Cover crops for the 21st century

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Soil conservation policy in the United States stems from the devastating erosion events of the 1920s and ’30s.

Out of concern for preserving agricultural productivity came the concept of tolerable soil loss and the creation of the T factor - the maximum annual soil loss that can occur on a particular soil while sustaining long-term agricultural productivity.

Research clearly shows that cover crops are an effective conservation practice

So why have cover crops been so underemphasized by conservationists and underutilized by farmers?

Conservationists have focused on reducing soil loss to T by applying practices, such as terraces, contour strips, grassed waterways, residue management and cover crops.

SOIL AND WATER CONSERVATION SOCIETY

JOURNAL OF SOIL AND WATER CONSERVATION

The science and art of natural resource management for sustainability

The subversive conservationist

Pete Nowak

Excerpt

Subversion is the process of attempting to change existing political structures or other forms of authority used to maintain the status quo. Subversive activities are tho… …ng abo… …nd co… … a co…

Has your career resulted in more program payments or more stewardship?

Let… …at the… …ter resources? This simple question is rarely asked. However, when it is asked, the answer, more times than not, supports the need for subversion.

Listen and see if you hear what I hear when asking this question. I hear the modern equivalent of the Tower of Babel—many agency voices representing a multitude of programs, all based on the implicit assumption that more programs and more money means more conservation.

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This Article

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Journal of Soil and Water Conservation July 2009 vol. 64 no. 4 113A-115A

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From : Steve Groff sgroff@hughes.net
Sent : Thursday, June 29, 2006 5:49 AM

Hi Joel,

We ended up with 14.8" of rain over a 4 day period. These pictures show how my friendly neighbors plowed fields look. The gully my son is standing in was up to 4' 4" deep and averaged about 3' deep in a 400' section- that is not a typo! The staked tomato picture is on my side of the property line looking from that ditch-100 feet away. I did have a little bit of erosion but could find nothing over 1" deep…

Steve


No rills deeper than 1 inch !
Tomatoes planted no-till into rolled cover crops

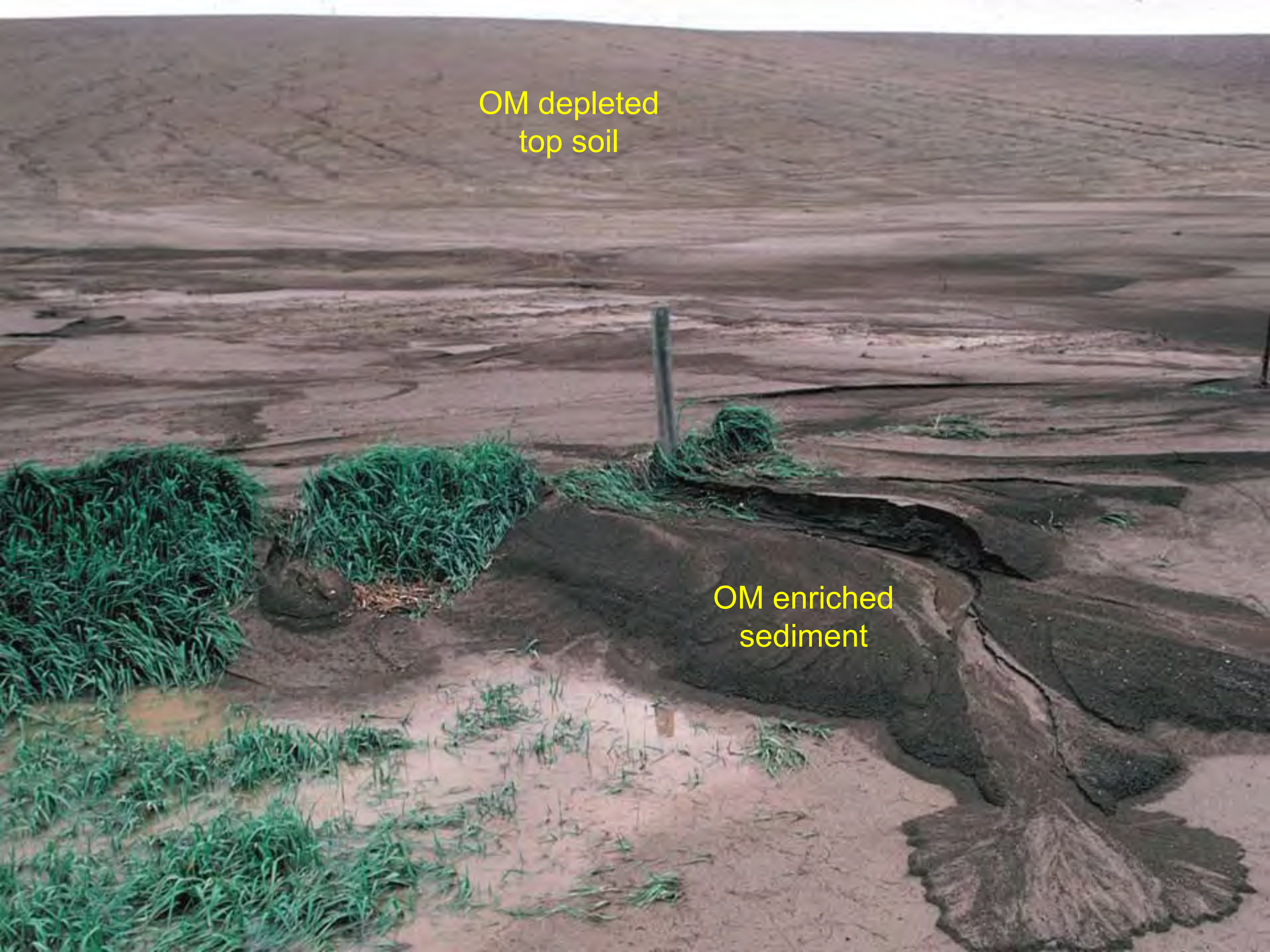
Soil Changes After Sixty Years of Land Use in Iowa

Jessica Veenstra, Iowa State University, 1126 Agronomy Hall, Iowa State University, Ames, IA 50010

Soils form slowly, thus on human time scales, soil is essentially a non-renewable resource. Therefore in order to maintain and manage our limited soil resources sustainably, we must try to document, monitor and understand human induced changes in soil properties. By comparing current soil properties to an archived database of soil properties, this study assesses some of the changes that have occurred over the last 60 years, and attempts to link those changes to natural and human induced processes. This study was conducted across Iowa where the primary land use has been row crop agriculture and pasture. We looked at changes in A horizon depth, color, texture, structure, organic carbon content and pH.

Hill top and backslope landscape positions have been significantly degraded.

Catchment areas have deeper topsoil.


OM depleted
top soil
OM enriched
sediment


Have you noticed changes on your farm?

Renewable Agriculture and Food Systems (2007), 22:271-281 Cambridge University Press

doi:10.1017/S1742170507001834

Research Article

Farmer perceptions of soil quality and their relationship to management-sensitive soil parameters

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[a1] Department of Environmental Science and Technology, University of Maryland, College Park, MD 20742, USA.

[a2] Department of Agriculture, Western Illinois University, Macomb, IL 61455-1390, USA.

Abstract

A critical step in the quantification of soil quality (SQ) is the selection of SQ benchmarks. The benchmarks used in this study were SQ ratings made by 32 farmer collaborators representing a range of farming systems, scales of operation and geographic locations in the Mid-Atlantic region of USA. Soils from 45 pairs of sites identified by their farmers as having good and poor SQ were sampled over three seasons and analyzed for 19 soil parameters. Farmer judgments of SQ were based on many factors, most commonly soil orga … ed and … f agre … diffe … dem … such … micr … para … s with … extractable C from MW sterilized soil, anthrone reactive C and macroaggregate stability (14.2, 7.7 and 3.7, respectively). Mineral fertility parameters (pH, Ca, Ca:Mg ratio, P and K) were not significantly related to farmer SQ ratings (*P* values >0.05). The strong relationships observed between soil C parameters, soil structural parameters and farmer SQ ratings suggest that efforts to improve SQ in the study region should focus on monitoring and enhancement of soil C and soil structure.

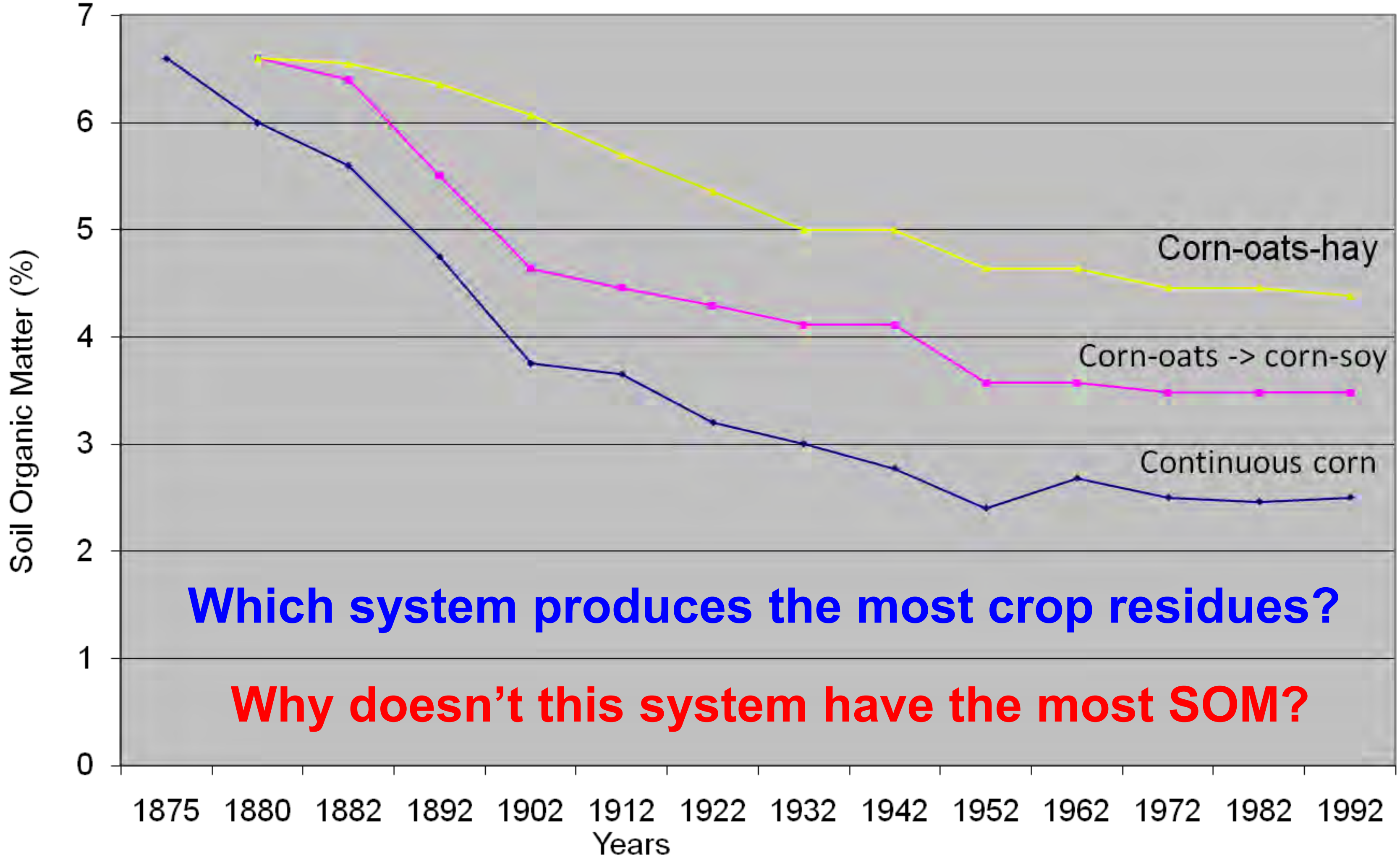
Mineral fertility parameters (pH, Ca, Mg, Ca:Mg ratio, P and K) were not significantly related to farmer SQ ratings. The strong relationships observed between soil C parameters, soil structural parameters and farmer SQ ratings suggest that efforts to improve SQ in the study region should focus on monitoring and enhancement of *soil C and soil structure*.

Morrow Plots

- started in 1876 at the U of I
- oldest agronomic experiment in the US

http://agronomyday.cropsci.uiuc.edu/2001/morrow-plots/

Change in Soil Organic Matter in the Morrow Plots



JOURNAL OF SOIL AND WATER CONSERVATION
The science and art of natural resource management for sustainability

Conventional row crop agriculture: Putting America's soils on a white bread diet

T. H. DeLuca

Excerpt

An analysis of the soils of the great plains will reveal their incredible wealth of native fertility, tilth, and rich dark color. Even after 100 years of cultivation, these soils retain much of their attractive appearance. On closer observation, however, conventi… roots, and little life com… s change? Is it simply b… s, or is there a greater o… ulture?

A white bread diet might make you fat but makes our soils skinny :->

It appea… ides may be a symptom … last 100 years, a diet that has only worsened with the advent of synthetic fertilizers.

Soil can be viewed as a complex respiring organism with sand and silt as the skeleton; water and its dissolved solutes are the blood, clay and organic matter the skin and connective tissues, and microorganisms are the respiratory and

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This Article

Journal of Soil and Water Conservation **May 1995**
vol. 50 no. 3 **262-263**

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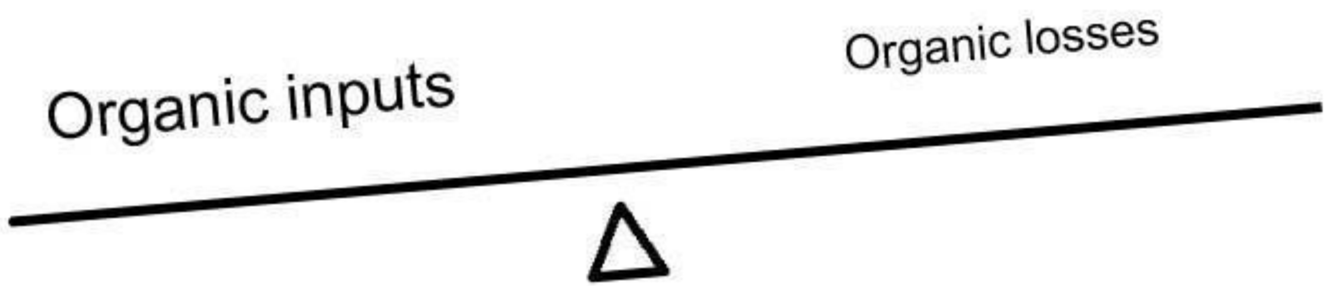
Drainage + Tillage + Lime + N = accelerated decomposition

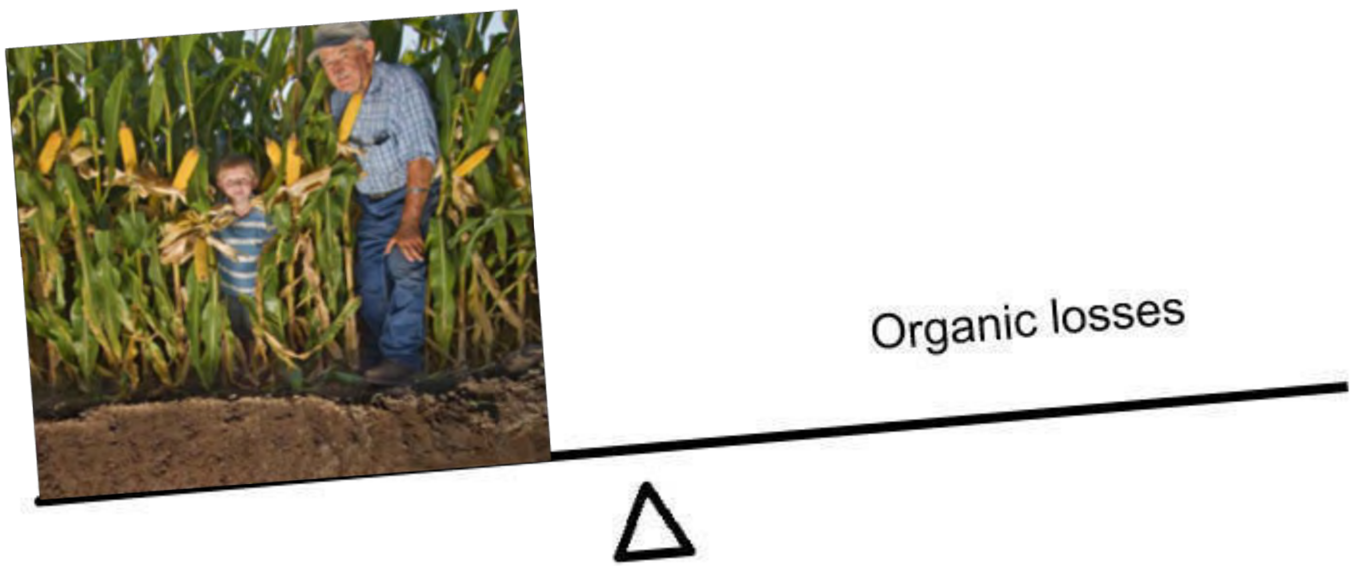
"But with the removal of water through furrows, ditches, and tiles, and the aeration of the soil by cultivation, what the pioneers did in effect was to fan the former simmering fires of acidification and preservation into a blaze of bacterial oxidation and more complete combustion. The combustion of the accumulated organic matter began to take place at a rate far greater than its annual accumulation. Along with the increased rate of destruction of the supply accumulated from the past, the removal of crops lessened the chance for annual additions. The age-old process was reversed and the supply of organic matter in the soil began to decrease instead of accumulating."

