great Plains resulted in precipitation storage efficiencies of about 20% in the early 1930s to about 40% in the late 1980s.

resources may become inherent to a cropping system, if the system is to be sustainable.

One problem associated with cropping systems is how to choose and sequence crops to develop the inherent internal resources of the system while taking advantage of external resources such as weather, markets, government programs, and new technology (Tanaka et al., 2002). To better understand and appreciate cropping systems

Dynamic Cropping Systems for Sustainable Crop Production in the Northern Great Plains

D. L. Tanaka,* J. M. Krupinsky, S. D. Merrill, M. A. Liebig, and J. D. Hanson

ABSTRACT

Producers need to know how to sequence crops to develop sustainable dynamic cropping systems that take advantage of inherent

have peaked for the present at 40% across all climatic zones (Peterson et al., 1996). Therefore, about 60% of the precipitation received during fallow is lost to

Tillage, Nitrogen, and Cropping System Effects on Soil Carbon Sequestration

Ardell D. Halvorson,* Brian J. Wienhold, and Alfred L. Black

ABSTRACT

Soil C sequestration can improve soil quality and reduce agriculture's contribution to CO₂ emissions. The long-term (12 yr) effects of tillage system and N fertilization on crop residue production and soil organic C (SOC) sequestration in two dryland cropping systems

With increased cropping intensity, one would expect that more crop residue and C would be added to the soil than with a crop-fallow system (Campbell et al., 1995, 2000b; Janzen et al., 1998a; Peterson et al., 1998). As the amount of crop residue returned to the soil is

Renewable Agriculture and Food Systems

cambridge.org/raf

Crop diversity effects on productivity and economics: a Northern Great Plains case study

David W. Archer, Mark A. Liebig, Donald L. Tanaka* and Krishna P. Pokharel

ry, P.O. Box 459, Mandan, ND

nability of cropping systems. omically viable. In this study systems with varying levels of stem effect on crop product-

Theme / Related Publications	1984	1987	1990	1993	1996	1999	2002	2005	2008	2011	2014	2017	2020
Using conservation tillage and crop residue management to reduce soil erosion													
Black and Bauer (1983); Tanaka and Hofman (1994); Merrill et al. (1999)													
Developing improved management recommendations for wheat production													
Black and Bauer (1990); Frank and Bauer (1996); Halvorson et al. (2000)													
Improving precipitation-use efficiency													
Tanaka and Anderson (1997); Tanaka et al. (2005); Merrill et al. (2007)													
Understanding soil organic matter dynamics													
Bauer and Black (1994); Halvorson et al. (2002); Liebig et al. (2009)													
Developing resilient and adaptable crop rotations													
Tanaka et al. (2002); Krupinsky et al. (2006); Hanson et al. (2007); Archer et al. (2018)													
Enhancing soil quality/health													
Wienhold et al. (1998); Wienhold et al. (2006); Merrill et al. (2013); Liebig et al. (2014)													
Mitigating greenhouse gas emissions													
Frank et al. (2006); Phillips et al. (2009); Phillips et al. (2012); Saliendra et al. (2018); Liebig et al. (2019)													

Challenges Remain

- Feed a Growing Population, *and*
- Protect the environment
 - Maintain grasslands & natural areas
 - Provide environmental benefits on ag. lands
 - Reduce negative effects on environment
- Provide opportunities for producers
 - Ability to earn a living
 - Good quality of life



Farming in the Northern Plains is Challenging...

Taking a long-term view is important

- Short-seasons, high weather variability, and variable land suitability
- Natural resources are especially sensitive to management perturbations
- Previous catastrophic events have underscored the value of conservation



