Colorado Conservation Tillage Association

in cooperation with

National Sunflower Association

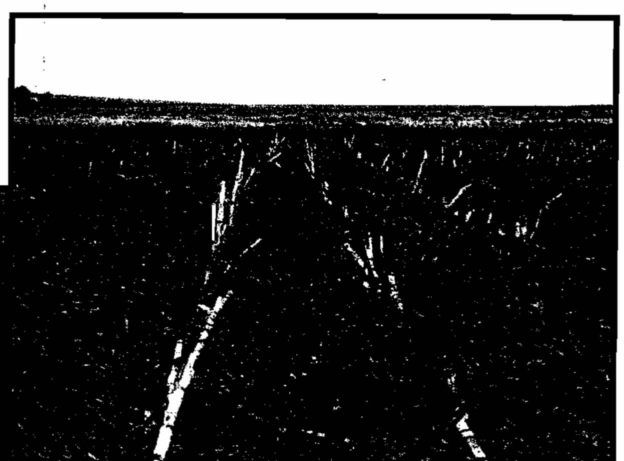
Presents

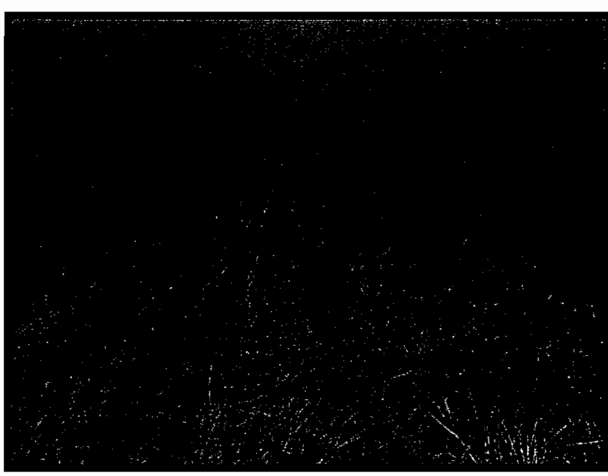
The High Plains No-Till Conference

17th Annual Winter Conference

Proceedings

Island Grove Park—Greeley
Feb. 1-2, 2005





Section L

Soil Changes when Switching to No-Till

Merle Vigil
USDA-ARS Central Great Plains Res. Stn.

Neil Hansen
Dept. of Soil & Crop Sciences, CSU

Soil Changes when Switching to No-Till

Speaker:	Dr Merle F. Vigil
Title:	Research Leader/Soil Scientist
Education:	BS Crop Science Colorado State University 1980 MS Agronomy Colorado State University 1983 Ph D. Soil Science Kansas State University 1989
Organization:	USDA-ARS Central Great Plains Res. Stn.
Address:	40335 Couty Rd GG
City, State, Zip:	Akron, Colorado 80720
Phone:	970-345-2259
E-mail:	Merle.Vigil@ars.usda.gov
Experience:	Ag Consultant Field Scout 1978-1983 Colorado State University Cooperative Ext agent 1983-1984 Research Associate Kansas State University 1984-1989 Soil Scientist and assistant Professor of Agronomy USDA-ARS Lincoln Nebraska and University of Nebraska Lincoln 1989-1991 Soil Scientist USDA-ARS, Akron Colorado 1991-2000 Research Leader USDA-ARS, Akron Colorado 2000-present

Speaker: Neil Hansen

Title: Associate Professor of Soil Science

Education:
1992 B.S. Brigham Young Univ., Provo, UT, Agronomy
1994 M.S. Brigham Young Univ., Provo, UT, Soil Science.
1998 Ph.D. Univ. of Minnesota, St. Paul, MN, Soil Science

Organization: Colorado State University

Address: Colorado State University
Department of Soil and Crop Sciences
1170 Campus Delivery

City, State, Zip: Fort Collins, CO 80523-1170

Phone: (970) 491-6804
Fax: (970) 491-0564

E-mail: Neil.Hansen@Colostate.edu

Experience:
2004-present Associate Professor, Department of Soil and Crc Sciences, Colorado State University
1998-2004 Assistant Professor, Department of Soil, Water, and Climate *and* West Central Research and Outreach Center, Univ. of Minnesota.