William Albrecht – 1938 Yearbook of Agriculture

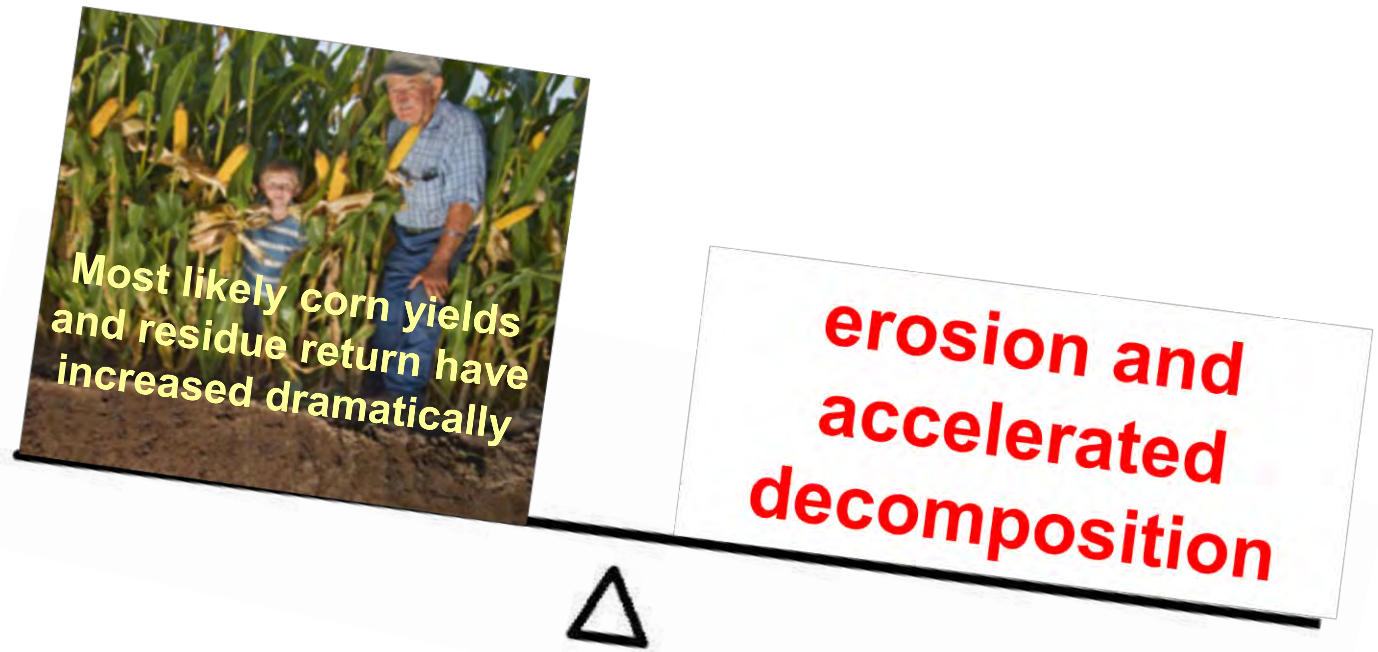
What is happening on your farm?

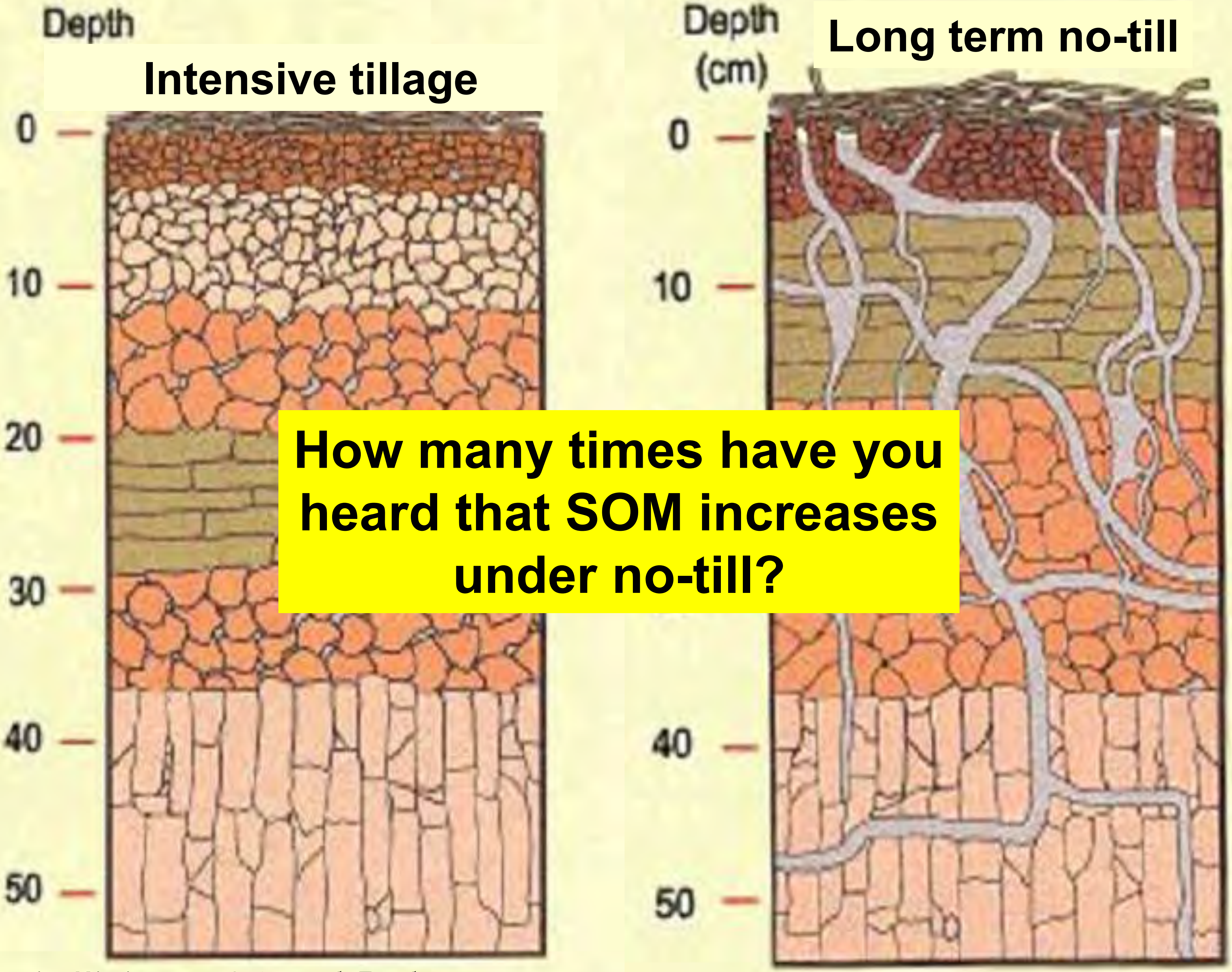


Most likely corn yields and residue return have increased dramatically



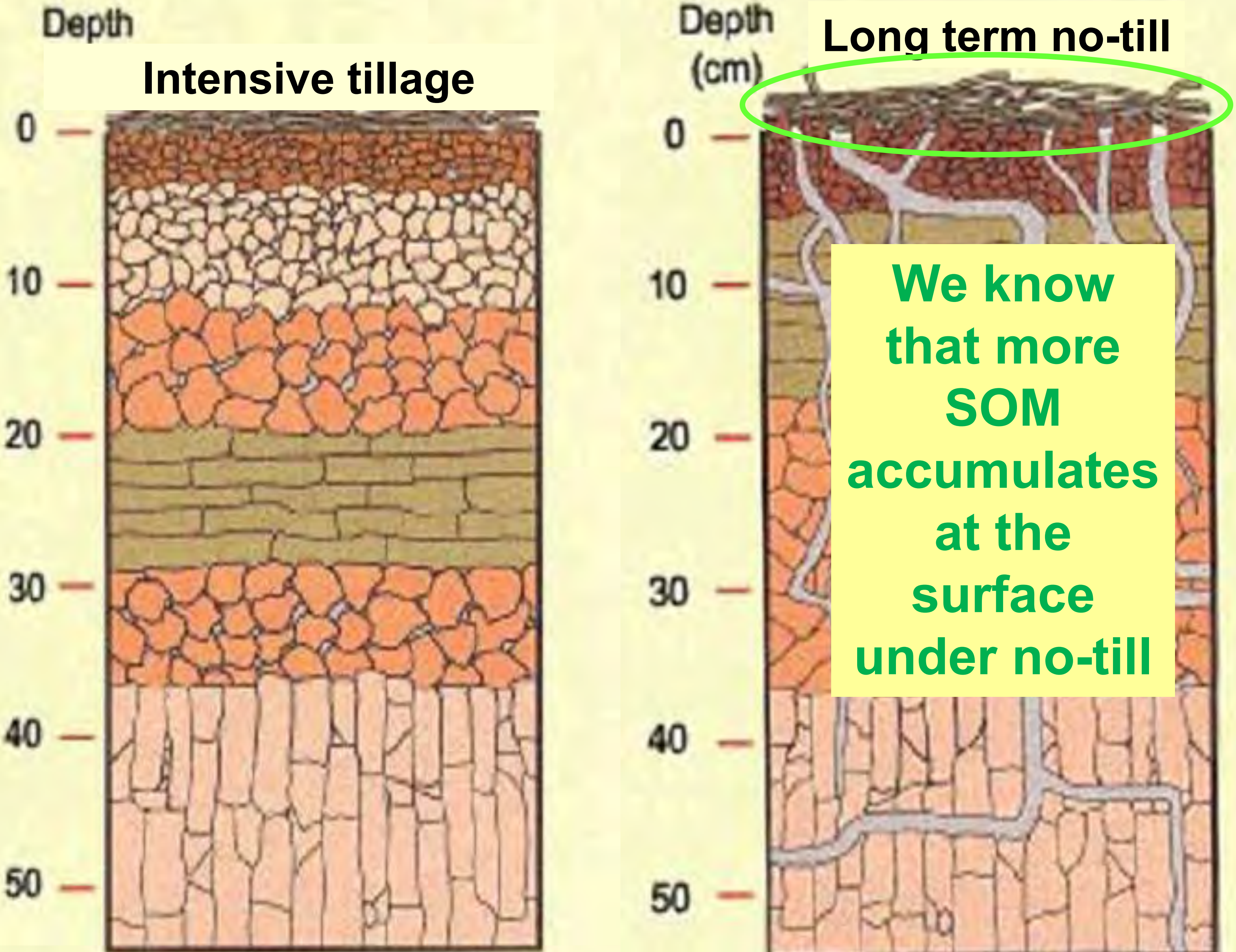
Unfortunately many farms in IL are just holding steady or even losing SOM despite very high levels of residue return !!



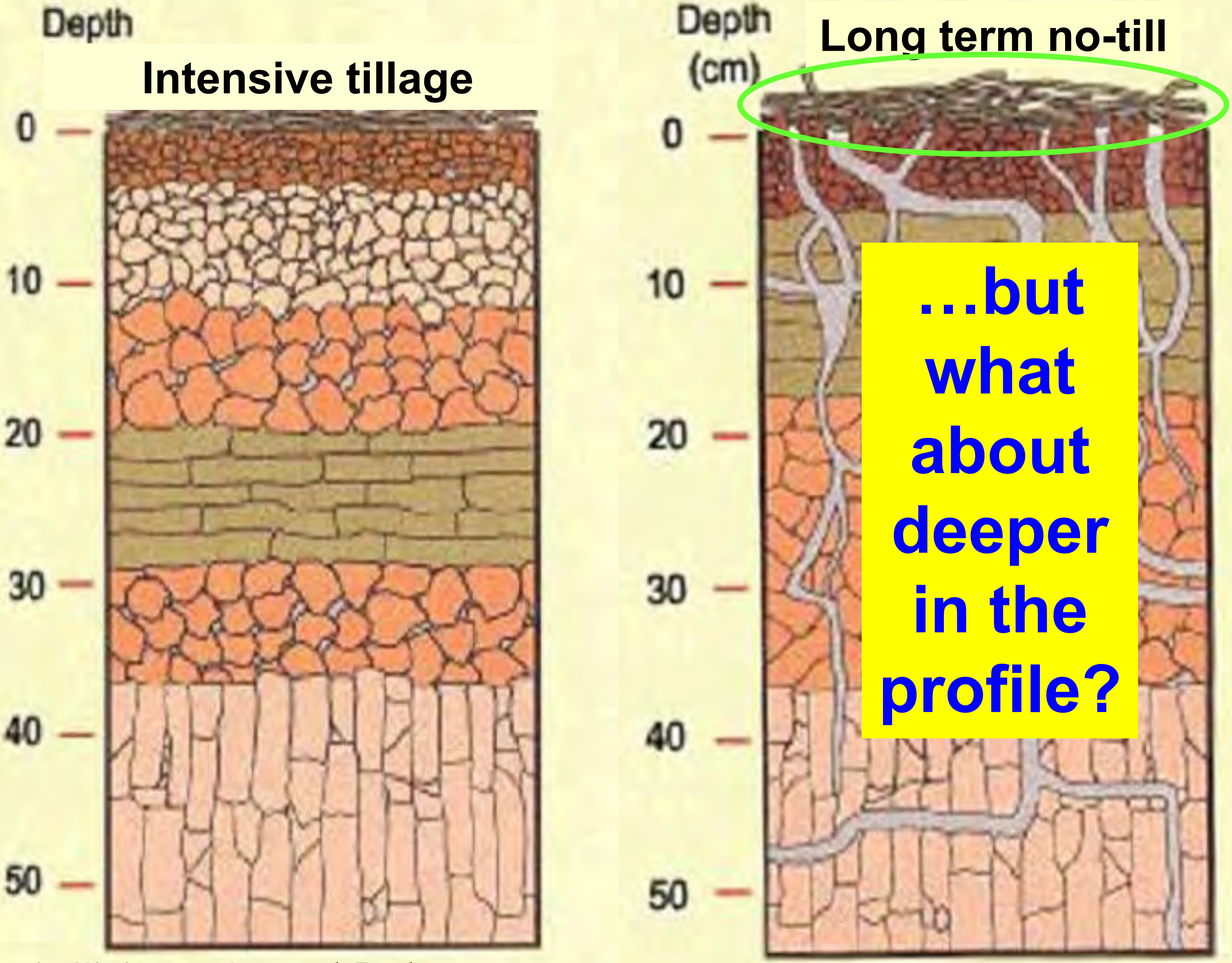


How many times have you heard that SOM increases under no-till?

Ontario Ministry of Ag and Food



Ontario Ministry of Ag and Food



Ontario Ministry of Ag and Food

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Agriculture, Ecosystems and Environment 118 (2007) 1–5

Agriculture Ecosystems & Environment

www.elsevier.com/locate/agee

Commentary

Tillage and soil carbon sequestration—What do we really know?

