THOMPSON AGRICULTURE ALTERNATIVES

2009 REPORT

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Water Quality, Soil Health

Reducing application rates of nitrogen fertilizer and manure are positive steps toward keeping groundwater free of nitrates. Nitrogen fertilizer and/or manure applied in early spring or late fall when crops are not growing can contribute to nitrate leaching. Soils high in organic matter also can be potential polluters if not managed carefully.

Nitrogen in soil organic matter is converted to nitrate by soil microbes. As spring temperatures rise, microbial activity is stimulated. Aeration resulting from spring tillage further excites these organisms. If fertilizer or manure are added at this time, nitrate nitrogen can easily end up in tile lines, streams and groundwater due to the absence of plant material to utilize these nutrients. Allowing early expression of weeds will use up some of these nitrates.

Cover crops, timing of tillage, N fertilizer and manure management are some techniques used in combination to reduce nitrate leaching on this farm. **Figure 6-1** illustrates differences of nitrogen nitrate levels in the top foot of soil in the fall between various cropping systems. **Figure 6-1a** shows the same results in the spring. Solid seeded crops use up nitrogen in the fall and spring which keeps the nitrates from going down into the ground water.

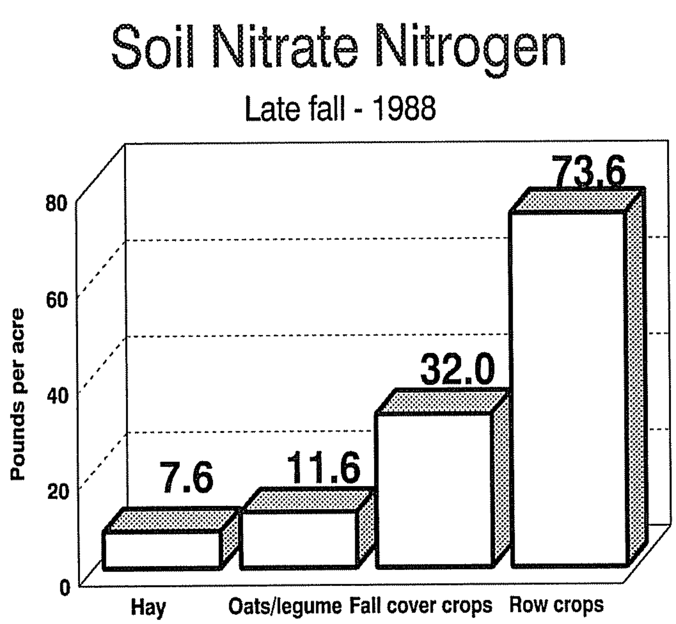


Figure 6-1

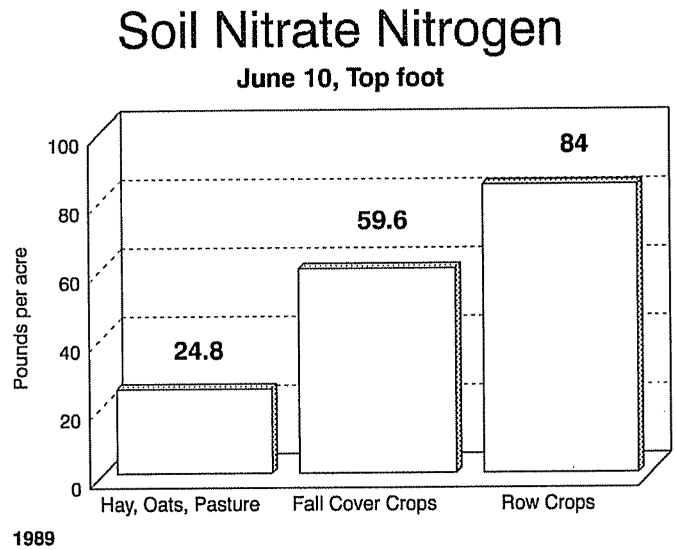


Figure 6-1a

In the system used on the Thompson farm, two rows of rye are fall drilled on the ridge top following corn harvest. That provides a living crop that can utilize available nitrate nitrogen in the soil. In the spring, this cover is removed from the ridge area by the planter sweep, rather than by turning the soil over with tillage. As the cover crop breaks down, some of the nitrogen becomes available to the growing crop. This practice reduces nitrate leaching and is an effective weed control practice as well. The need for herbicide is reduced and can be used in emergency spot application rather than a pre-emerge application.