Relevant Publications:

- Gessel, P.D., N.C. Hansen, J.F. Moncrief, and M.A. Schmitt. 2004. Application Rate Of Liquid Swine Manure: Effects On Runoff, Sediment And Phosphorus Transport. J. Envir. Qual. 33:1839-1844.
- Gessel, P.D., N.C. Hansen, S.M. Goyal, L.J. Johnston, and J. Webb. 2004. Persistence of zoonotic pathogens in soil treated with different rates of liquid hog manure. Applied Soil Ecology 25:237-243.
- Hansen, N.C., M.A. Schmitt, J.E. Anderson, and J.S. Strock. 2003. Iron Deficiency of Soybean in the Upper Midwest and Associated Soil Properties. Agronomy J. 95:1595-1601.
- Hansen, N.C., T.C. Daniel, and A.N. Sharpley. 2002. Fate and Transport of Phosphorus in Agricultural Systems. J. Soil and Water Conservation 57:408-417.
- Hansen, N.C., J.F. Moncrief, S.C. Gupta, P.D. Capel, and A.E. Olness. 2001. Herbicide banding and tillage system interactions on runoff losses of alachlor and cyanazine. J. Environ. Qual. 30: 2120-2126.
- Hansen, N.C., J.F. Moncrief, and S.C. Gupta. 2000. Herbicide banding and tillage system impacts on runoff, sediment, and phosphorus losses in runoff. J. Environ. Qual. 29:1555-1560.

- Hansen, N.C., S.C. Gupta, J.F. Moncrief. 2001. Snowmelt Runoff, Sediment, and Phosphorus Losses Under Three Different Tillage Systems. Soil and Tillage Res. 57:93-100.
- Balogh, S.J., M.L. Meyer, N.C. Hansen, J.F. Moncrief, and S.C. Gupta. 2000. Transport of mercury from a cultivated field during snowmelt. J. Environ Qual. 29:871.

Synergistic Activities

- New at Colorado State Univ in summer of 2004
- Assume leadership for the longterm Dryland Agroecosystems research project
- Teach Soil and Crop Management Courses at CSU

Changes in the Soil after14 years of No-till

Alternative Crop Rotation Research

USDA-ARS Central Great Plains Research Station

CCTA Annual Meeting Tuesday, February 1, Wednesday February 2nd, 2005,
High Plains No-till Conference Island Grove park, Greeley, Colorado

The Team: Merle F. Vigil, David Nielsen, Joe Benjamin, Brien Henry , Maysoon Mikha, Francisco Calderon (Randy Anderson and Rudy Bowman.)

Introduction

This Alternative Crop Rotation experiment (ACR) was started in 1990 to identify rotations suitable to replace winter wheat summer fallow (**WF**). As many as 23 different rotations have been evaluated. Nine of those, presented here, have remained unchanged for the duration of the experiment. Early conclusions focused on the increase in total grain yield on an annualized basis of >60% for Wheat-Corn-Sunflower-fallow (**WCSF**), Wheat-Corn-Fallow (**WCF**) and Wheat-Corn-Millet-Fallow (**WCMF**) over **WF**. However, recently we have found several "good" changes in soil properties associated with the intensive no-till rotations. In general, an increase in soil organic mater at the soil surface, a decrease in soil pH and an increase iron and zinc availability have all been associated with the change from conventional winter wheat-summer fallow to the intensive no-till rotations. Also we have found that wheat yields are highest in the WCMF and WCF rotations than in the other rotations. The following are some additional conclusions gleaned from the experiment over the years.

Definitions of terminology used

SOC is soil organic carbon (C). **SOM** is soil organic matter. It includes SOC but also other components of organic matter like nitrogen (N), hydrogen (H)and oxygen (O), phosphorous (P) and several other less important components. **POM** this is particulate organic matter. POM is the crop residue and insect arthropod, or animal debris that is still recognizable from mineral soil but can be separated from the soil by wet seiving on a 53 micron sieve. **Glomalin**: is a protein manufactured by soil mycorrhizae in association with plant roots it acts as binding agent or glue for soil particles/soil aggregates. **Mycorrhizae:** fungal organism which forms a beneficial (symbiotic) relationship with many crop plants by infecting the crops root system. This association enables the plant to explore a greater volume of soil through the fungis's hyphal network. The hyphal network of this fungi also physically binds soil particles together. **Aggregate stability**: is a measure of the structural integrity of soil particles or aggregates. This measure of the stability of soil aggregates tells us about the soils ability to resist water or wind erosion. Soils with good aggregate stability do not erode as easily as those soils with poor aggregate stability.