John M. Baker[a,b,*], Tyson E. Ochsner[a,b], Rodney T. Venterea[a,b], Timothy J. Griffis[b]

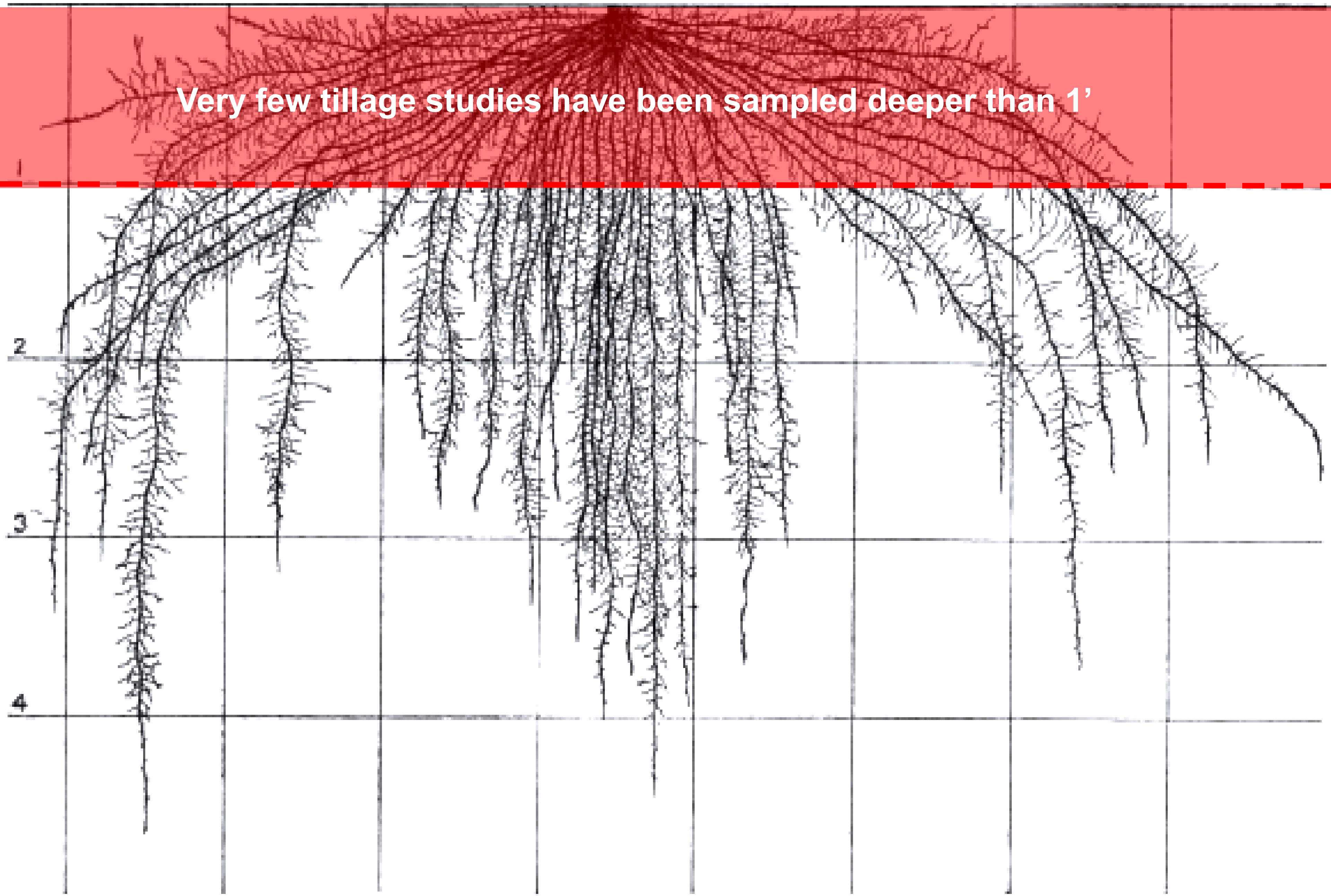
[a] USDA-ARS, 454 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108, USA

[b] Department of Soil, Water & Climate, University of Minnesota, 439 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108, USA

Received 1 February 2006; received in revised form 24 April 2006; accepted 3 May 2006

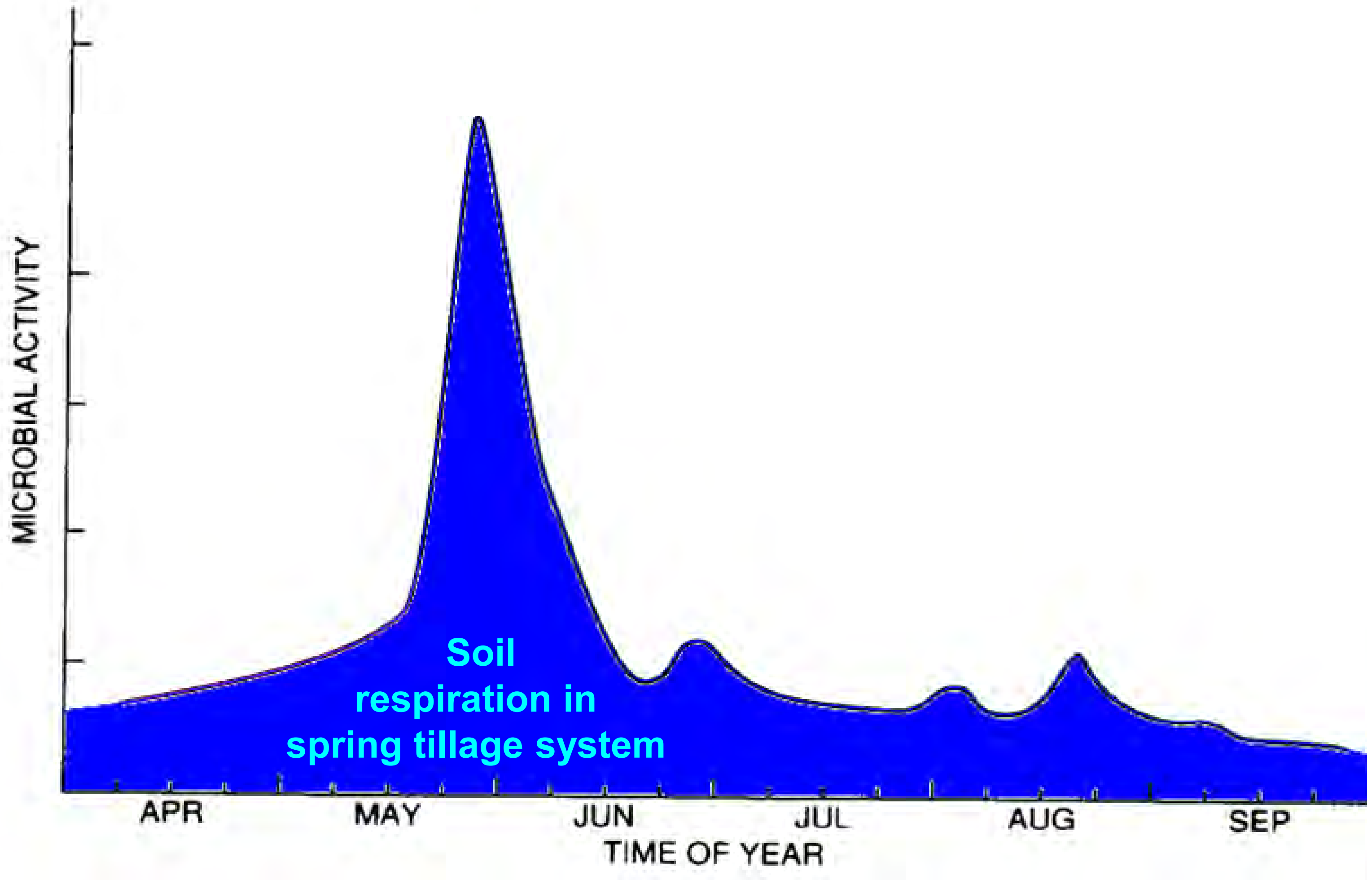
Available online 27 June 2006

It is widely believed that soil disturbance by tillage was a primary cause of the historical loss of soil organic carbon (SOC) in North America, and that substantial SOC sequestration can be accomplished by changing from conventional plowing to less intensive methods known as conservation tillage. This is based on experiments where changes in carbon storage have been estimated through soil sampling of tillage trials. However, sampling protocol may have biased the results. *In essentially all cases where conservation tillage was found to sequester C, soils were only sampled to a depth of 30 cm or less…*


Very few tillage studies have been sampled deeper than 1’
1
2
3
4

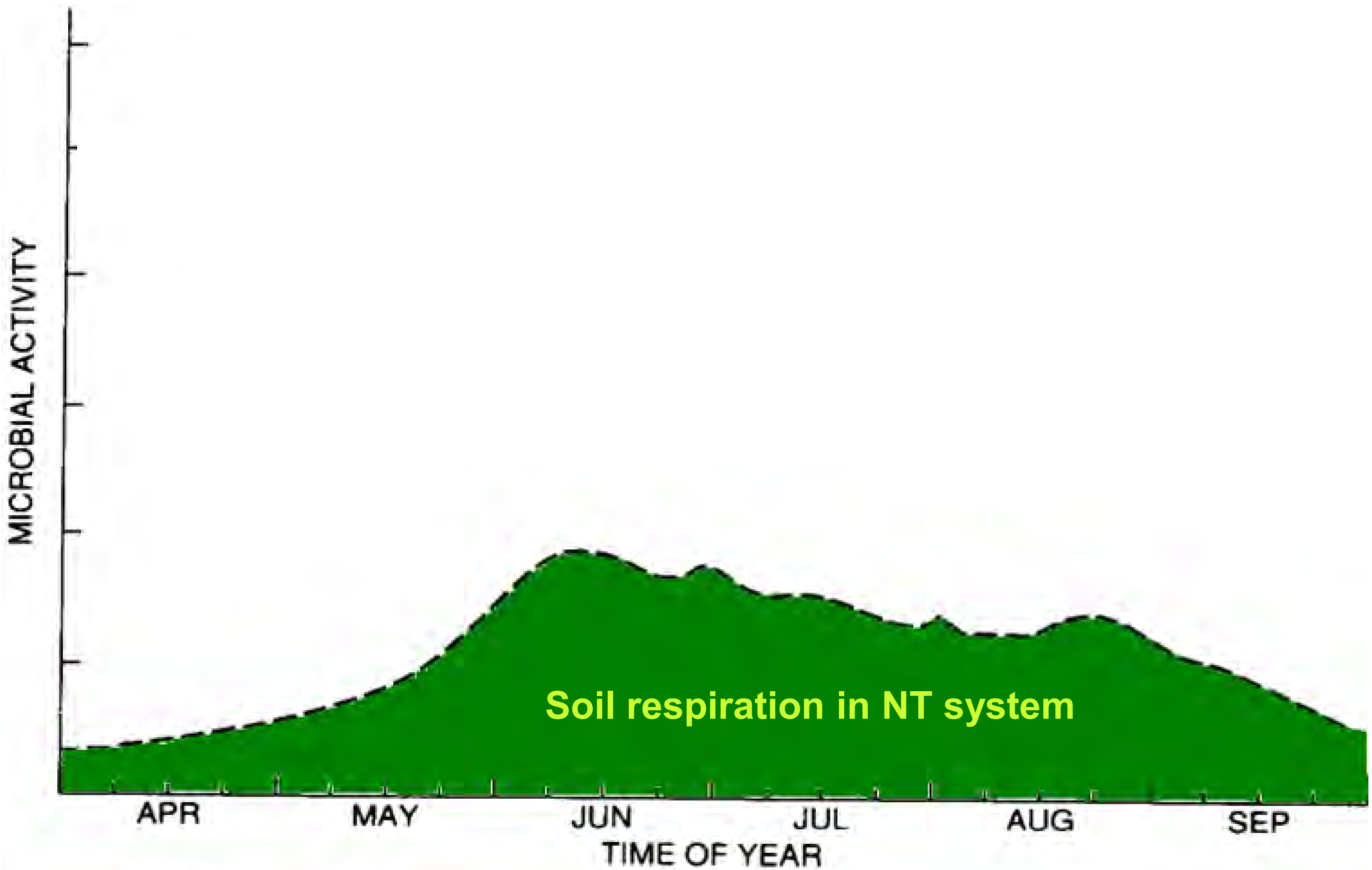

Many have only been sampled 6" deep!
1
2
3
4

Effect of tillage on microbial activity



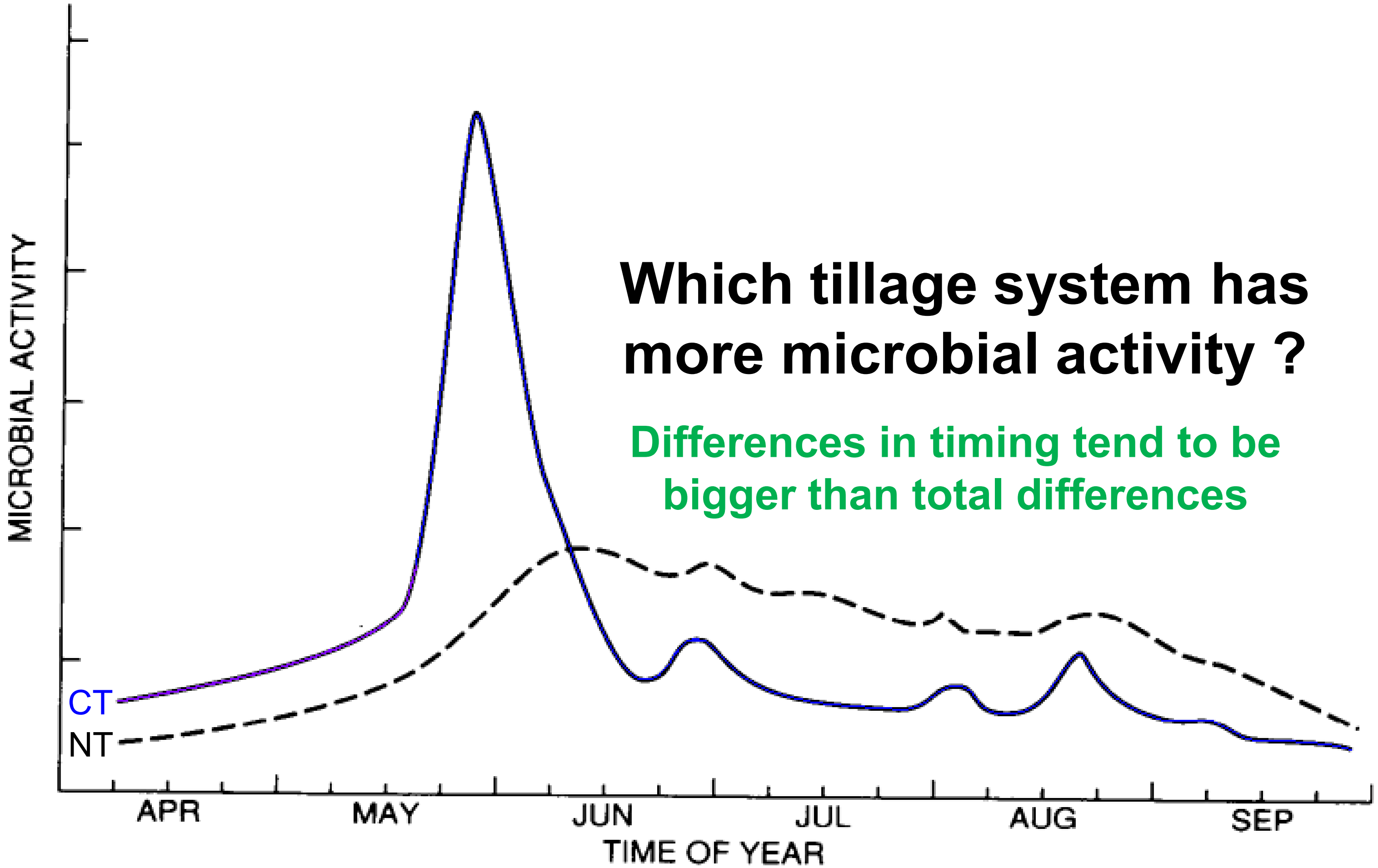
Havlin et al. (1999)

Effect of tillage on microbial activity



Havlin et al. (1999)

Effect of tillage on microbial activity

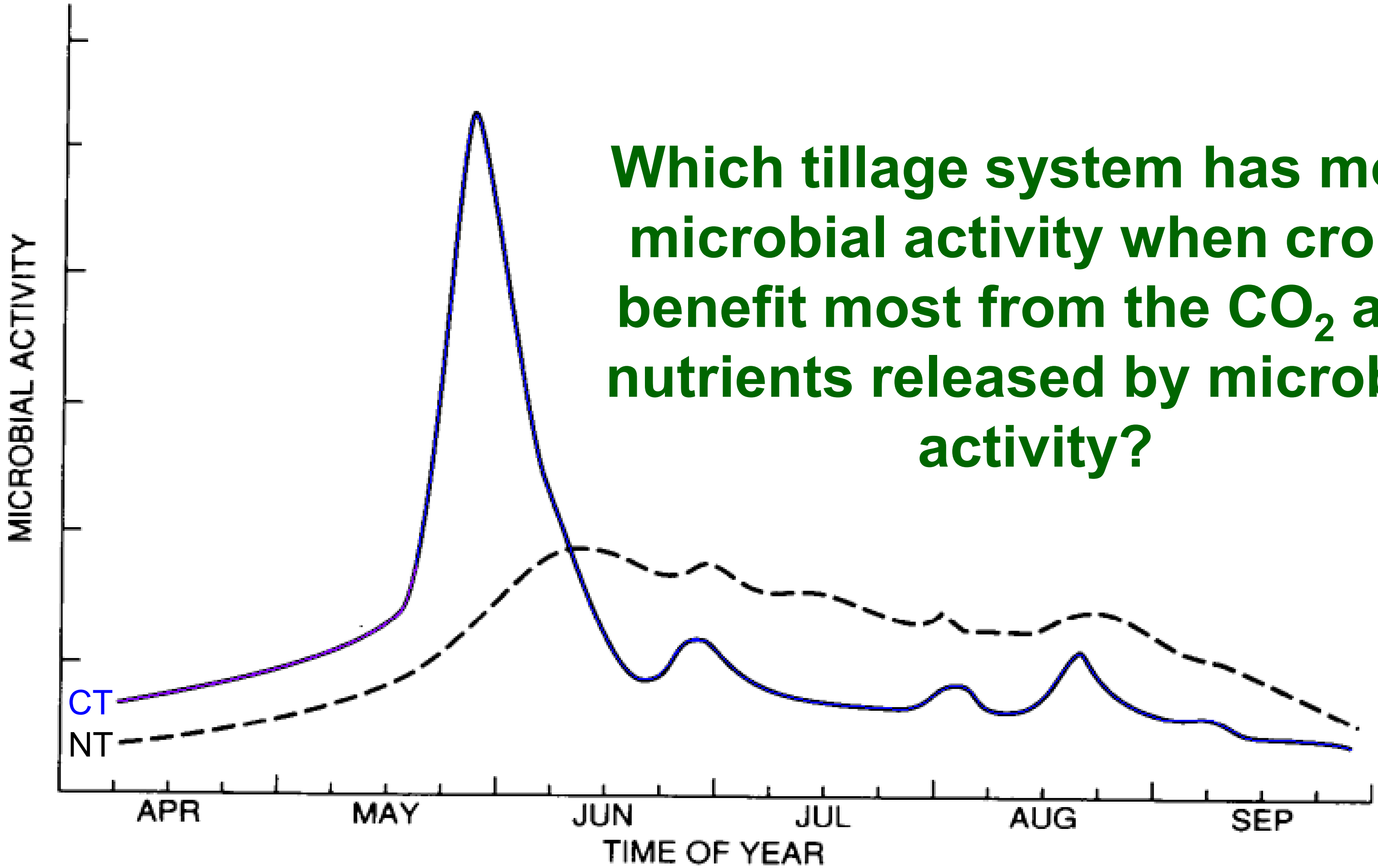


Which tillage system has more microbial activity ?