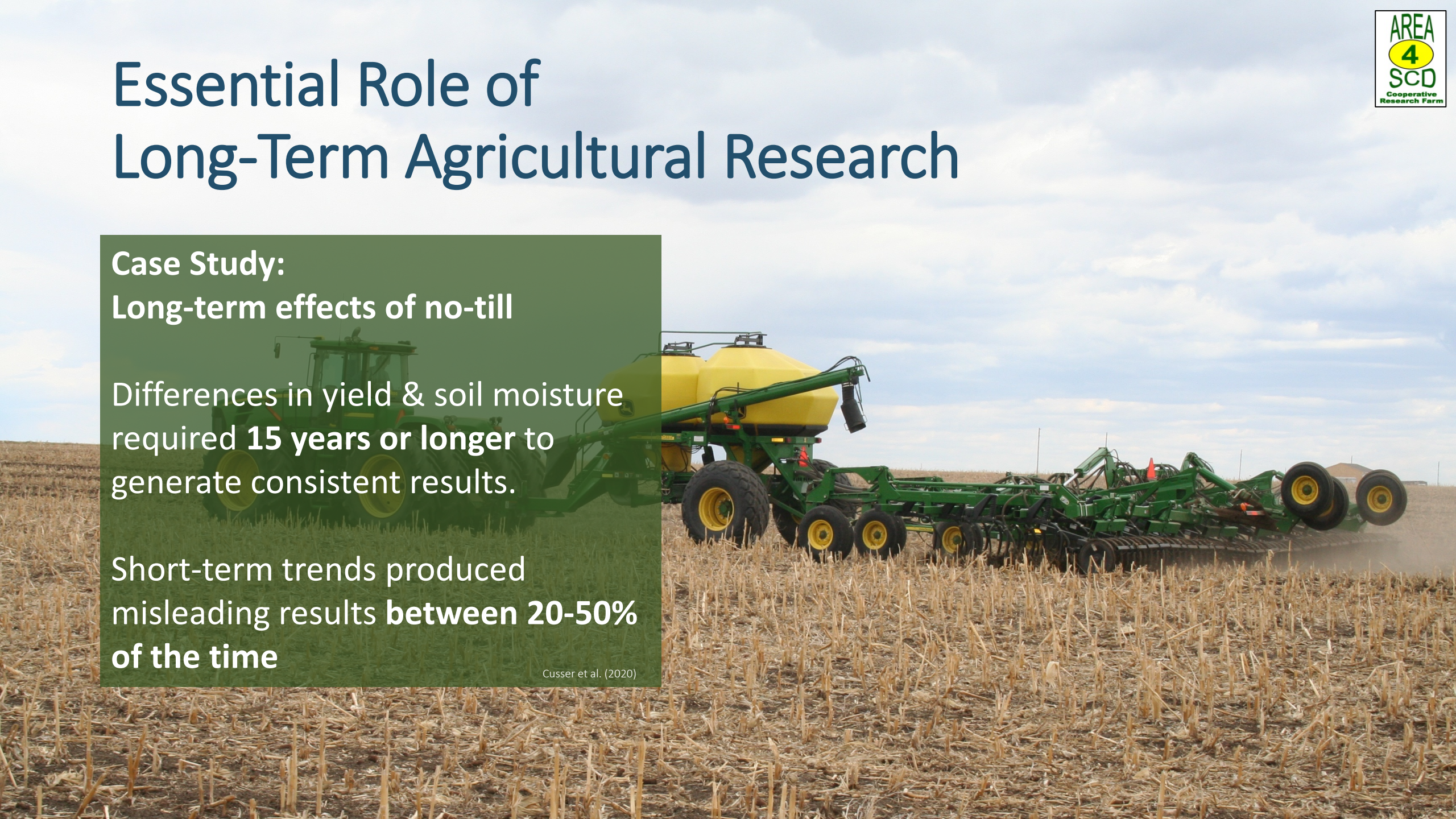
Essential Role of Long-Term Agricultural Research

Case Study: Long-term effects of no-till

Differences in yield & soil moisture required **15 years or longer** to generate consistent results.

Short-term trends produced misleading results **between 20-50% of the time**

Cusser et al. (2020)