This technique was compared to a conventional tillage system on the Thompson farm in 1989 by Dr. John Doran of USDA/ARS. Results from his work indicated decreases of nitrate in the ridge–till system of 79% on May 6, 60% on May 15 and 40% on June 1, when compared to the conventionally tilled system without cover **(Figure 2-11)**.

A split application of nitrogen fertilizer is used because **the cover crop can tie up too much nitrogen** as it is breaking down (for further detail, please see the Cover Crops section). Half of the rate is row applied with the planter for use by the corn crop while the cover decomposes, and the remaining 50% is applied at first cultivation. Additional fertilizer is applied only if indicated by the late spring nitrate test. Soil is tested when the corn is at the whorl stage, approximately 12 inches. If the test indicates that the soil nitrate level is deficient, nitrogen is side dressed at ridging. Thus, this ridge-till system not only saves labor, fuel, and money by reducing the trips across the field, it also helps to keep nitrates out of the water supply.

Controlled Traffic For Larger Machines

Specific questions are asked about the equipment set up. While modifications of currently owned machinery are done on the farm, special care is taken to purchase equipment that works with the controlled field traffic patterns.

As most compaction occurs in the first trip across the field, this system was designed for larger equipment based on a 36-inch row spacing that would use the same wheel tracks for most field operations. A tractor with a 72-inch wheel spacing would pull a 10-row planter, rotary hoe and cultivator. Tractor wheels would travel in the same tracks for each of these operations, including manure spreading.

The wheel spacing of the combine, shredder and grain drill would be slightly different from the other pieces of equipment. However, care should be taken to utilize previously established wheel tracks and create as few new tracks as possible. This controlled traffic pattern is illustrated in **Figure 6-2.**

Erosion

Soil loss in a traditional corn–soybean rotation in Boone County averages 11 tons/acre/year. Soil loss on the Thompson farm in a ridge–till system has been measured at 4 tons/acre/year in a corn, soybean, corn, oat, hay rotation, and at a rate of 2 ton/acre/year in a corn, soybean, oat, three-year meadow rotation. The three year cash grain rotation (C-SB-O/L) soil loss is 3 ton/acre/year.These numbers were calculated by the USDA Soil and Water Conservation Service using the Universal Soil Loss Equation **(Figure 6-2A).**

The National Soil Tilth Laboratory at Iowa State University initiated a program in 1989 to monitor surface runoff on adjacent fields, which includes two different cropping systems: a conventionally farmed corn and soybeans system owned by a neighbor, and our five-year rotation, ridge-tillage system. Experiments were conducted using a rain simulator to measure runoff.