Differences in timing tend to be bigger than total differences

Havlin et al. (1999)

Effect of tillage on microbial activity



Which tillage system has more microbial activity when crops benefit most from the CO_2 and nutrients released by microbial activity?

Havlin et al. (1999)

Journal of Environmental Quality 2007

The Myth of Nitrogen Fertilization for Soil Carbon Sequestration

S. A. Khan,* R. L. Mulvaney, T. R. Ellsworth, and C. W. Boast University of Illinois

A controversial article

Intensive use of N fertilizers in modern agriculture is motivated by the economic value of high grain yields and is generally perceived to sequester soil organic C by increasing the input of crop residues. This perception is at odds with a century of soil organic C data reported herein for the Morrow Plots, the world's oldest experimental site under continuous corn (*Zea mays* L.). After 40 to 50 yr of synthetic fertilization that exceeded grain N removal by 60 to 190%, a net decline occurred in soil C despite increasingly massive residue C incorporation, the decline being more extensive for a corn–soybean (*Glycine max* L. Merr.) or corn–oats (*Avena sativa* L.)–hay rotation than for continuous corn and of greater intensity for the profile (0–46 cm) than the surface soil. The findings [illegible] N [illegible] the decomposition of crop residues and soil organic matter and are consistent with data from numerous cropping experiments involving synthetic N fertilization in the USA Corn Belt and elsewhere, although not with the interpretation usually provided. There are important implications for soil C sequestration because the yield-based input of fertilizer N has commonly exceeded grain N removal for corn production on fertile soils since the 1960s. To mitigate the ongoing consequences of soil deterioration, atmospheric CO_2 enrichment, and NO_3^- pollution of ground and surface waters, N fertilization should be managed by site-specific assessment of soil N availability. Current fertilizer N management practices, if combined with corn stover removal for bioenergy production, exacerbate soil C loss.

The shift from biological- to chemical-based N management that provided the impetus for modern cereal agriculture originated during the late 1940s as synthetic N fertilizers became more widely available following World War II. By the 1950s, traditional legume-based rotations that had long been practiced in the Midwestern USA were being replaced by more intensive row cropping with corn as the principal source of grain production. The past five decades have seen a remarkable increase in corn yield and in the use of fertilizer N (USDA, 2007).

Despite the use of forage legumes, many Midwestern soils had suffered [illegible] decline in their content of [illegible] organic matter by the mid-twentieth century, except in cases involving regular manuring. There was good reason for concern that this decline could adversely affect agricultural productivity and sustainability because organic matter plays a key role in maintaining soil aggregation and aeration, hydraulic conductivity, and water availability; cation-exchange and buffer capacity; and the supply of mineralizable nutrients. There were also important implications for atmospheric CO_2 enrichment because soils represent the Earth's major surface C reservoir (Bolin, 1977).

With the introduction of chemical-based N management, a new strategy became available for increasing not only grain yield, but also the input of crop residues, which was assumed to be of value for maintaining soil organic matter (SOM) (Lyon et al., 1952; Melsted, 1954; Tisdale and Nelson, 1956). Ample fertilizer N was believed to promote humus formation by narrowing the C/N ratio of carbonaceous residues and by providing a major elemental constituent (Lee and Bray, 1949; Millar and Turk, 1951; Melsted, 1954).

Ecological Applications 2009

Nitrogen fertilizer effects on soil carbon balances in Midwestern U.S. agricultural systems

Ann E. Russell,[1,3] Cynthia A. Cambardella,[2] David A. Laird,[2] Dan B. Jaynes,[2] and David W. Meek[2]

[1]*Department of Natural Resource Ecology and Management, Iowa State University, Ames, Iowa 50011 USA*
[2]*USDA-ARS National Soil Tilth Laboratory, Ames, Iowa 50011 USA*

Newer study with similar conclusions

Abstract. A single ecosystem dominates the Midwestern United States, occupying 26 million hectares in five states alone: the corn–soybean agroecosystem [*Zea mays* L.–*Glycine max* (L.) Merr.]. Nitrogen (N) fertilization could influence the soil carbon (C) balance in this system because the corn phase is fertilized in 97–100% of farms, at an average rate of 135 kg $N \cdot ha^{-1} \cdot yr^{-1}$. We … termine the soil C balance, the rates … of N fertilization, 0, 90, 180, and 270 … in Iowa, USA. We compared the cor… tems fertilized with N in the corn pha… *na sativa* L.)–alfalfa (*Medicago sativa* L.; corn–oats–alfalfa–alfalfa; and continuous soybean. In all systems, we estimated long-term OC inputs and decay rates over all phases of the rotations, based on long-term yield data, harvest indices (HI), and root : shoot data. For corn, we measured these two ratios in the four N treatments in a single year in each site; for other crops we used published ratios. Total OC inputs were calculated as aboveground plus belowground net primary production (NPP) minus harvested yield. For corn, measured total OC inputs increased with N fertilization ($P < 0.05$, both sites). Belowground NPP, comprising only 6–22% of total corn NPP, was not significantly influenced by N fertilization. When all phases of the crop rotations were evaluated over the long term, OC decay rates increased concomitantly with OC input rates in several systems. Increases in decay rates with N fertilization apparently offset gains in carbon inputs to the soil in such a way that soil C sequestration was virtually nil in 78% of the systems studied, despite up to 48 years of N additions. The quantity of belowground OC inputs was the best predictor of long-term soil C storage. This indicates that, in these systems, in comparison with increased N-fertilizer additions, selection of crops with high belowground NPP is a more effective management practice for increasing soil C sequestration.

Key words: agroecosystems; carbon mineralization; corn, oats, alfalfa, and soybean crop rotations; Midwestern U.S. corn–soybean ecosystem; Nashua and Kanawha sites, Iowa, USA; net primary production; nitrogen fertilization; root production; soil carbon sequestration.

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Increases in decay rates with N fertilization offset gains in carbon inputs to the soil in such a way that soil C sequestration was virtually nil in 78% of the systems studied, despite up to 48 years of N additions.

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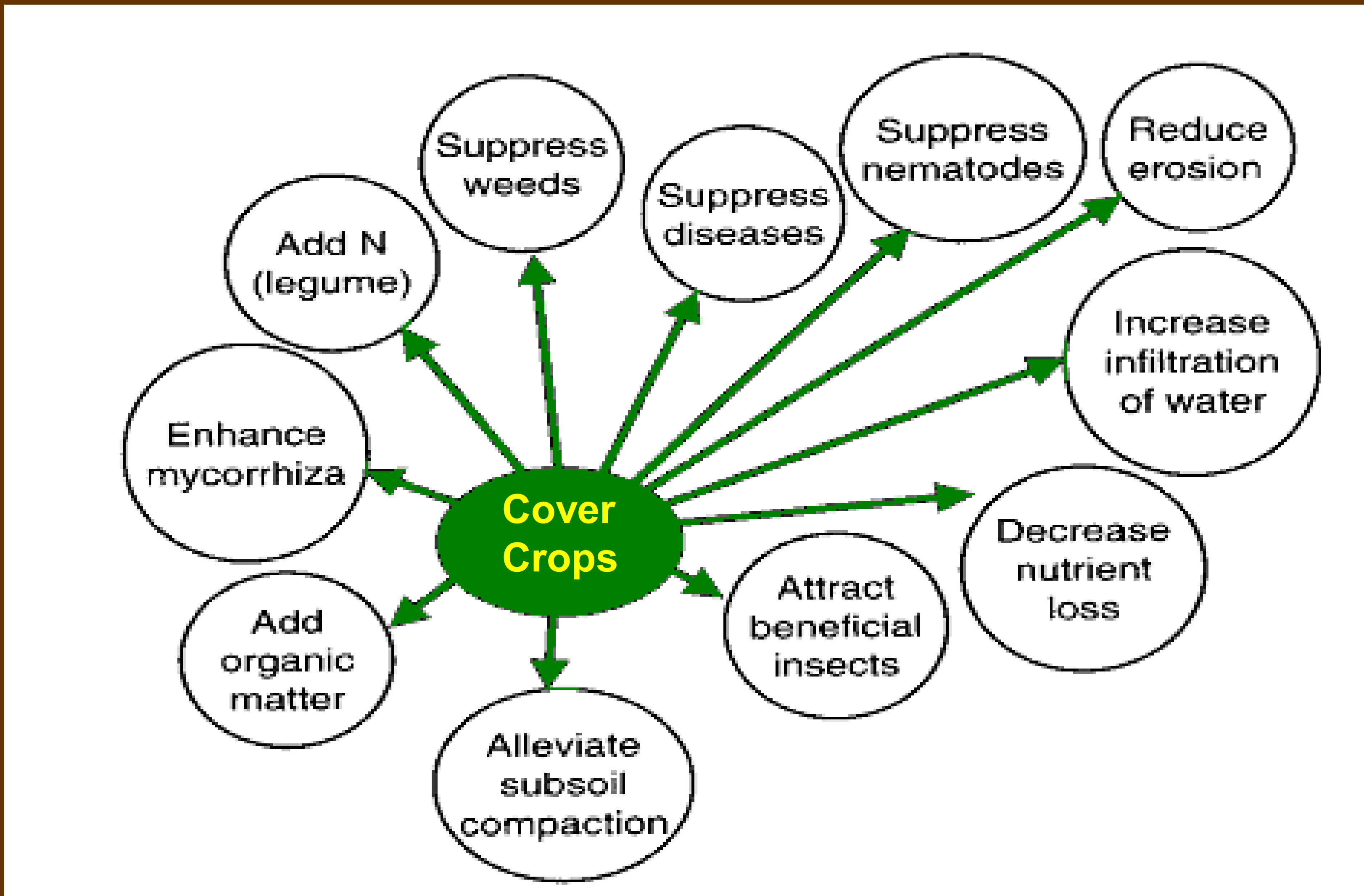
Cover crops are a great way to add more belowground organic inputs to cropping systems !!

nitrogen fertilization; root production; soil carbon sequestration.

20 years of similar tillage intensity and C inputs
but contrasting types of organic inputs

Cover crops are multi-functional



Adapted from Magdoff and Weil (2004)

In contrast, most ag inputs have 1 target effect

Adapted from Magdoff and Weil (2004)


Cover crops are not idiot-proof!
Using cover crops to capture multiple benefits normally requires more management
There are few profits in idiot-proof systems

What to Look For in A Cover Crop

- Fast germination and emergence
- Competitiveness
- Tolerance to adverse climatic & soil conditions
- Ease of suppression/residue management
- Fertility/soil quality benefits
- Low-cost

Matching objectives with species

http://www.sdnotill.com/Field_Facts_wheat_cover_crop.pdf

Grazing

turnips, rape, radish, ***lentils***, *rye, oat, triticale, sorghum-sudan*

Reducing Compaction

radish, canola, turnip (and hybrids), *sugarbeet, sunflower, sorghum-sudan*, ***sweet clover, alfalfa***

N-fixation

clovers, vetches, lentils, cowpeas, soybean, field pea, chickling vetch

Residue Cycling

canola, rape, radishes, turnips, mustards

?

Nutrient Cycling

sunflower, sugarbeets, ***brassicas***, *small grains*

Matching objectives with species

http://www.sdnotill.com/Field_Facts_wheat_cover_crop.pdf

Grazing

turnips, rape, radish, ***lentils***, *rye, oat, triticale, sorghum-sudan*

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N-fixation

clovers, vetches, lentils, cowpeas, soybean, field pea, chickling vetch

Other key considerations

How will I seed the cover crop?
What will soil temperature and moisture conditions be like?
What weather extremes and field traffic must it tolerate?
Is it compatible with my herbicide program?
Will it winterkill in my area?
Should it winterkill, to meet my goals?
What kind of regrowth can I expect?
How will I kill it and plant into it?
Will I have the time to make this work?
Do I have the needed equipment and labor?
What's my contingency plan—and what is at risk — if the cover crop doesn't establish or doesn't die on schedule?

Other key considerations

Be realistic about potential cover crop challenges


Forage radish was aerial seeded into soybeans and conditions were favorable for germination but the radishes are growing very poorly


Residual herbicide effects?
Yes- records indicate probably 'Callisto'

Residual Herbicide Carryover - Brassicas

Herbicides Used on Wheat and/or Barley

\# of Months between application and seeding a Brasica = (#)

- Ally – (34)
- Ally Extra – (22)
- Amber – Bioassay
- Beyond – (18)
- ClearMax – (18)
- Curtail M – (5)
- Everest – (9)
- Glean – (9)
- GoldSky – (9)
- Huskie – (9)
- Maverick – Bioassay
- Olympus – (22)Bioassay
- PowerFlex – (9)
- Rimfire – (10)
- Silverado – (10)
- Starane – (4)
- WideMatch – (4)
- Wolverine – (9)

http://www.ag.ndsu.edu/smgrains/Best of Best West 2010/Cover Crops 2010 Ashley.pdf

Residual Herbicide Carryover - Legumes

Herbicides Used on Wheat and/or Barley

of Months between application and seeding a Legume = (#)

Ally – (34)
Ally Extra – (22)
Amber – (4)Bioassay
Beyond – (9)
ClearMax – (9)
Curtail M – (10.5 to 18)
Everest – (9 to NCS)
Glean – Bioassay
GoldSky – (9)
Huskie – (9)
Maverick – Bioassay
Olympus – (12)Bioassay
PowerFlex – (9)
Rimfire – (10)
Silverado – (10)
Starane – (4)
WideMatch – (10.5)
Wolverine – (9)

http://www.ag.ndsu.edu/smgrains/Best of Best West 2010/Cover Crops 2010 Ashley.pdf

Low Residual Herbicides for Wheat

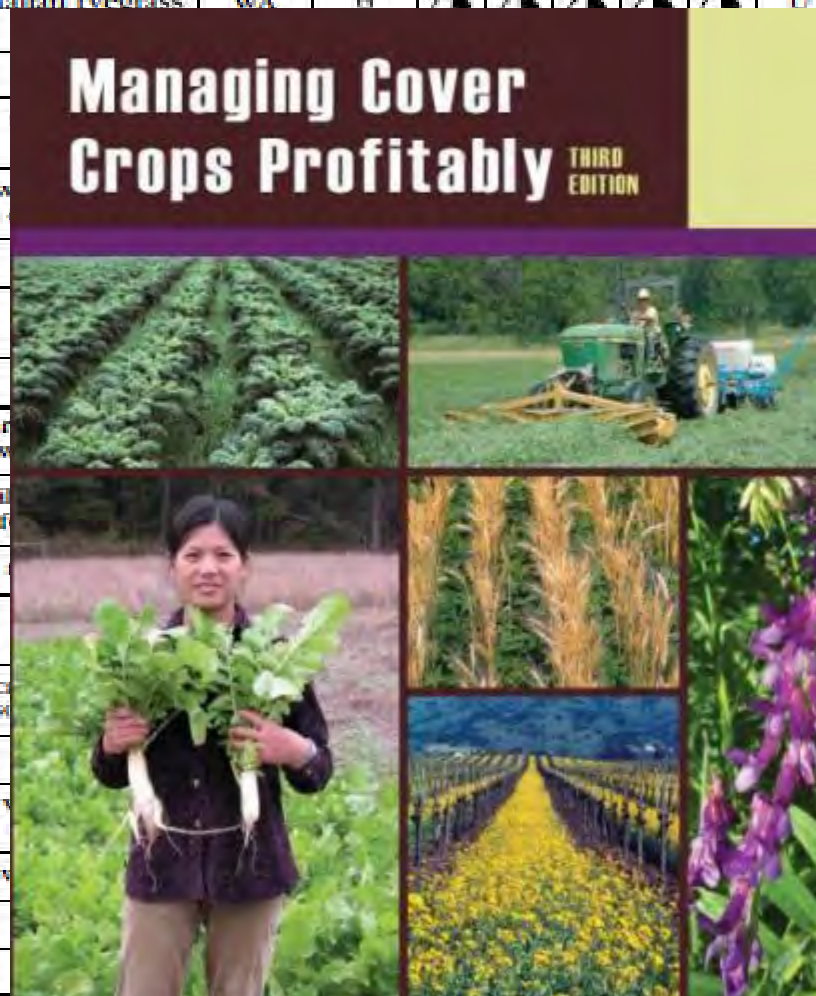
2,4-D 30 to 90 DAA
Affinity 60 DAA for Brassicas & 45 DAA all other crops
Buctril (Bromoxynil)
Discover 30 DAA
Express 60 DAA for Brassicas & 45 DAA all other crops
Harmony 45 DAA
MCPA
Paraquat
Roundup (Glyphosate)
Vida 30 DAA

http://www.ag.ndsu.edu/smgrains/Best of Best West 2010/Cover Crops 2010 Ashley.pdf