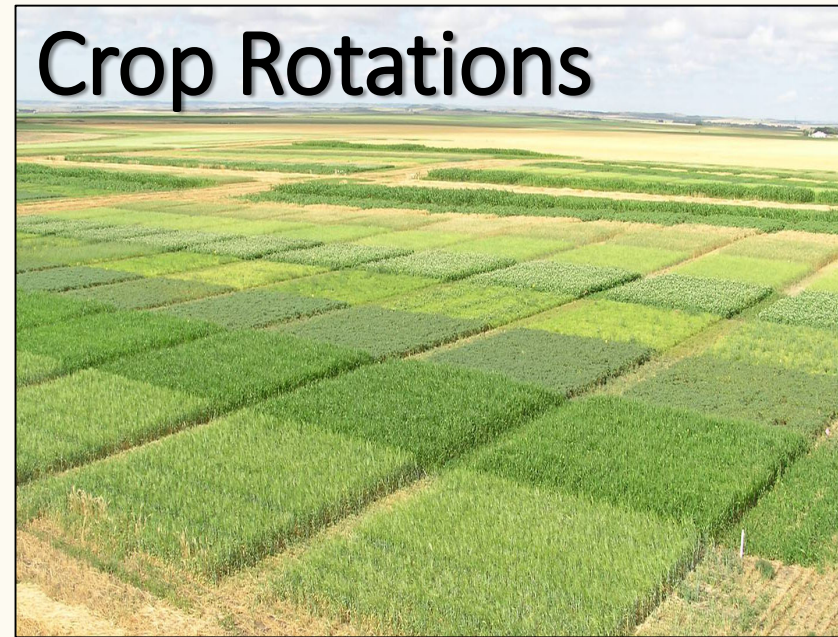


Cover Crops



**Wildlife
Pollinators
Yield
Soil Health
Resilience**

Crop Rotations



Perennial Forages



The Area 4 SCD Cooperative Research Farm

Ongoing research

Friends and Neighbors Day (July)



Translating science to practice
through effective outreach

>1200 attendees annually



Winter Workshop (February)



Engaging the
agricultural community

[Home](#)[Friends & Neighbors Day](#)[History](#)[Farm Field History](#)[Media](#)[2020 Crop Map](#)[Winter Workshop](#)[Crop Sequence Calculator](#)

Farming and Ranching for the Bottom Line

Discover the Triple Bottom Line:
Economics, Ecology, & Sociology



February 25 & 26, 2020
BSC National Energy Center for Excellence

FEATURED TOPICS

FEBRUARY 25

Soil & Human Health Connection
NDSU Agribiome Initiative
Weather Crystal Ball
Innovative Producer Panel

2018 Research Results

2017 Research Results



Featuring Keynote Speaker

Ask a question or request a free semi-annual newsletter from the Northern Great Plains Research Laboratory at Mandan, ND