- **Soil organic matter** (SOM), SOC, aggregate stability, POM and glomalin contents increase in **intensive no-till rotations** as compared to **WF.** Continuous cropping, is the most similar to native grass, when analyzed for these soil quality parameters. SOM/glomalin aggregate stability are in order of greatest to smallest:
  Sod > WCM > WCMF=WCF > WF-no-till >= WF-conv-till.

- Eight years after rotation establishment we found 6% more SOC in **WCM** than in **WF (NT/CT)** in the top two feet of the soil profile. 25% more SOC in 0-2 inch depth, 13% more SOC in the top 6 inches, and 9% more in the top 12 inches. **WCM** has 0.81% SOC whereas **WF** has 0.68% SOC (top 6 inch). The pH is lower in **WCMF and in WCM** than in **WF** primarily because of annual applications of ammoniacal fertilizers at the soil surface, and to a lesser degree because of greater residue accumulations in these intensive rotations as compared to **WF**.

- **Metal (Zn, Mn, Fe) availability** is increased by the pH drop in the intensive rotations and the increase is most pronounced in the continuously cropped **WCM**. Phosphorous availability also tends to increase with continuous cropping in the surface soil (top 2 inches).

- Wheat yields are reduced by up to 29% in **WSF** rotations. And are reduced by 24% in **WCSF** rotations.

- **Sunflowers** should be grown in rotations longer than three years in length. An assessment of all of our data suggests that sunflowers should not be grown on the same land any more frequent than once every 6- 8 years.

- A positive **"rotation effect"** (see table below) is apparent when averaged over the 8 years after the first four years for winter wheat. Corn and millet yields don't appear to be significantly affected by rotation although there is a trend for higher yields in the longer rotations than in the shorter ones and those with a fallow period after wheat trend higher (Table 1).It is important that **WCF** is providing 2 crops in three years and **WCMF**, 3 crops in four years.

- Most of the **variability in yield** that we measure in these plots can be explained by **differences in moisture**.

- About ~3-4 inches more water is available when the wheat first breaks dormancy in the spring in **WF** (NT) and **WCF** (NT) than in **WF** conventional till. And in the corn year more water is generally available in **WCF** than in **WF** conventional till.

- Millet yields decline by about 295 lbs for each inch decline in available water at planting time.

Table 1. Eight year average yields (1994-2001) for Corn, millet and wheat in select ACR rotations at Akron, Colorado and the percent increase/decrease in wheat yields compared to WF-no-till.

Rotation	Corn	Proso millet	Wheat	Wheat yield increase/decrea
	bu/acre			— % —
WCMF	46	34	40	+8
WCF	46		42	+7
WMF		37	36	-4
WCSF	41		32	-24
WSF			26	-29
WCM	40	35	20	-45
WM		25	18	-50
WF-no-till			37	----
WF-sweep-till			29	-20
P>F	0.73	0.87	0.0001***	0.0001***

*** P>F This indicates statistical significance. The smaller the number, the greater the significance. In this table, we see that wheat is significantly affected by rotation whereas corn and proso millet are on average not affected significantly by rotation sequence.

Some Notes on the weather: One objective of the units research is to find out what happens in the extreme years. Well, the last few years have been just that. In one aspect, this provides us with some unique opportunities. We don't enjoy seeing drought stressed wheat any more than the next guy, but the extremes in low pre-plant soil water contents and low growing season precipitation really test the system. And having those points for the bottom portion of the graph/data set is really helpful. We need to know, what the extremes will do to the system. We really would rather not have it this dry again, but there is some critical information to be gleaned from all of this.

If there is any consolation, if you look at the long time weather record, most of the time, we don't have two years back to back, where both are dry. **Most of the time, dryer than average years, are followed by wetter than average years**. And so there is this oscillation back and forth, wet/dry, wet/dry. In fact, ****30 times**** in our weather record, a wet year follows a dry year. Seven times we have wet years back to back and about 7 times we have dry years back to back. "Pray for rain".