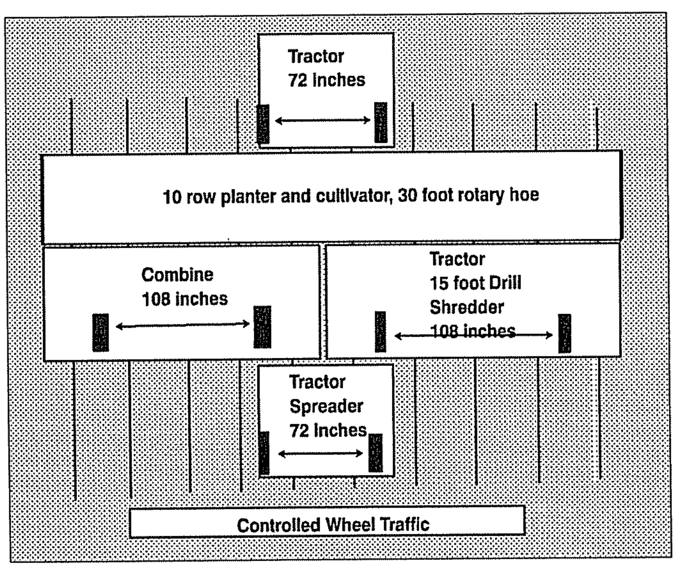


Figure 6-2

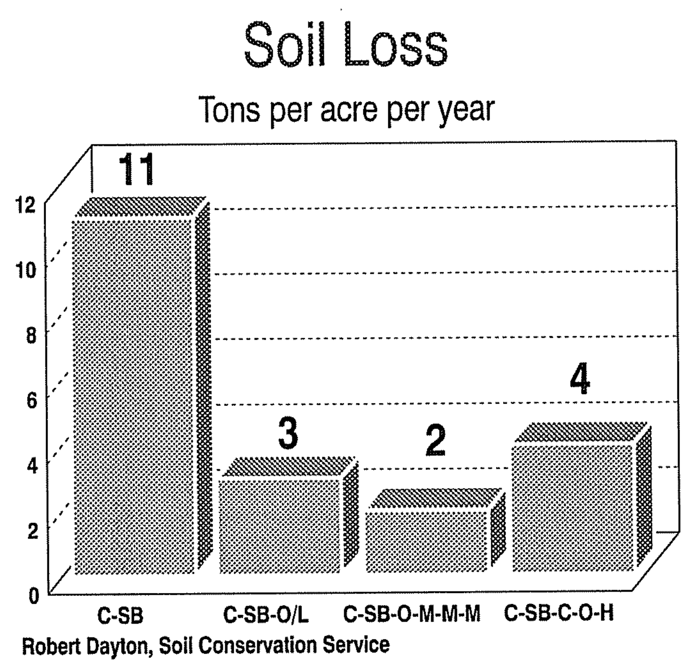


Figure 6-2A

First observations indicate few differences in runoff on a level soil surface. However, on the hillside, runoff was measured at 187 ml/minute on the alternative system and 439 ml/minute on the conventionally tilled land.

Double ring rainfall infiltration studies conducted in 1991 on the Webster soils showed higher infiltration rates for the alternative system. The measurements were in (um/s), 47.64 on the alternative system and 23.62 for the conventional system **(Figure 6-3).**

In 1989, earthworm counts were considerably higher on the field where the farming system is diverse and where green and animal manures are used. These counts decreased in 1990. In–row infiltration rates were five times faster where earthworm holes were present and two times faster without the presence of earthworm holes.

The average earthworms counts for each 8 inch cylinder for the years of 89 and 90 were considerably more for the alternative system. The alternative count was 1.27 million per acre for the alternative system and 18,718 per acre for the conventional system **(Figure 6-4).** Earthworm counts taken ourselves in 1986 were 3.92 million per acre in the alternative system with 19 inch hairy vetch cover crop and zero count for the conventional system. The worm count in 1987 was 2.83 million per acre in the alternative system and zero for the conventional practices. Worm counts are taken in late April.

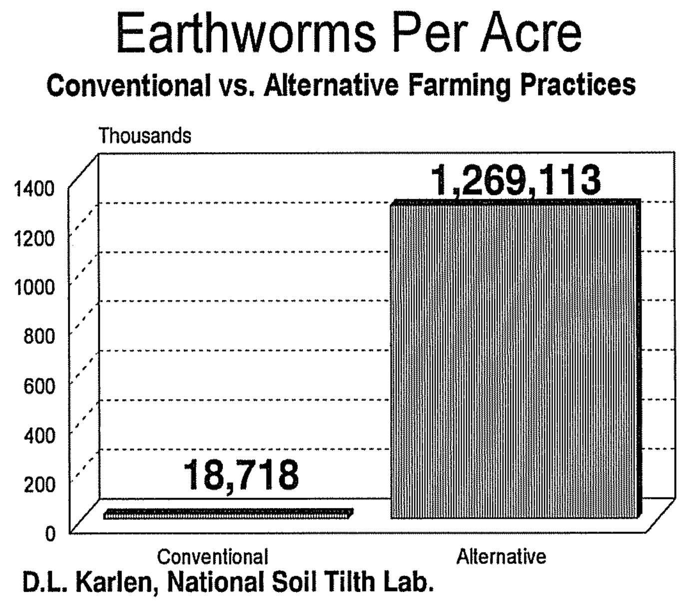


Figure 6-4

The alternative cropping system had better water stable aggregates and a lower in row bulk density than the conventional farm. The 90-91 data showed more stable soil aggregates for the alternative system. The percent stable soil aggregates was 72.5 and 44.9 for alternative and conventional systems respectively **(Figure 6-5).**