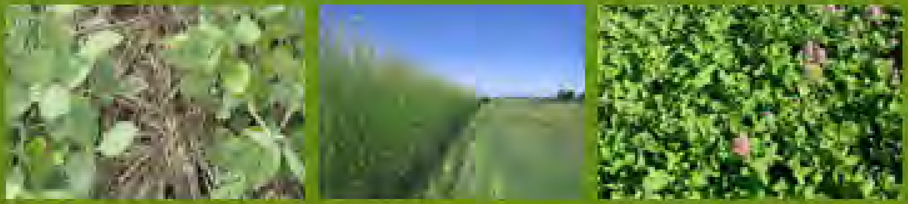
Single best source of information

Chart 3A CULTURAL TRAITS

Species	Aliases	Type[1]	Hardy through Zone[2]	Tolerances					Habit[3]	pH (Pref.)	Best Established[4]	Min. Germin. Temp.
NONLEGUMES												
Annual ryegrass *p. 74*	Italian ryegrass	WA	6						U	6.0–7.0	ESp, LSu, EF, F	40F
Barley *p. 77*										6.0–8.5	F, W, Sp	38F
Oats *p. 93*										4.5–7.5	LSu, ESp W in 8+	38F
Rye *p. 98*										5.0–7.0	LSu, F	34F
Wheat *p. 111*										6.0–7.5	LSu, F	38F
Buckwheat *p. 90*										5.0–7.0	Sp to LSu	50F
Sorghum–sudan. *p. 106*										6.0–7.0	LSp, ES	65F
BRASSICAS												
Mustards *p. 81*										5.5–7.5	Sp, LSu	40F
Radish *p. 81*										6.0–7.5	Sp, LSu, EF	45F
Rapeseed *p. 81*										5.5–8	F, Sp	41F
LEGUMES												
Berseem clover *p. 118*										6.2–7.0	ESp, EF	42F
Cowpeas *p. 125*										5.5–6.5	ESu	58F
Crimson clover *p. 130*										5.5–7.0	LSu/ESu	
Field peas *p. 135*										6.0–7.0	F, ESp	41F
Hairy vetch *p. 142*										5.5–7.5	EF, ESp	60F
Medics *p. 152*										6.0–7.0	EF, ESp, ES	45F
Red clover *p. 159*										6.2–7.0	LSu; ESp	41F
Subterranean cl. *p. 164*	subclover	CSA	7						P/SP	5.5–7.0	LSu, EF	38F



Midwest Cover Crops Council



Illinois Indiana Iowa Michigan Minnesota North Dakota Ohio Wisconsin Ontario

Home

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- **History**
- **Mission and vision**
- **Supporters**
- **MCCC meetings**

Cover Crop Resources

- **Cover crop species**
- **Cover crops selector**
- **Innovator Profiles**
- **Extension material**

WELCOME TO THE MIDWEST COVER CROPS COUNCIL WEBSITE

The goal of the *Midwest Cover Crops Council* (MCCC) is to facilitate widespread adoption of cover crops throughout the Midwest, to improve ecological, economic, and social sustainability.

WHO WE ARE?

The MCCC is a diverse group from academia, production agriculture, non-governmental organizations, commodity interests, private sector, and representatives from federal and state agencies collaborating to address soil, water, air, and agricultural quality concerns in the Great Lakes and Mississippi river basins (including Indiana, Michigan, Ohio, Manitoba, Ontario, Illinois, Wisconsin, Minnesota, Iowa, and North Dakota).

WHY COVER CROPS?

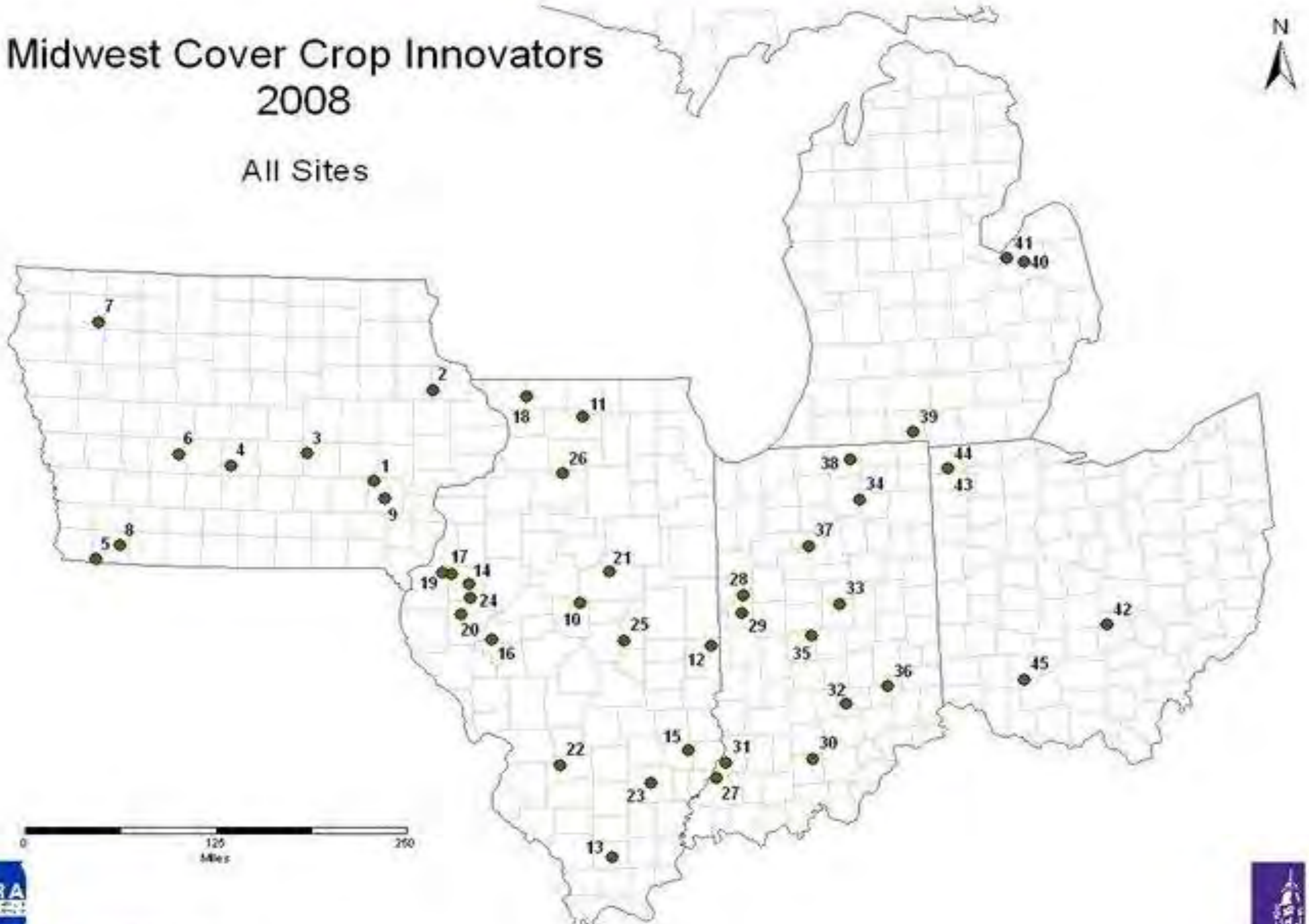
NEWS

Three new fact sheets are available from OSU Extension

- Using Cover Crops to Convert to No-Till
- Sustainable Crop Rotations with Cover Crops
- The Biology of Soil Compaction

2010 MCCC Meeting/Workshop
March 3-4
Ames, IA
Click here for the brochure

INNOVATOR PROFILES



INNOVATOR PROFILES

Terry Taylor
Geff, IL

Summary of operation

300 acres of continuous no-till corn with cover crops
1500 acres of continuous no-till corn/corn/soybeans with cover crops whenever possible
600 acres of bottom ground no-till on ridges
320 acres of CRP and filter strips

Background information

Terry Taylor is from Geff, IL and has operated his several thousand acre farm as a single unit since his father's retirement. He attended the University of Illinois and is currently 55 years old. He has spoken at many conferences such as the Tri State Conservation Tillage Conference and has been interviewed for various magazines such as Prairie Grains. He became interested in cover crops by growing up on a livestock farm with legumes, small grains, and hay as a vital components.

Cover crop management

Mr. Taylor uses hairy vetch on his continuous corn acres as much as possible. Any other acres harvested before September 20th get annual ryegrass seeded into them. Cereal rye gets seeded on any other acres that get a cover crop after that date. Mr. Taylor plants hairy vetch before Sept.


Terry Taylor's
continuous NT corn
w/ hairy vetch system

Red clover frost seeded into winter wheat.

Seed is broadcast onto frozen and cracked soil in mid-March after snow melt. Seedlings remain relatively small until wheat harvest, at which time they have full sunlight and three months to grow and fix atmospheric nitrogen. Total nitrogen accumulation typically exceeds 100 lbs./a by the end of the growing season.

Probably the most tried and true system of cover crop establishment and benefit to the next crop

How much N can frost seeded red clover fix ??

Year	Legume	Lbs. DM/a	Total lbs. N/a
1991	Red clover	4456	128
1992	Red clover	3918	110
1993	Red clover	4125	119
1994	Hairy vetch	4459	146
1995	Red clover	3407	100
1996	Red clover	5049	147
1997	Hairy vetch	2110	84
1998	Red clover	4458	109
1999	Red clover	7607*	265
Mean		4399	134

Hairy vetch can be successfully planted after wheat harvest. On the two occasions (out of 18 site-years of the WICST trial) when the red clover failed to establish well, the vetch produced an average of 115 lbs./a of nitrogen, providing an excellent “back-up plan” that reduces one of the potential risks of relying on a companion-seeded cover crop for nitrogen. Late July vetch plantings can be riskier than frost seeding clover.

Cover crops can provide much of the nitrogen required by corn.

WI trials to determine whether supplemental nitrogen was worthwhile found that additional nitrogen (either starter or sidedressed) produced a significant yield increase only about one-fourth of the time. The exceptions always occurred during years with cool springs, when there is a slow release of legume nitrogen.

REALITY CHECK

PLANTED ACREAGE - PRINCIPAL CROPS

Crop	Illinois		United States	
	2009	Indicated 2010	2009	Indicated 2010
	Thousand acres			
Corn - All purposes	12,000	12,600	86,482	88,798
Soybeans	9,400	9,500	77,451	78,098
Winter Wheat 1/	850	350	43,311	37,698
Sorghum - All purposes	40	40	6,633	6,360
Oats	40	40	3,404	3,364
All Hay 2/	610	610	59,755	60,460

1/ Includes acreage sown preceding fall.
2/ Hay acres for harvest.

Brand new bulletin from Penn State

Agronomy Facts 67

Management of Red Clover as a Cover Crop

BENEFITS

Red clover is a short-lived perennial that is winter hardy throughout Pennsylvania. Red clover can be used as a cover crop that provides many benefits such as fixing nitrogen (N) to meet needs of the following crop, protecting soil from erosion, improving soil tilth, competing with weeds, as well as supplying forage

Red clover is ad
winter hardy in
clover survives
does best on wel
drained soil. It p
are two types of
clover. Medium
lish than mamm

Broadcasting red clover seed into soybeans just before leaf fall (when soybean leaves start to turn yellow) has been proven a successful method. The leaves that fall after the red clover seed has been broadcast help increase humidity around the seeds.

NITROGEN FIXATION

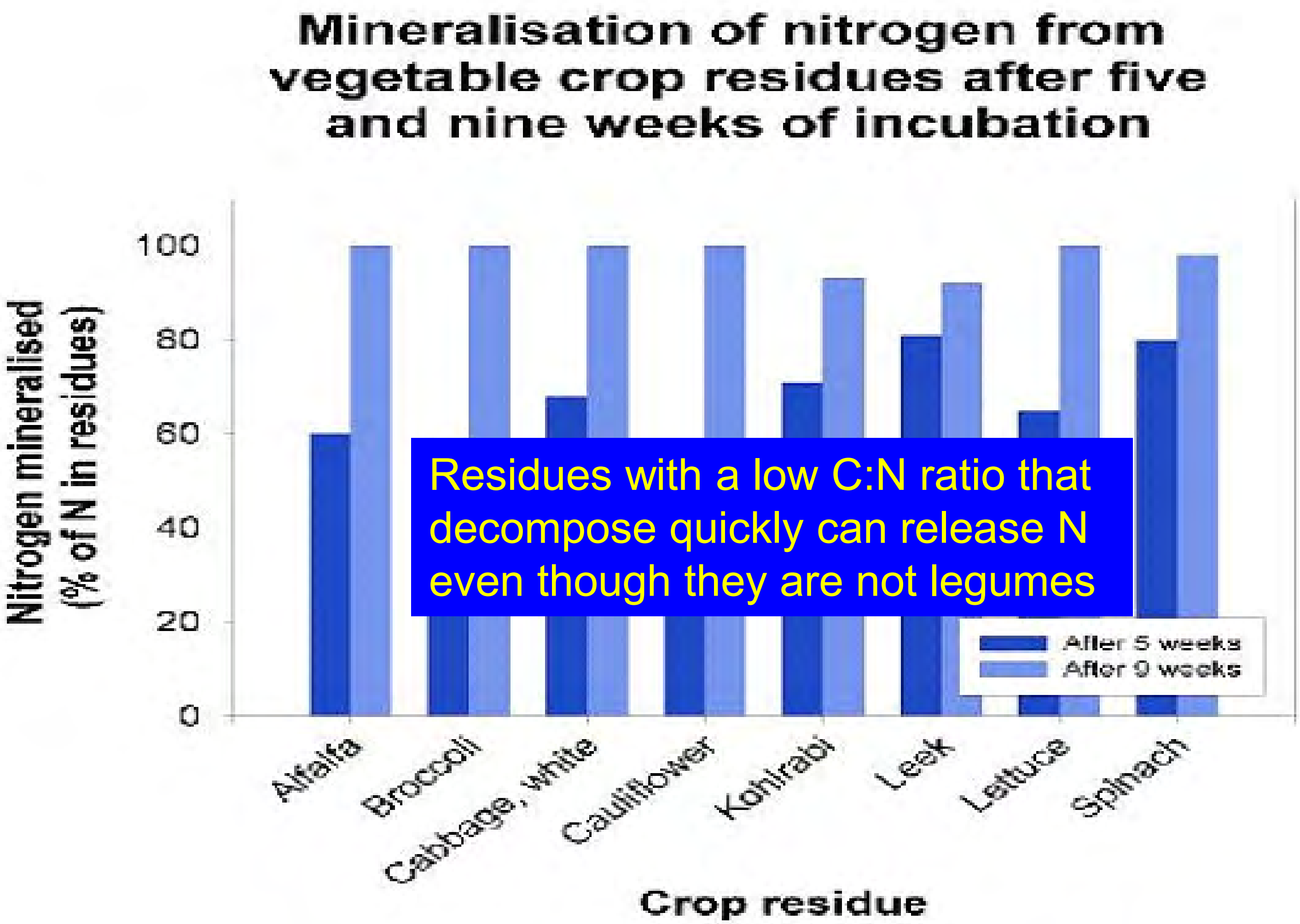
In a study in Wisconsin, red clover fixed enough nitrogen to supply the equivalent of 160 pounds per acre of nitrogen fertilizer. A lower nitrogen contribution is more common, however. A study in Pennsylvania showed that a one-year-old red clover stand (without harvest) contributed 70 pounds of nitrogen per acre to the first corn crop following it, while

approximately 75 percent of that supplied in the first year (in our example this would be 40 x 0.75 = 30 pounds of N in the second year). If the red clover is established in late summer or early fall, it might not fix as much nitrogen as calculated here. Several studies have shown that the nitrogen benefit from the legume is similar whether it is incorporated or left
ng the mulch at the
ol and will lead to

er than 0.5 inch.
deeper. So, check
en using a no-till
epending on field
hat has been inocu-
ain to guarantee
establishment is in early spring or early summer, although establishing it after small grain crops come off is possible. The earlier the red clover is established, the more benefits it can be expected to produce the following year.

An easy method of establishment is to frost-seed red clover into standing winter wheat or barley from February to April. With this method, the red clover seed is simply broadcast

Many vegetable crop residues are comparable to a legume cover crop



Residues with a low C:N ratio that decompose quickly can release N even though they are not legumes

http://res2.agr.ca/stjean/publication/bulletin/nitrogen-azote_e.pdf

Pat Sheridan (Fairgrove, Michigan)

http://talk.newagtalk.com/forums/thread-view.asp?tid=73097&mid=521773#M521773

We've done some PSNT tests with and w/o fall seeded radish. **Kind of a moving target (year to year) in N credits, but I will say that we've always had a bigger credit following radish than what we had without.** That could be for a lot reasons. Weather, soil types, temp, etc. I've had an increase of almost 80#s of N using radish vs none, and I've had an increase of 20# vs none.