Name *

Email *

Subject

Message

Online Resources

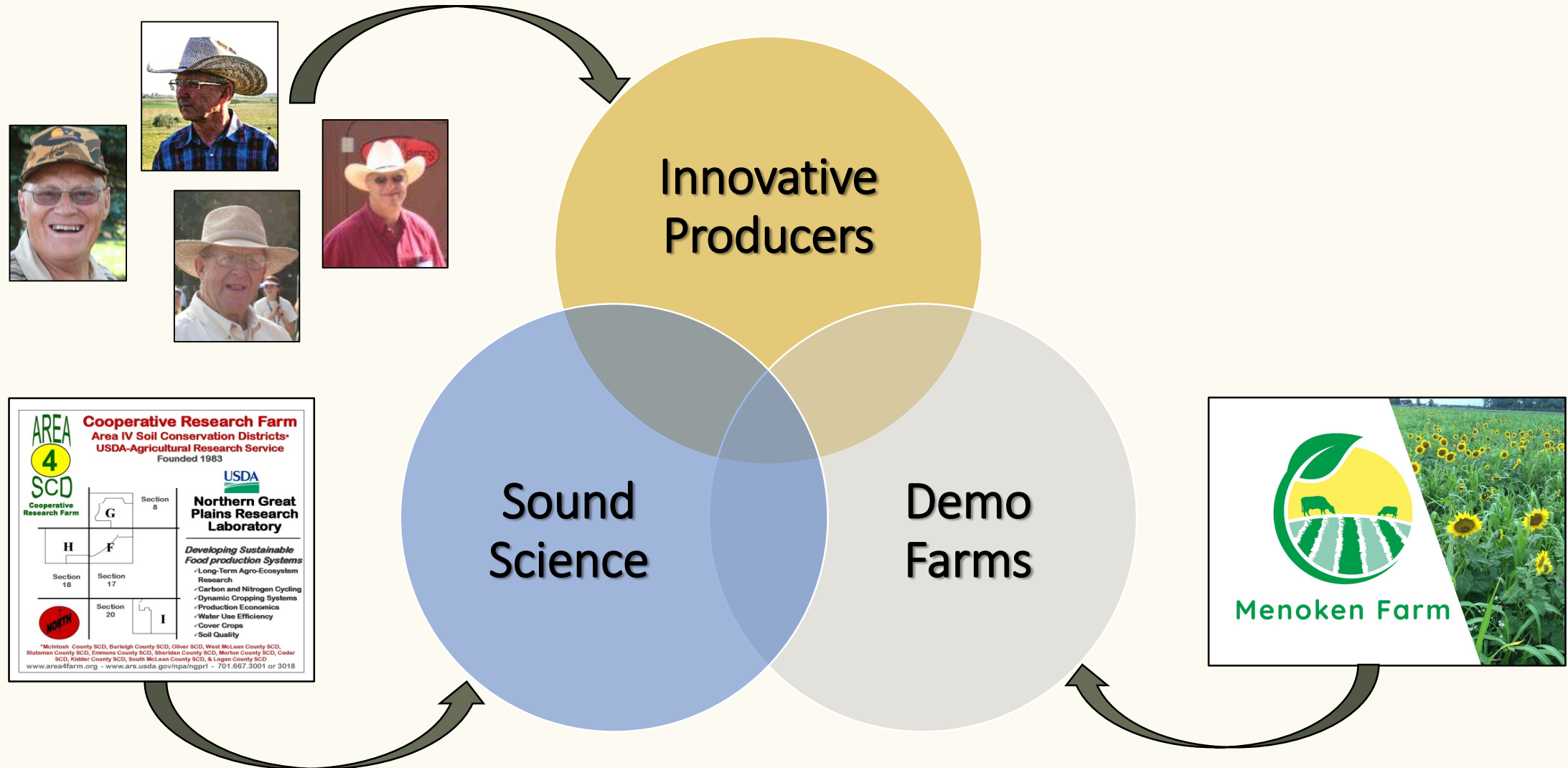
www.area4farm.org

Send

AREA

Cooperative Research Farm
Area IV Soil Conservation Districts*

Incubator for Transformative Solutions



AREA 4 SCD Cooperative Research Farm
Area IV Soil Conservation Districts*
USDA-Agricultural Research Service
Founded 1963

USDA
Northern Great Plains Research Laboratory
Developing Sustainable Food production Systems

- Long-Term Agro-Ecosystem Research
- Carbon and Nitrogen Cycling
- Dynamic Cropping Systems
- Production Economics
- Water Use Efficiency
- Cover Crops
- Soil Quality

*McIntosh County SCD, Burleigh County SCD, Oliver SCD, West McLean County SCD, Blount County SCD, Emmet County SCD, Sheridan County SCD, Morton County SCD, Cedar SCD, Kidder County SCD, South McLean County SCD, & Logan County SCD
www.area4farm.org - www.ars.usda.gov/nrpl - 701.667.3001 or 3018

Established conservation-based systems



Cover Crops



Livestock
Integration



Perennials

DYNAMIC CROPPING SYSTEM

Ecosystem service assessment framework

Can future systems...

PRODUCTION

- Increase production of food, feed, fiber, fuel?
- Improve nutritional quality of agricultural products?

ENVIRONMENT

- Improve soil, air, and water quality?
- Increase resistance/resilience to stress?
- Improve pollinator resources?