The percent organic matter was higher in the alternative system. The readings are 6.0 and 2.9 percent for the alternative and conventional systems respectively **(Figure 6-6).** National Soil Tilth

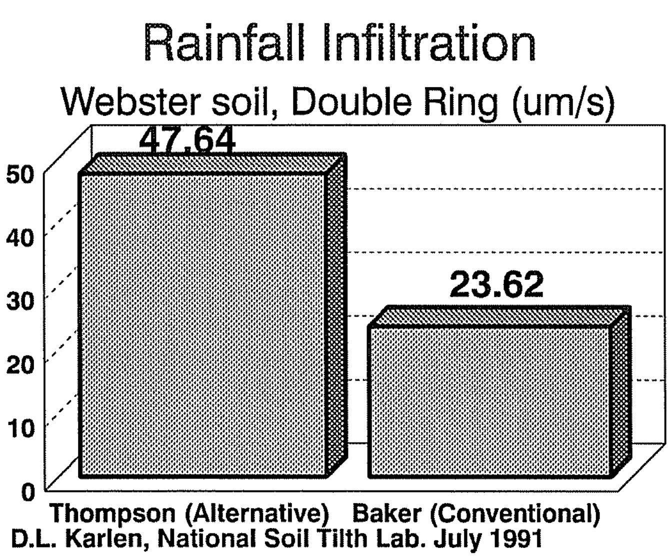


Figure 6-3

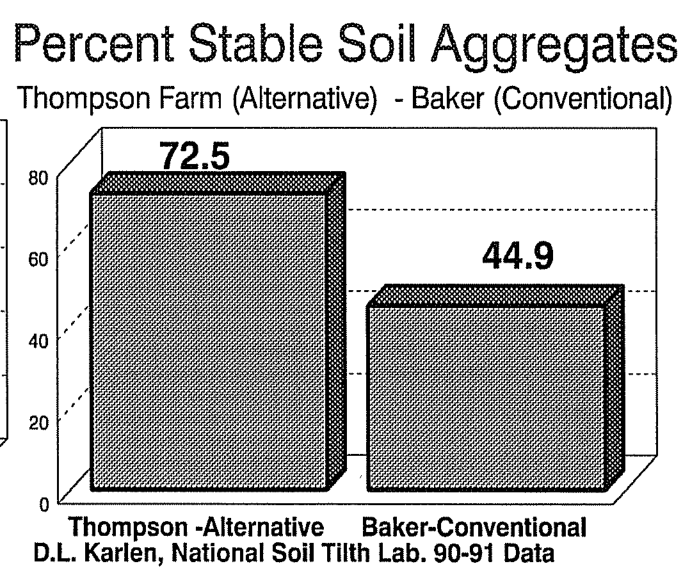
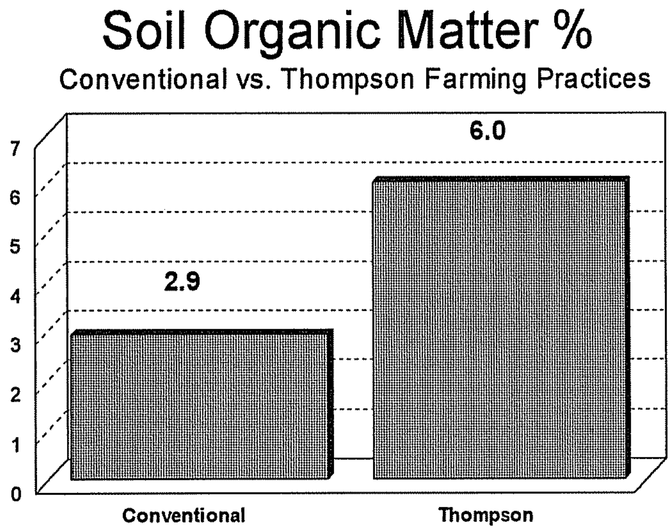


Figure 6-5



D.L. Karlen, National Soil Tilth Lab (soilom)

Figure 6-6

Lab. has sampled field #3 and found the organic matter percent readings from 5.76 to 6.72 during 1994 through 1998 **(Table 2-4).**

One hundred years cropping with a Corn-Oats-Hay rotation at the Morrow plots in Illinois had one percent more organic matter left than did the continuous corn system **(Figure 6-7).** The second rotation was Corn-Oats from1885 to 1953, then changed to Corn-Soybeans from 1954 to 1984.