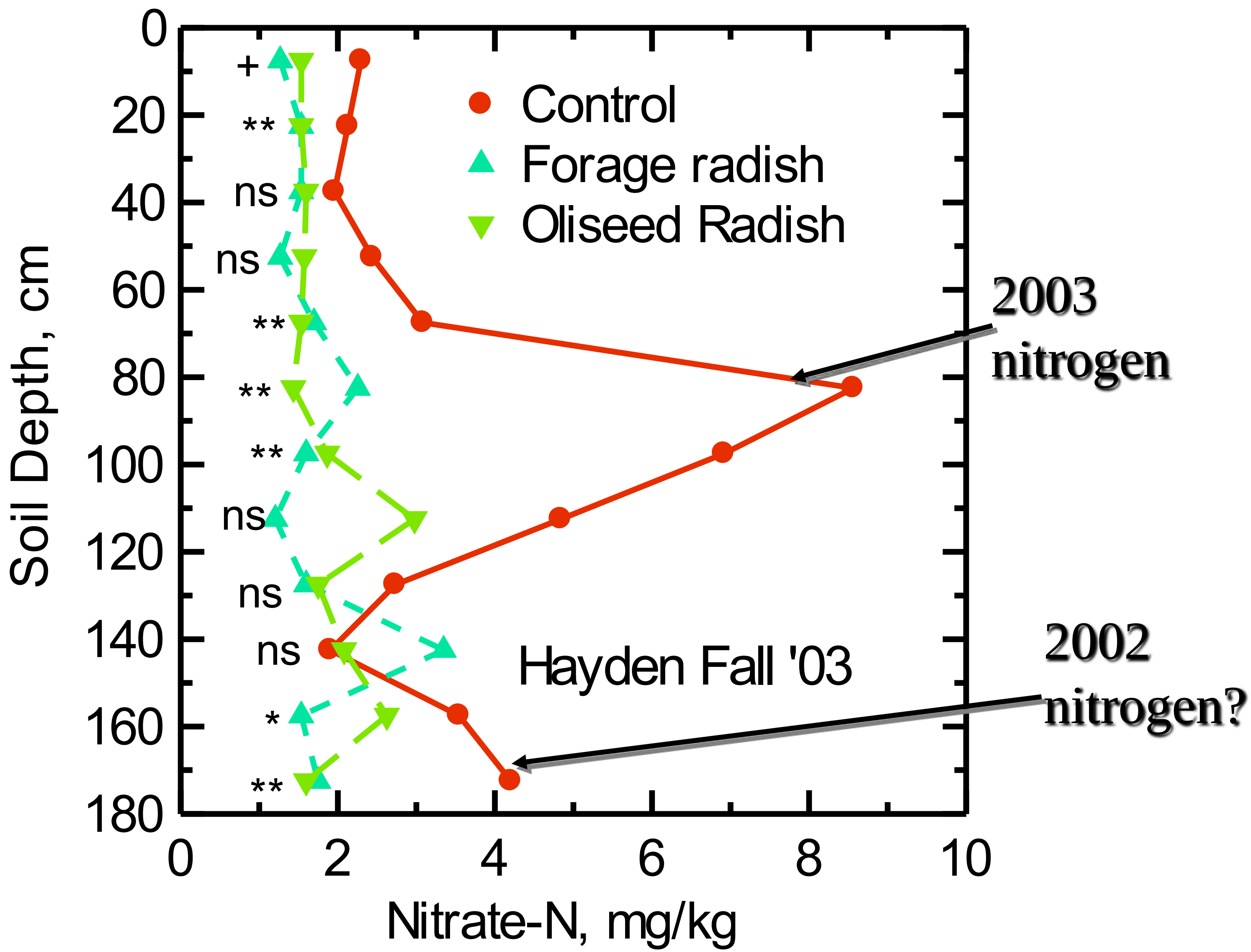
N credit is a very nice benefit of using a cover like radish, but I also like the other benefits from radish we've observed. Trouble with cover crops is putting a $ benefit on many of them. I can hardly ever say that if I spend 10 bucks on a particular cover, it'll for sure give me 20 back next year. In the big picture, I feel that if looked at over say a 5 or 10 year period, we've put more money in the bank by using covers than we've spent. I don't know how to quantify things $ wise like the value of increased OM, for example.


Forage brassicas have good cover crop potential
Ethiopian cabbage
Hunter
Winfred

http://www.jennifermackenzie.co.uk/2005/12/brassicas.html

Fall growth and N uptake by brassicas is often faster than small grains

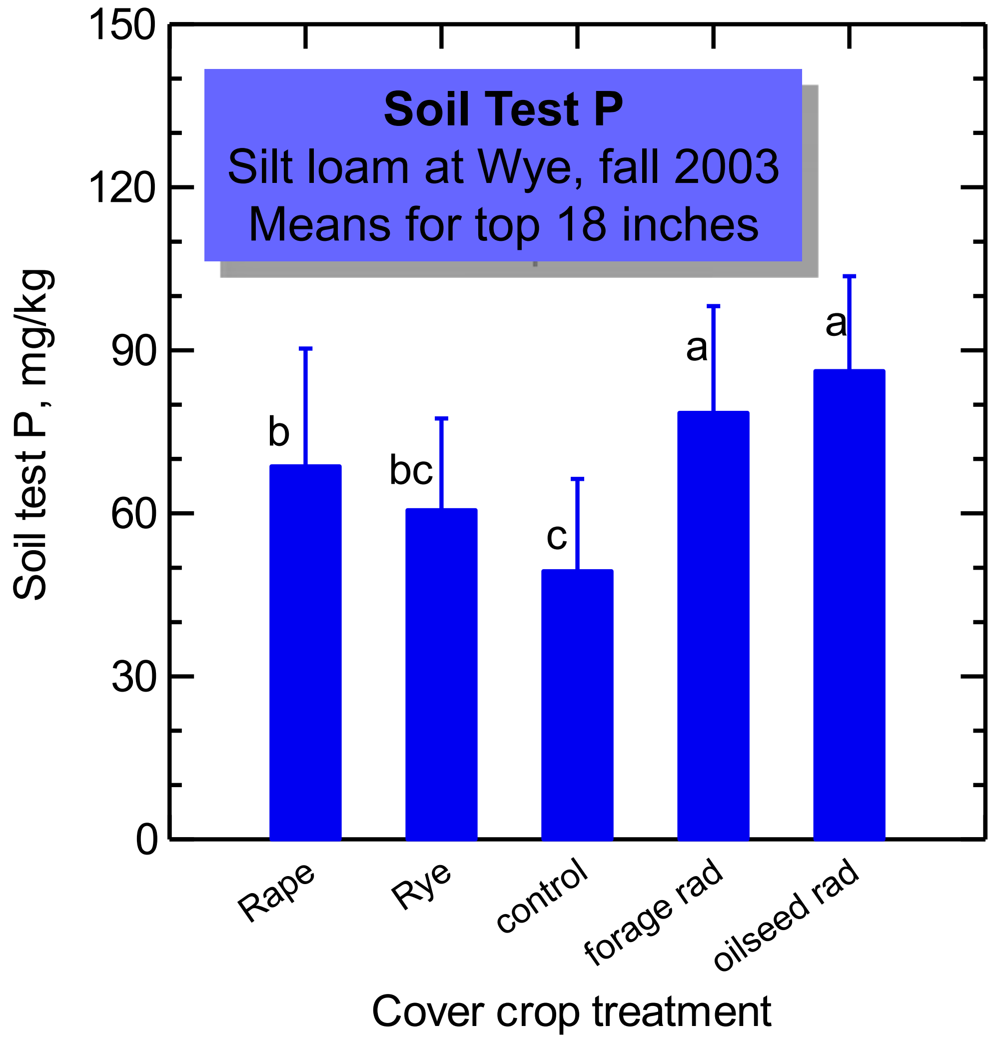
Ability of radishes to capture soil N in fall



RWeil

Nutrient cycling: Phosphorus

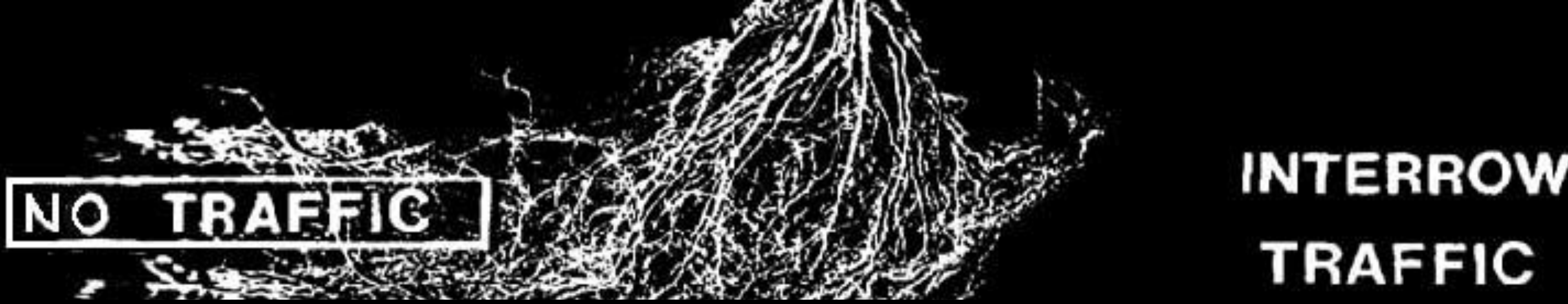
Brassicas appear to be particularly adept at solubilizing P



Biological pumping + organic acid root exudates

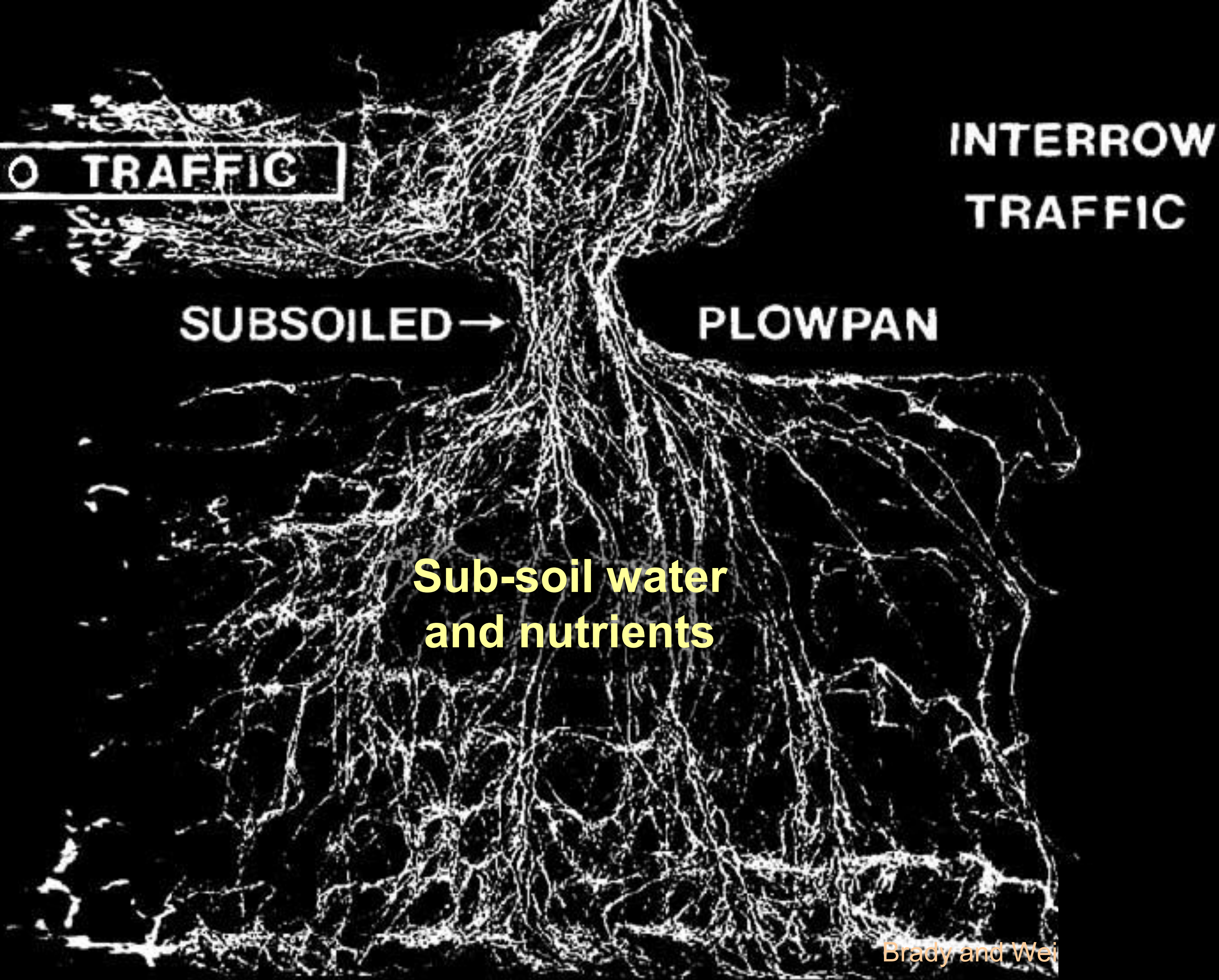
Third year of cover crop treatments in a corn-soybean rotation

RWeil



PLOW PAN

Compaction can severely limit root growth


NO TRAFFIC
INTERROW
TRAFFIC
SUBSOILED→
PLOWPAN
Sub-soil water
and nutrients
Brady and Wei

Did this happen on your farm last fall?

Which solution would you use ?

Visual evidence of biodrilling

Canola root

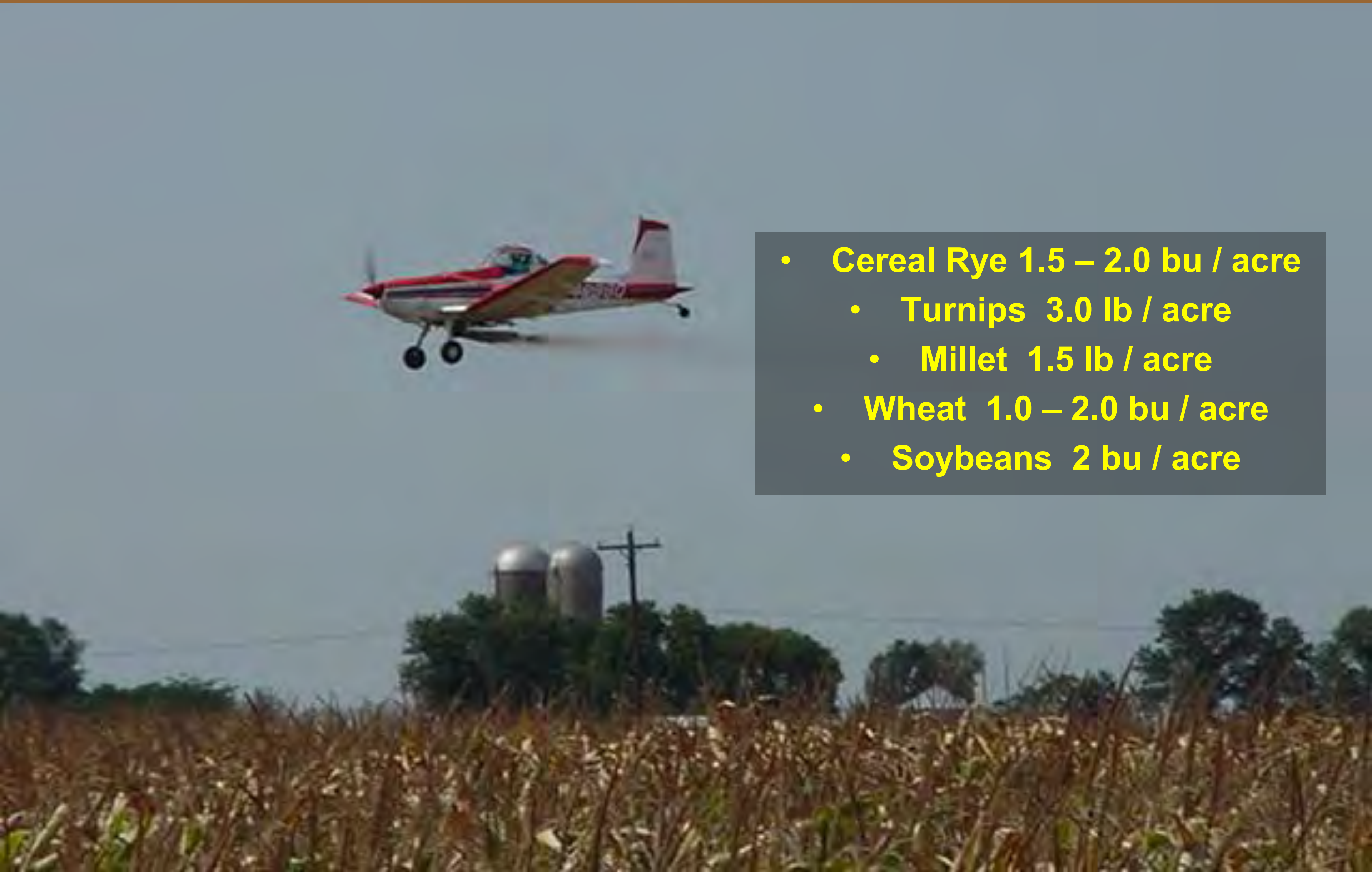
WIU Allison Organic Research Farm – September 2007


January


Early May
Please plant me no-till!