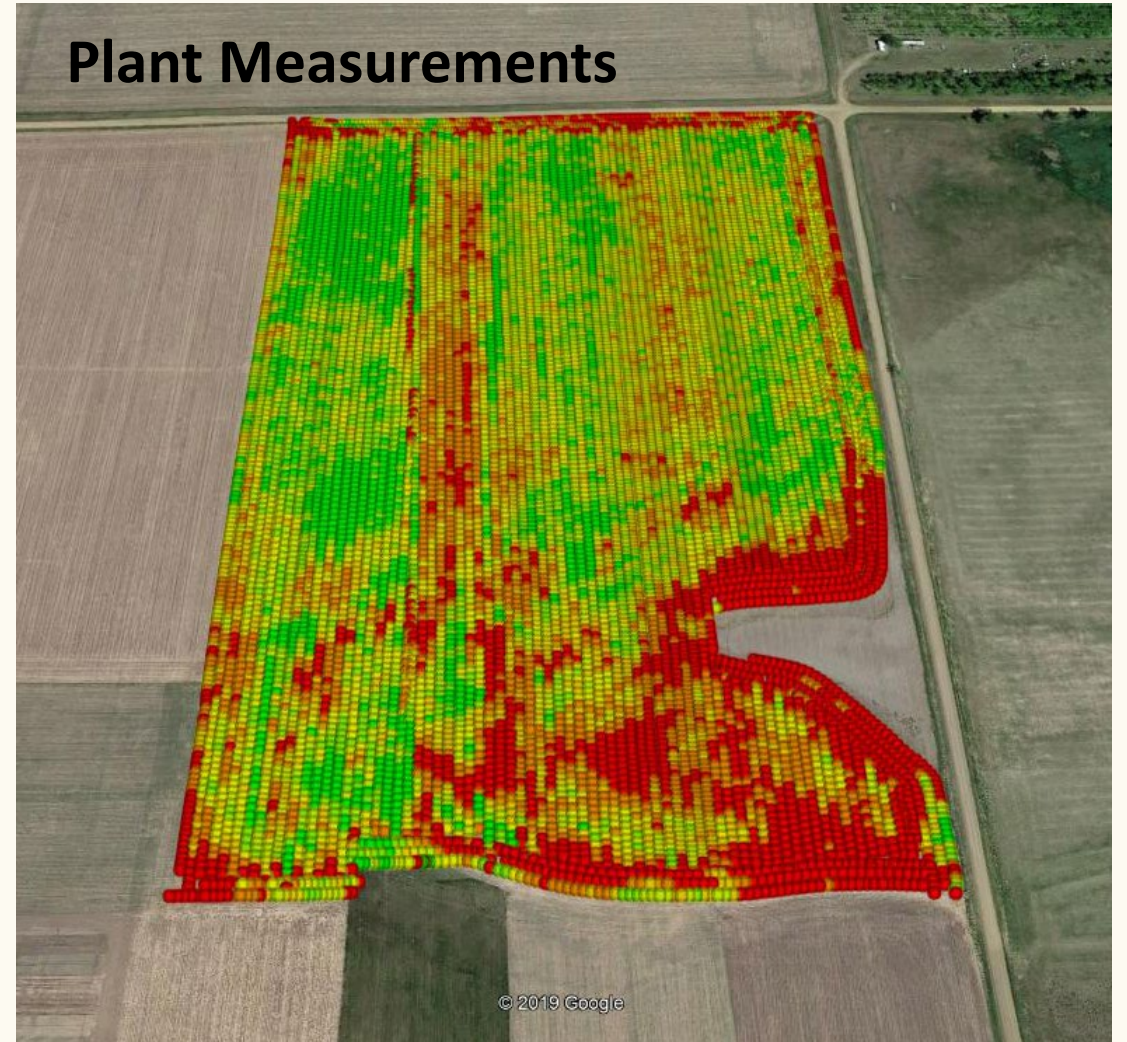
SOCIETY

- Increase farm/ranch profitability?
- Improve rural economies?
- Improve rural landscapes?



35+ Years of Investment in the Area 4 Farm

Investment of labor and \$



35+ Years Investment in the Area 4 Farm

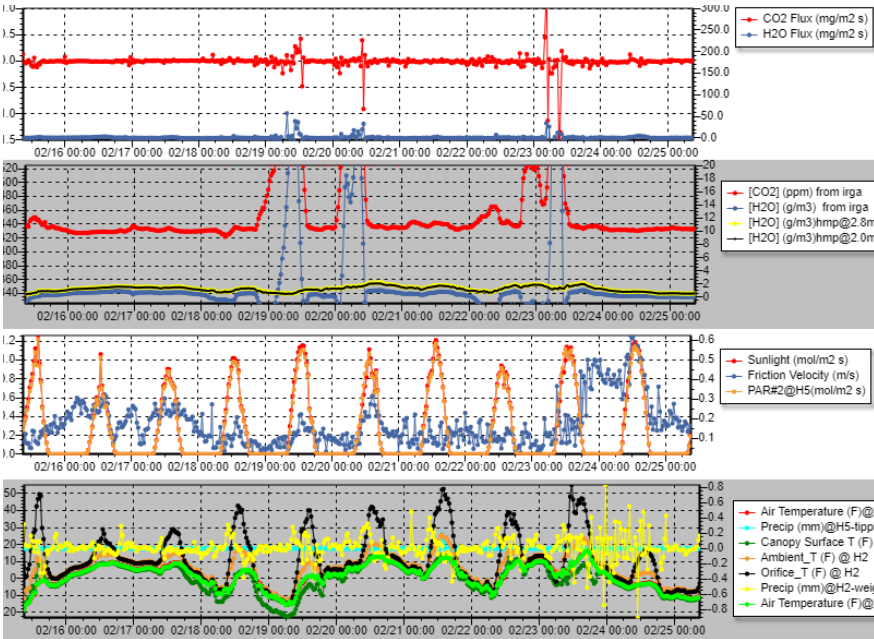
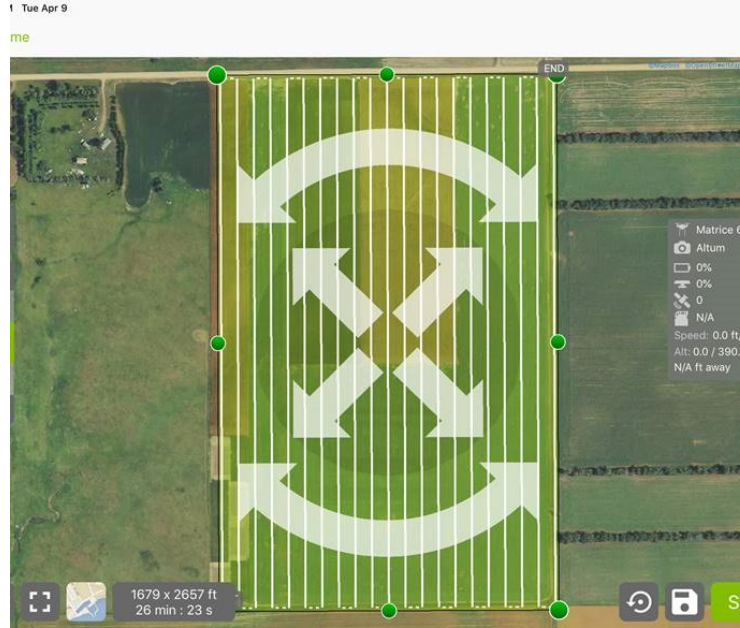