The 2003 corn yields from the Morrow plots are listed in **Figure 6-8** Continuous corn since 1876 had the poorest yields at 58 bushels, corn-soybean rotation yield was 104 and the corn-oats-hay rota-

Morrow Plots

2003 Corn Yields. Bushels per acre

	Cont. Corn	C-SB	C-O-H
No inputs	58	104	164
Lime, NPK since 1954	170	206	261

In place since 1876

Figure 6-8

tion corn yield was 164 bushels per acre. Adding lime and NPK since 1954 raised all yields to 170, 206, and 261.

Adding manure to the continuous wheat program at the Sanborn field in Missoui over a 70 year period had about one percent more organic matter at the end of the experiment **(Figure 6-9).** Longer rotations including cereal grains and forages, which have less tillage, slow down the carbon loses from the soil.

Organic Matter Percent

Morrow Plots, Illionis

X-Axis Labels	Corn-Oats-Hay	Corn-Oats, Corn-SB	CC
1880	3.75	3.75	3.75
1890	3.6	3.2	3
1900	3.4	2.85	2.7
1910	3.2	2.55	2.3
1920	3	2.35	2.1
1930	2.8	2.25	1.8
1940	2.75	2.1	1.75
1950	2.6	2	1.6
1960	2.55	1.95	1.55
1970	2.5	1.9	1.5
1980	2.45	1.8	1.45
1990	2.4	1.75	1.45

OMMPT

Figure 6-7

Organic Matter Percent

Sanborn field, Missouri

	Wheat, 6TManure	Corn, 6Ton,Manure	Cont. Wheat	Cont. Corn
1890	2.6	2.6	2.6	2.6
1900	2.25	2.2	2	1.8
1910	1.85	1.8	1.5	1.25
1920	1.7	1.55	1.2	0.85
1930	1.6	1.4	1	0.8
1940	1.95	1.3	0.85	0.8
1950	1.9	1.25	0.85	0.8
1960	1.9	1.25	0.85	0.8

OMSF

Figure 6-9

The amount of nitrogen supplied by the manure (164 pounds per acre per year) was over twice the amount supplied by nitrogen fertilizer (74 pounds) in the conventional system. However, the amounts of nitrate and ammonium nitrogen found below the six-foot depth were essentially the same **(Figure 6-10).**

Doug Karlen, project leader at the NSTL attributes most of the improvements in the alternative system soil to reduced tillage and the additions of carbon through manure, cover crops, oats and hay. Carbon is a food for the earthworms and improves soil structure.

This new working relationship with The National Soil Tilth Laboratory could potentially provide a great deal of solid data on benefits accrued in diverse crop systems. It will also help to identify system limitations that need to be addressed in the future.

Incorporated Pre-Plant Herbicides

Incorporated pre-plant herbicides are not in the best interest of soil conservation. The soil has been tilled and the herbicide will stop any germination or growth of weeds. This process makes this soil very vulnerable to wind and water erosion.

We should learn how manage these early weeds and let them work for us in erosion control and managing later weeds.

Virgin Prairie vs. Tilled Soil

Soil samples were taken from a fence corner in 1987 that had never been farmed. These samples are compared to soil taken from a tilled field in **Figure 6-11.** Cultivation of the soil reduced the organic matter, phosphorus, magnesium, and potassium levels. The CEC increased along with the pH and calcium levels.

1995 Observations

On April 26, 1.25 inches of rain causes a large pond to form in a neighbor's conventional corn-soybean system. This field was planted to soybeans in 1994. Anhydrous was applied in the fall of 1994. In an adjacent field #2, using the alternative system, there was no water standing. This field was planted to corn in 1994, 75% of the cornstalks were removed for cow feed in the fall which reduces nitrogen tie-up for the following early spring oat crop, the field was fall chiseled to reduce wind erosion and cause faster drying in the spring for early oat planting. The point being is that a little soybean residue left of the surface of compacted soil does not insure water infiltration. Last year's soybean fields seal over after one tillage pass in the spring and rain infiltration is very poor.

On May 8, 1.3 inches was measured in the rain gauge. Field #3 was in hay production in 1994, manure was applied in the fall and plowed under.