What is this??
08.07.2009

Aerial seeding cover crops into standing crops



- Cereal Rye 1.5 – 2.0 bu / acre
- Turnips 3.0 lb / acre
- Millet 1.5 lb / acre
- Wheat 1.0 – 2.0 bu / acre
- Soybeans 2 bu / acre

Cliff Schuette

Turnips
and Cereal Rye

Airseed 8/25/2000

Barkant Turnips-3 lbs
Rye 2 Bu
Airplane $8/Acre
Corn 183 Bu/acre
Atrazine 1 lb
Partner April 28

November 1, 2000
Turnips - Spring Oats-
Corn Stalks
Seeded August 15
Turnips- 4 lbs
Oats 1 Bu.
40 LBS N

November 1, 2000
Spring Oats -Cereal Rye-
Corn Stalks
Seeded August 15
Oats- 1 Bu.
Rye-1 1/2 Bu.
40 LBS N


Cow eating whole turnip

11/30/00

Protein 16.59
RFV 114

01/19/2001

Protein 12.79
RFV 92

Paul Smith

Annual ryegrass aerial seeded into standing corn

Fall, 2001

John Hebert
Inspecting
ryegrass
no-till drilled
into corn
stubble
Fall, 2001


•Tyler Johnson
•King’s Grant Farm, Chestertown
•Forage Radish
•Seeded by airplane into standing corn

Charles Martin and his sons from Perry County, PA built this High-boy cover crop air seeder. The platform extends to 9’6 “ high to run through standing corn and it drops cover crop seed through tubes from the air seeder down in between each row of corn. It covers 18 rows of corn with a pass.

It’s hydraulic driven and has an individual hydraulic drive on each wheel, you can turn both the front and rear set of wheels. There is a variable speed drive that synchronizes the ground speed with the seed box flutes turning so the seed drop flow is coordinated with the ground speed. And you can disengage that when at the end of the field and for turning. The headlands will be a challenge on some fields, running down some plants in the headlands to get through.

AUTOCAST

WEBSITE

Support British Design & British Manufacturers

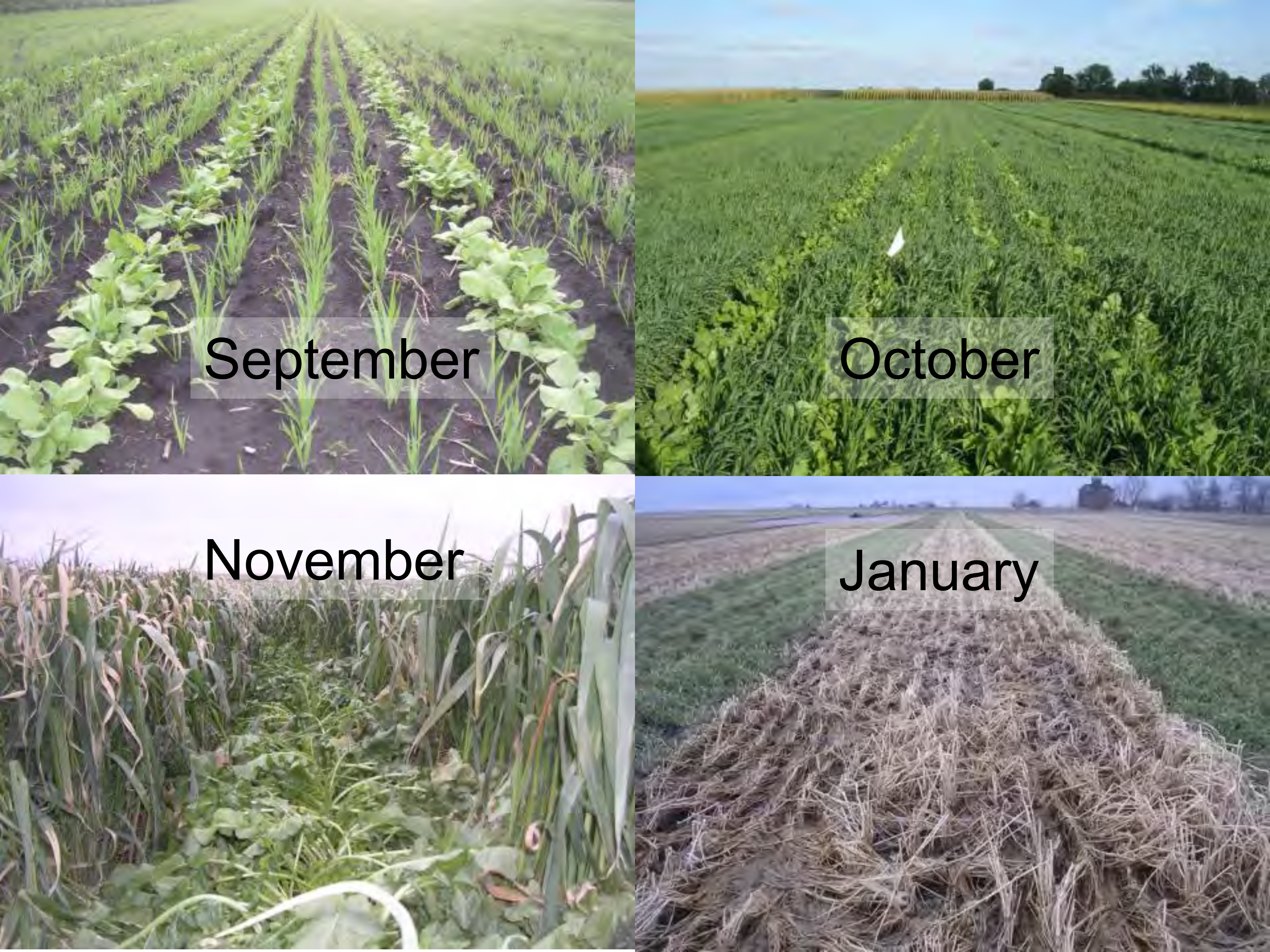
For the low cost & accurate establishment of OSR, Mustard, Stubble Turnips and other small seeds and pellets...

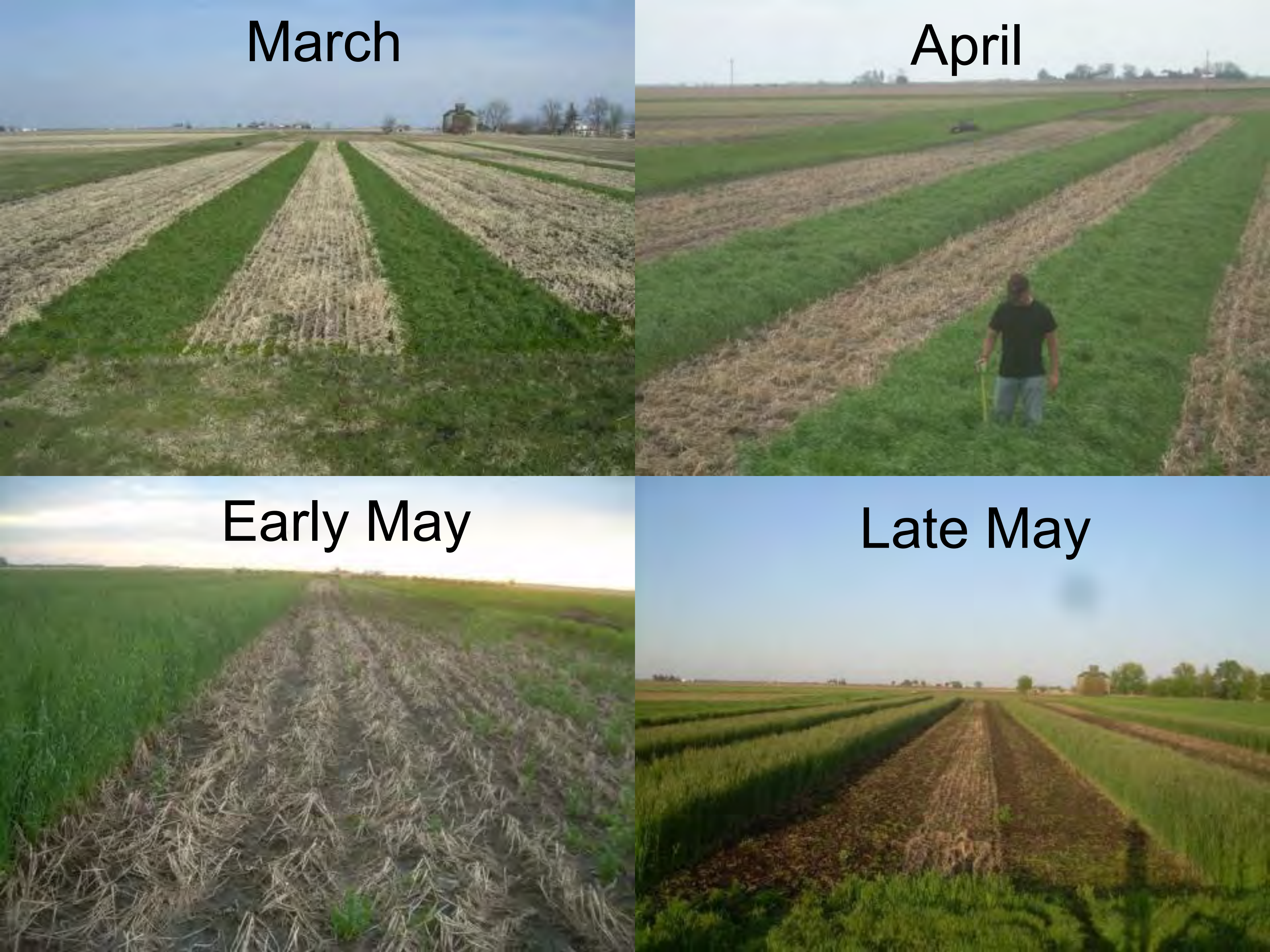
Please be patient while pictures load

Tillage System experiment at the WIU Organic research farm

Conventional till
Bio-strip-till
No-till

Established in fall 08


September
October
November
January


March
April
Early May
Late May

Options for rolling cover crops

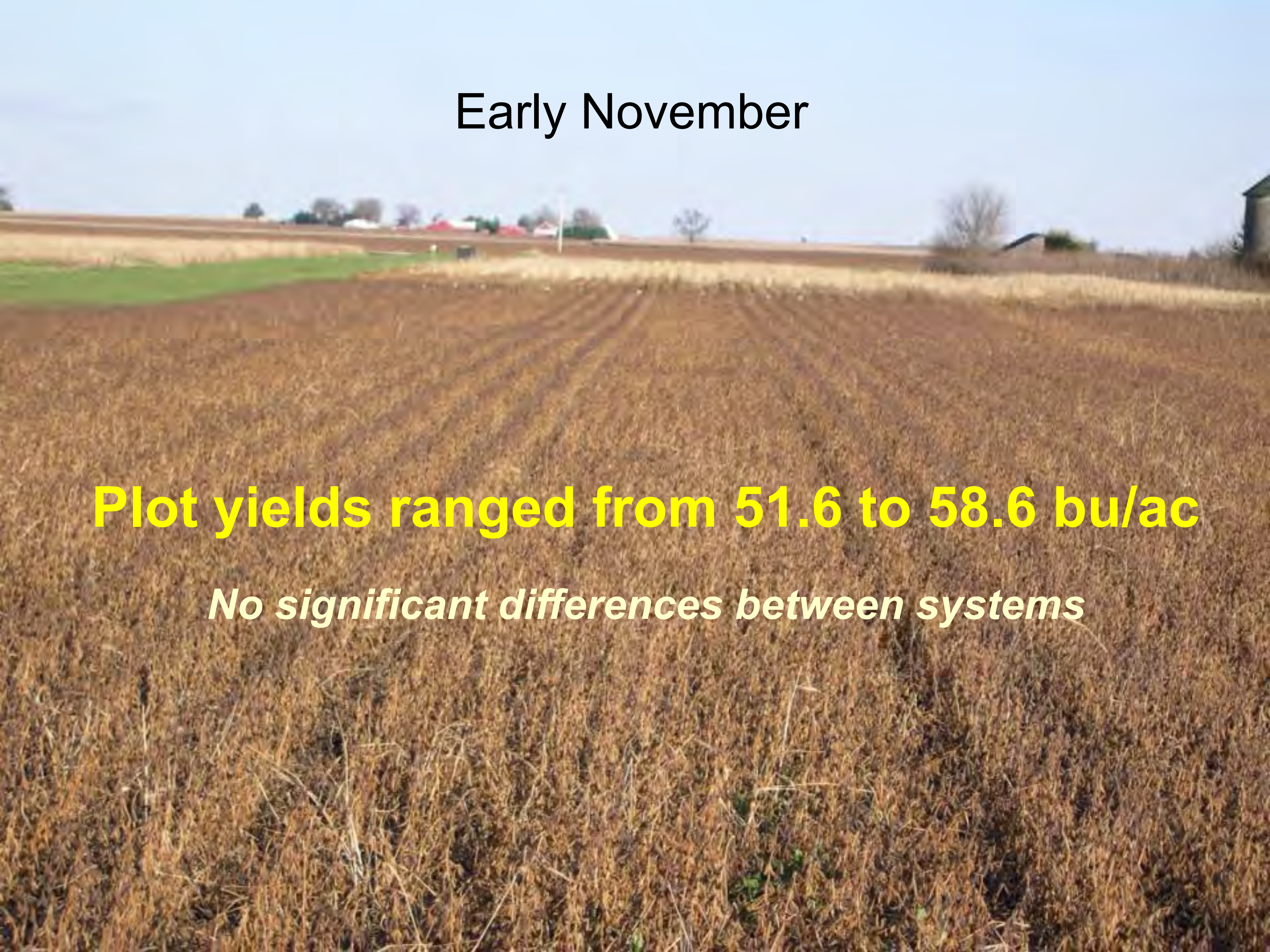
Rodale design

Cultimulcher


Early June
1 week later


~2 weeks after planting

July
August
late September


Early November
Plot yields ranged from 51.6 to 58.6 bu/ac
No significant differences between systems

Early September 2009


Early November 2009
Tillage radish on 30” rows with oats on 7.5” rows

Early November 2009

Tillage radish solid seeded on 7.5” rows (~ 10 lbs/ac)

Potential relative reductions in nitrate leaching in Corn Belt for specific corn/soybean mgt. changes

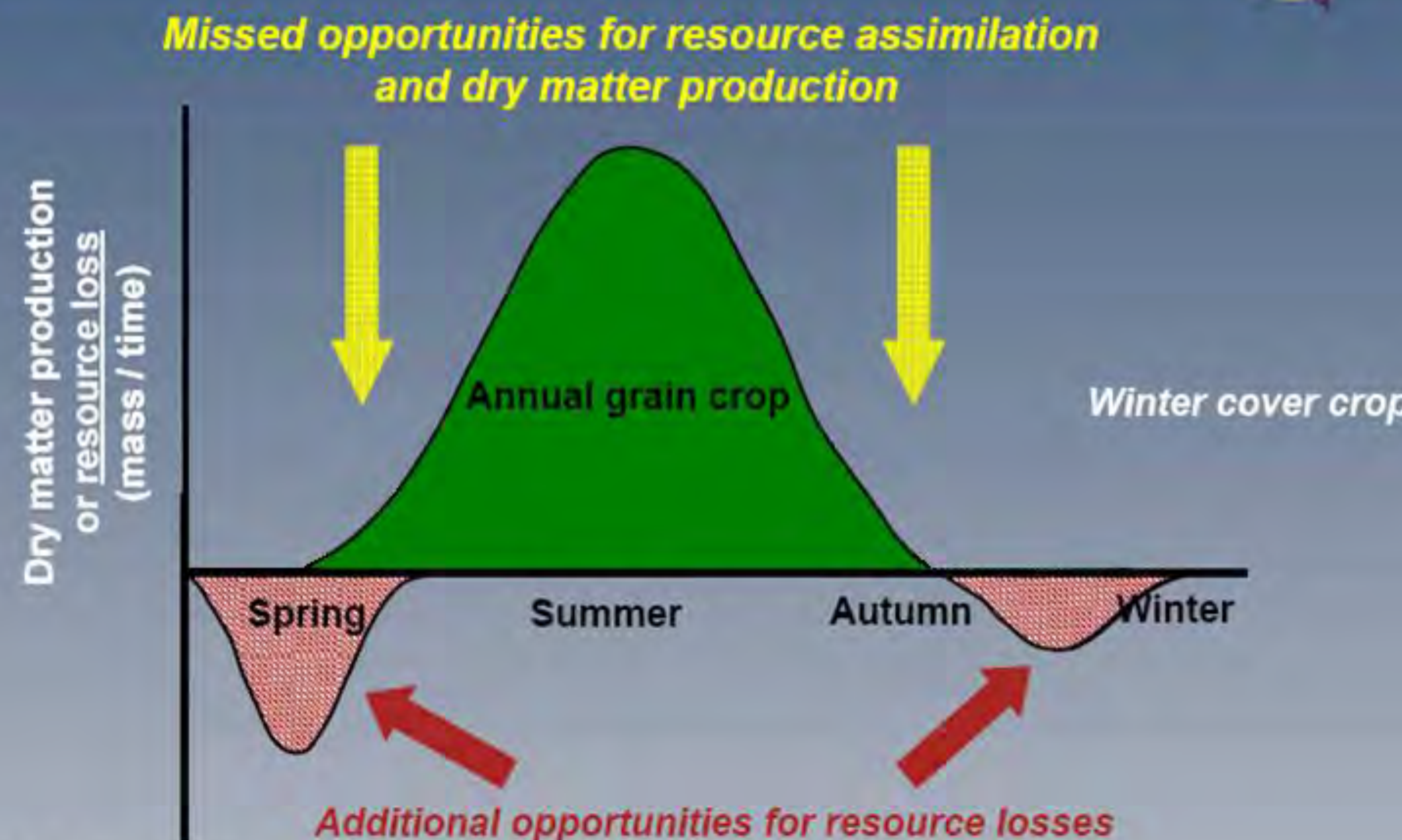
PRACTICE	CHANGE	REDUCTION POTENTIAL
N rate on corn	150 reduced to 125 lb/ac	
timing	no fall N-fertilizer applications	
cropping	switch to perennials	
buffer strips	1-5% of area	
tillage	plow to long-term, continuous no-till	
wetlands	1-5% of area	