**Extensive archives
to explore long-
term impacts**

ID	Year	Plot	Yield	Test Wt	TKW	GrainN
1	1994	105	3501	62.5	29.10	22.3
2	1994	106	3095	62.4	29.00	19.8
3	1994	107	2925	61.9	28.70	21.7
4	1994	108	2311	62.2	28.70	22.5
5	1994	111	3645	61.9	29.60	23.3
6	1994	112	3383	62.9	30.20	24.7
7	1994	113	2545	62.7	29.60	25.1
8	1994	114	2584	62.3	28.90	24.4
9	1994	117	3422	62.1	29.60	28.8
10	1994	118	3501	61.4	29.20	28.3
11	1994	119	3422	62.1	29.60	28.8
12	1994	120	3422	62.1	29.60	28.8
13	1994	121	3422	62.1	29.60	28.8
14	1994	122	3422	62.1	29.60	28.8
15	1994	205	2930	62.0	29.40	22.0
16	1994	206	3422	62.3	29.60	22.0
17	1994	213	3359	62.1	29.60	22.7
18	1994	214	3359	62.1	29.60	22.7
19	1994	215	3359	62.1	29.60	22.7
20	1994	220	2979	62.0	30.80	21.7
21	1994	221	2797	62.3	27.20	18.7
22	1994	222	2299	61.9	29.60	19.2
23	1994	223	2544	62.4	29.70	20.0
24	1994	224	2840	62.6	29.60	19.4
25	1994	303	2622	62.2	28.40	21.8
26	1994	304	3096	62.2	29.00	24.0
27	1994	305	3045	61.6	27.40	23.1
28	1994	306	2910	61.1	28.50	23.9
29	1994	309	3133	62.3	29.90	25.3
30	1994	310	3496	62.5	29.30	24.1
31	1994	313	2876	62.6	28.50	22.6
32	1994	314	3311	62.1	27.80	24.0
33	1994	317	3145	61.4	29.50	27.5
34	1994	318	3260	61.9	28.40	22.5
35	1994	321	2446	60.7	30.30	24.0
36	1994	322	3515	63.4	29.30	22.5
37	1995	103	1506	55.8	22.71	24.4