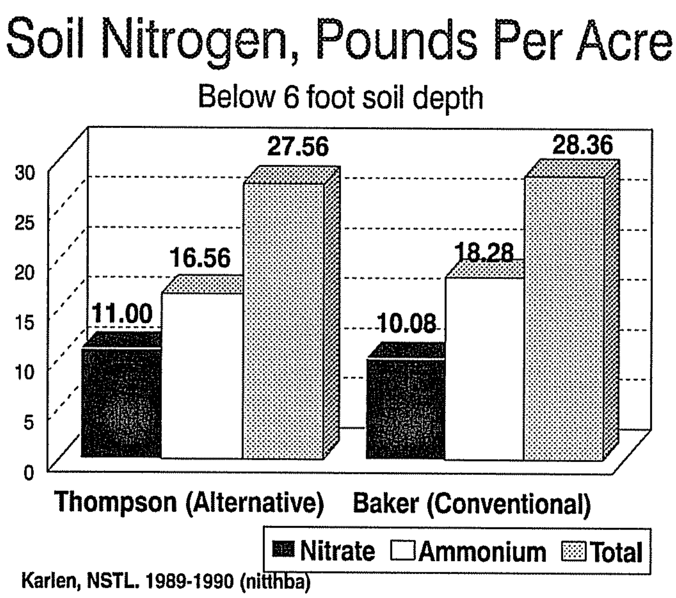


Figure 6-10

Virgin Prairie vs. Tilled Soil

1987 Soil Tests

Soil Makeup	Virgin Prairie	Field #1
CEC	19.9	23
% Organic Matter	7	5.3
pH	6.8	7.6
# Phosphorus/A.	102	81
# Calcium/A.	5576	7471
% Calcium	69.9	80.6
# Magnesium/A.	1184	951
% Magnesium	24.7	17.7
# Potassium/A.	834	305
% Potassium	5.4	1.7

Virgin Prairie fence corner, never farmed

Figure 6-11

Applicators on the plow scattered grain rye and the leveling bar covered the rye. This field was green in the fall and early spring. This plowed field with the rye cover soaked up all this rain and there was no water running to the low areas. However, water did run to the low area in this field, it came from a neighboring 1994 no-till drill soybean field. The water shed area of the neighbor's field is about 40 acres. The water came under and over the road and filled our pond. Again, a little residue on the surface of tight soils does not promise water infiltration.

1996 Observations

The pond in field #3 was full after the 3 1/2 inch rain on June 16. The soybeans were replanted in the pond on June 25 while the neighbors pond (conventional) still had water standing at this date and was never replanted.

We are encouraging water and soil conservation people to promote a more diversified rotation of crops with rotation of tillage along with residue management.

1998 Observations

Field #2 was in hay in 1997, this field was manured and fall plowed. Fourteen rainy days in June produced 10.42 inches of rain. All this rain went into the plowed soil and the side hills were very wet. This field needed to be cultivated on June 24 because the corn was getting too tall for the four row cultivator. We left some very deep ruts in the field. The corn picker got stuck once in the fall because of these ruts.

The neighbor was cultivating his corn with a 12 row and not having any problems with wet side hills. The previous crop was soybeans, anhydrous applied in the fall, tilled once in the spring and planted to corn. The fine soybean soil structure caused the rain to run off the field and made a pond in the low area.

Summary:

"They raise corn one year and oats the next year, this they call rotation of crops, but they return nothing to the soil, and wonder why they can't raise big crops as they used to. This is very rich land--no better in the State of Illinois--and should raise sixty bushels of oats per acre and eighty bushels of corn per acre, if they would rotate their crops, keep part of it in grass; keep some livestock--cattle, sheep, or hogs--and use some phosphate." Samuel W. Allerton, 1907, farmer from Illinois.

Some things never change, now in the year 2000, in the midwest farmers raise corn and soybeans and call it a rotation. As Mr. Allerton said "keep part of the farm in grass and keep some livestock" the farmers of 2000 would take better care of their families, communities and the environment.

Putting a strip of grass along the creek does not address the problem. Adding oats with grasses and legumes to the rotation and moving it around on all the farm would lessen the need for pesticides and purchased fertilizers, less tillage is needed during those years and the carbon content in the soil will start to go back up. This additional carbon will lessen soil movement and help hold the nutrients for the crops.