How equivalent is combining summer crops with winter cover crops?

http://www.epa.gov/msbasin/pdf/symposia0406/2_baker.pdf

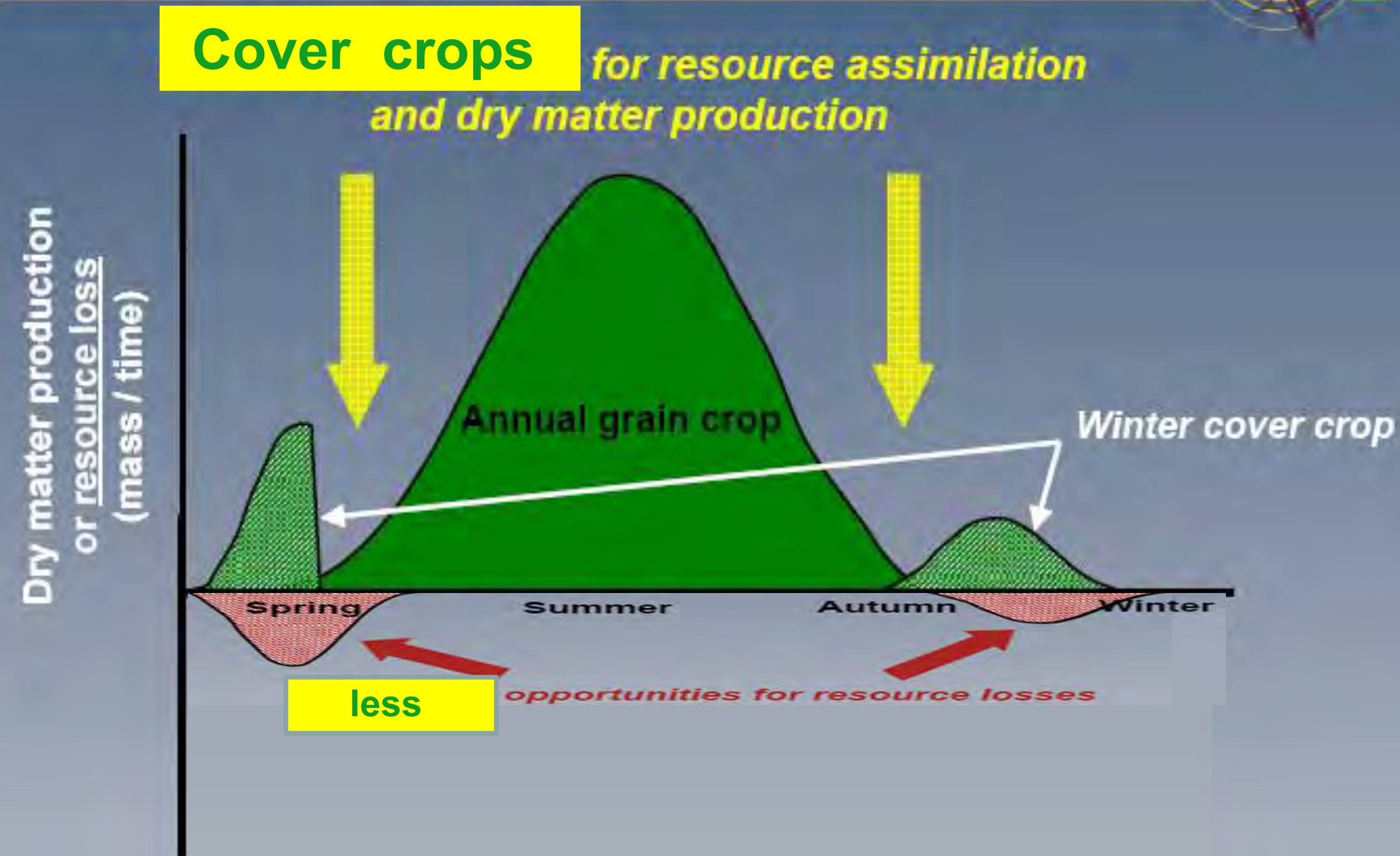
Biomass Production

Annual Cropping Systems



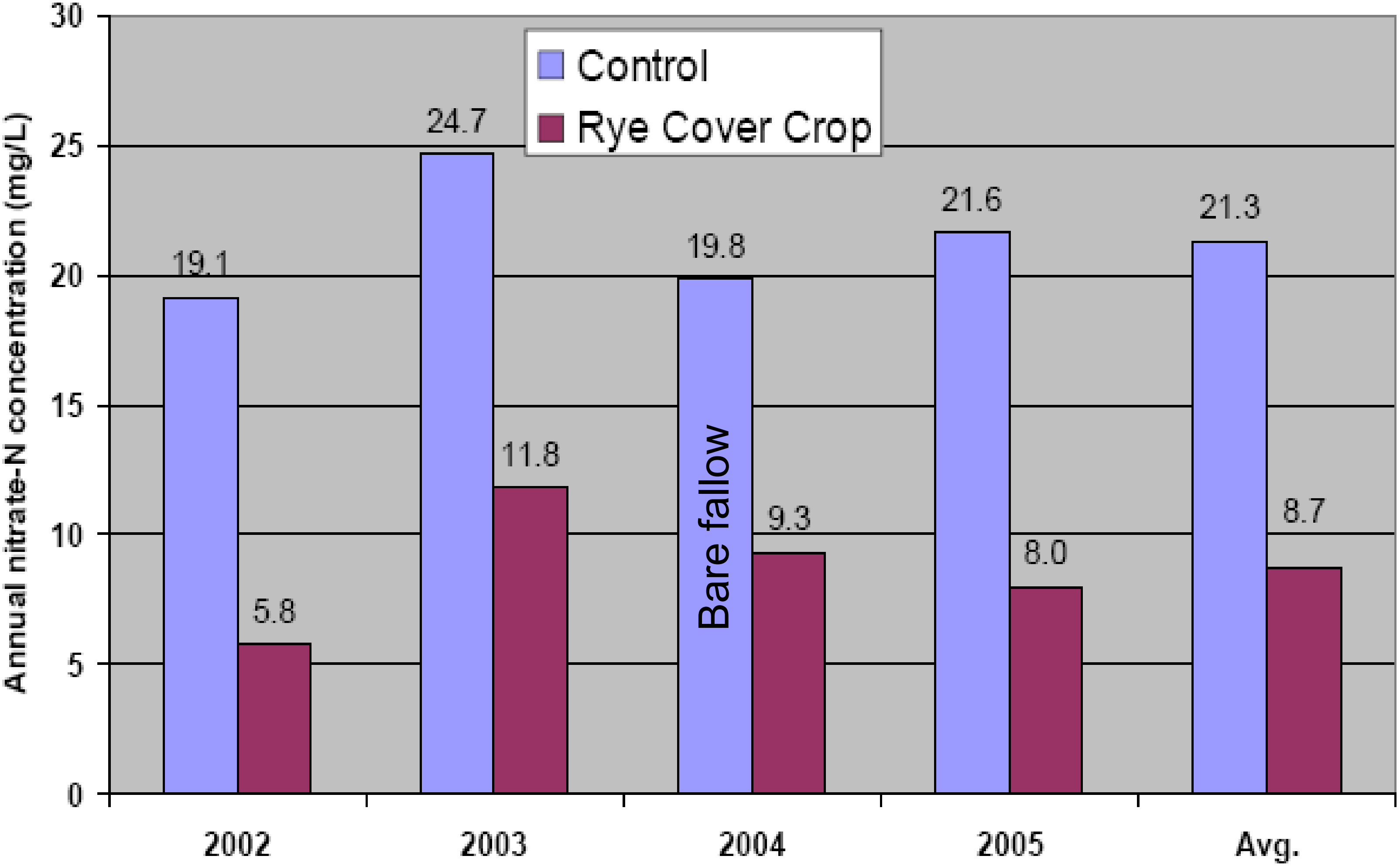
after A.H. Heggenstaller

Biomass Production
Annual Cropping Systems

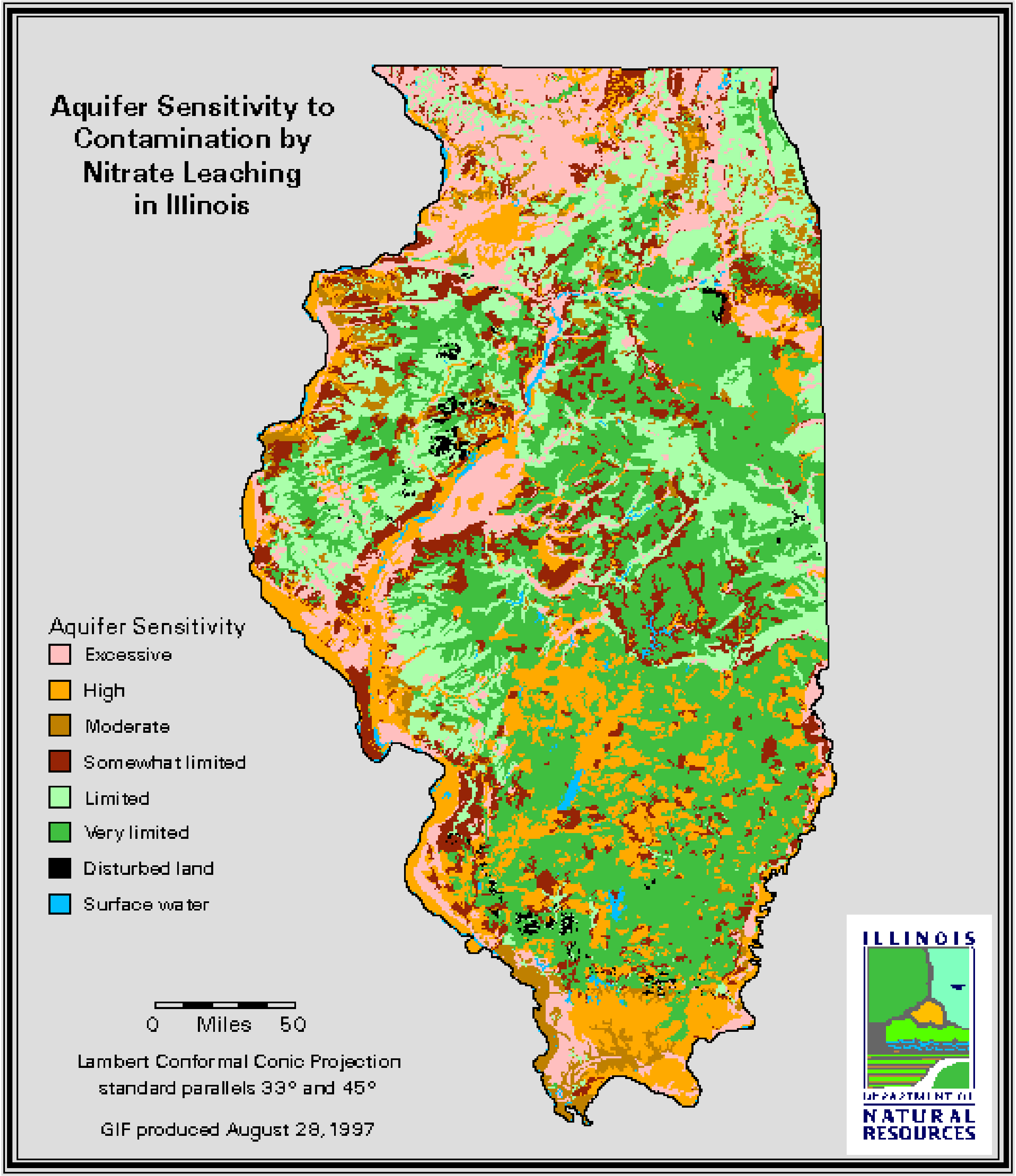


after A.H. Heggenstaller

Average annual flow-weighted nitrate-N concentration of drainage water for 2002-2005



Kaspar et al. J. Environ. Qual. 36:1503-1511



This is not just a problem in the Gulf of Mexico!

~ 14 % of wells in IL are contaminated with excessive nitrate

Impact of cover crops on soybean cyst nematodes

Site	Bare	Cereal Rye	Ryegrass
		Egg count	
1	7533	717*	117**
2	3650	320*	0**
3	1559	722*	386*
4	1202	390*	279*

* Significant .05   ** Significant .01

M Plumer

2 years /3 replications

Bulk density (g/cm^3)

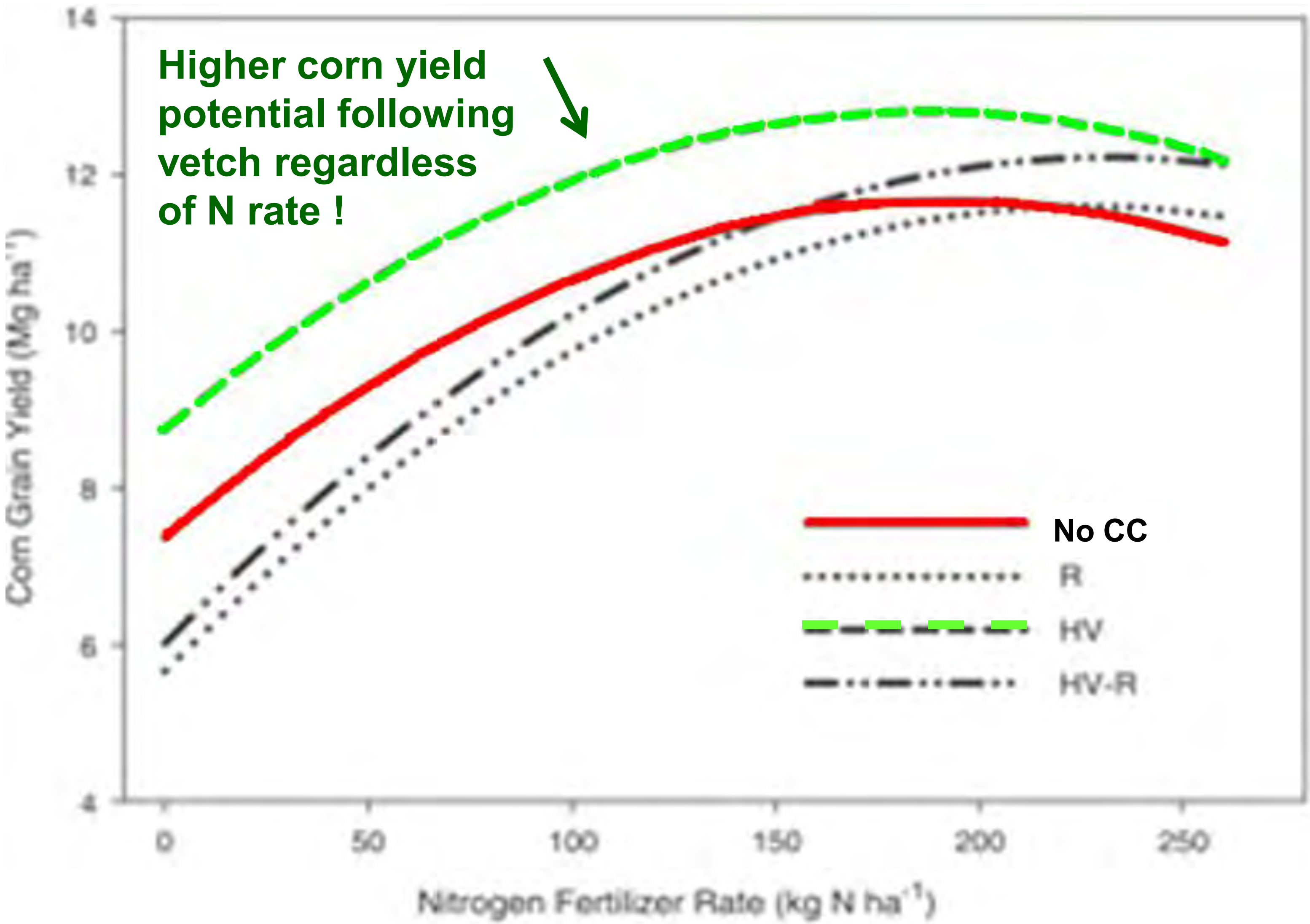
all no-tilled 9+ years

	Ryegrass cover crop for 6 years	No cover crop
10”	1.49*	1.66
16”	1.58	1.54
24”	1.48*	1.65

M Plumer

* sig. .05

Impact of hairy vetch and rye cover crops on corn yield in IL




Innovative
Cover Cropping


Are you a
cover crop
innovator?


If not, are you ready to become a cover crop innovator?

Closing Thoughts

"The best way to farm hasn't been invented. I reserve the right to change my mind tomorrow."

Dick Thompson