Data archive
>15 long-term studies





An Exciting Future for the Area 4 Farm

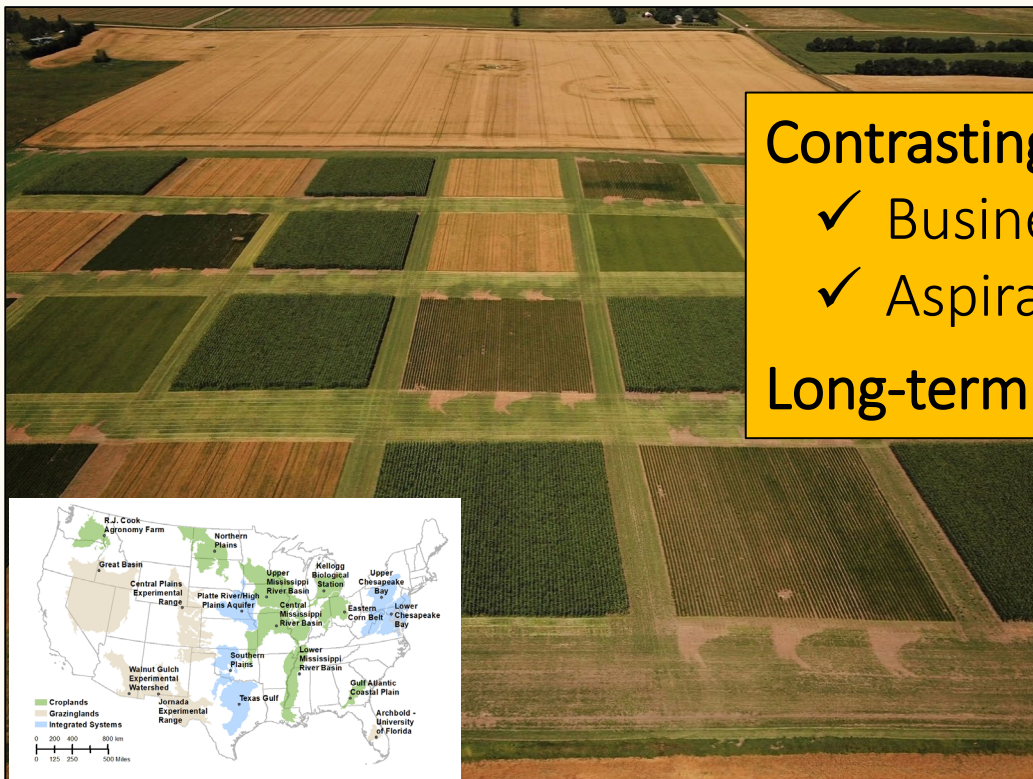
Application of precision technologies

Aligning data streams in real-time to facilitate adaptive management

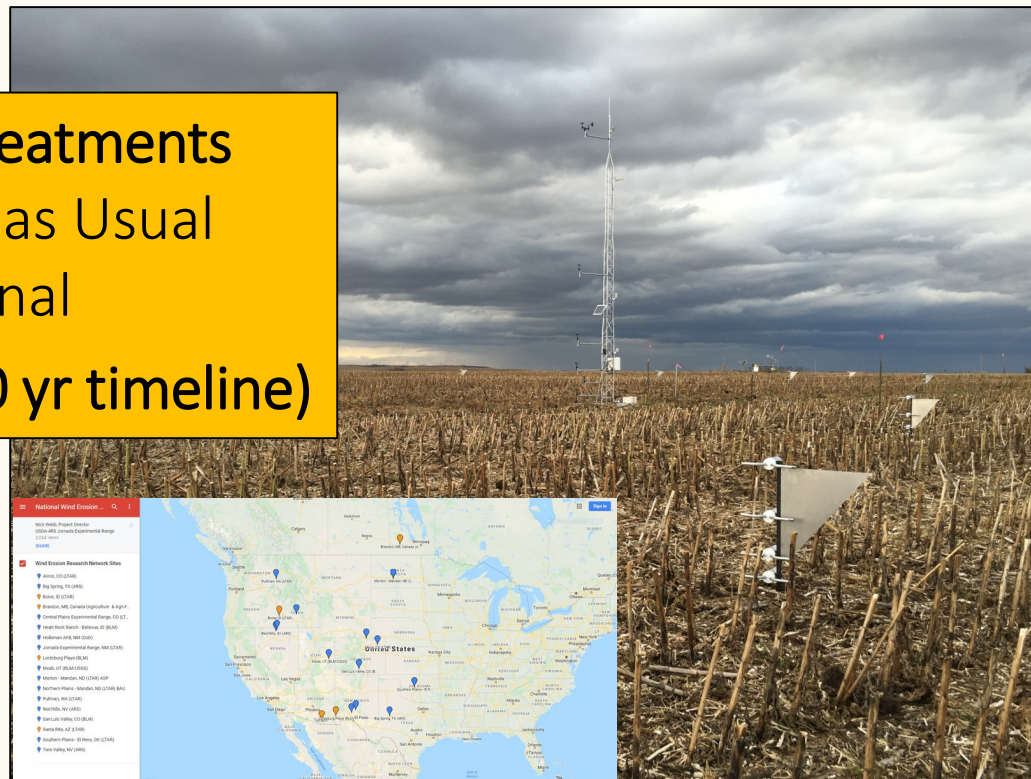
An Exciting Future for the Area 4 Farm

Engagement in national research networks

Long-Term Agroecosystem Research Network



National Wind Erosion Research Network



Contrasting treatments

- ✓ Business as Usual
- ✓ Aspirational

Long-term (30 yr timeline)

An Exciting Future for the Area 4 Farm

Health Soil – Healthy Food – Healthy People

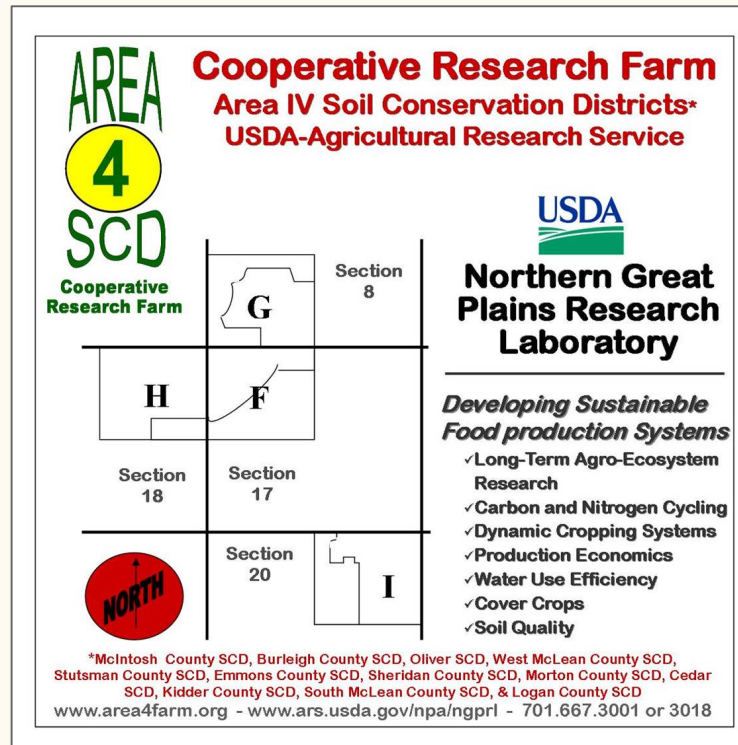
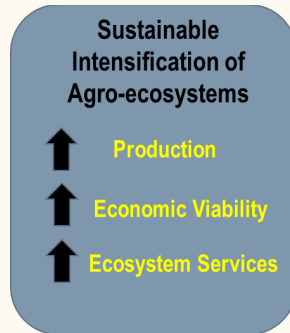
Assess long-term management impacts to:

- Soil health
- Nutrient content of foods
- Human health

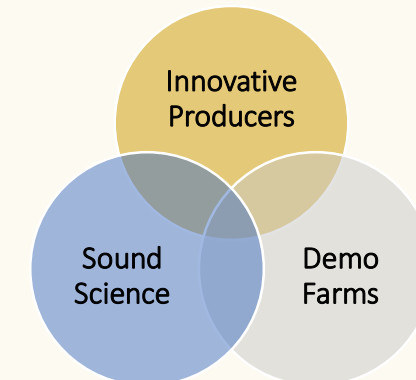
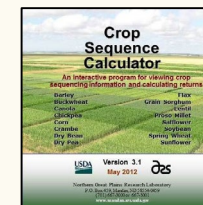
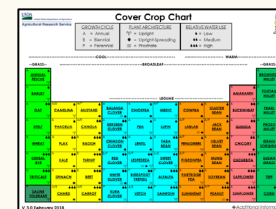


A Legacy for the Future

Long-Term Agricultural Research and the Area 4 SCD Cooperative Research Farm



Theme / Related Publications	1984	1987	1990	1993	1996	1999	2002	2005	2008	2011	2014	2017	2020
Using conservation tillage and crop residue management to reduce soil erosion													
Developing improved management recommendations for wheat production													
Improving precipitation-use efficiency													
Understanding soil organic matter dynamics													
Developing resilient and adaptable crop rotations													
Enhancing soil quality/health													
Mitigating greenhouse gas emissions													



Thank you for your attention
Questions?

