Cover crops, tillage and soil quality

Dr. Joel Gruver
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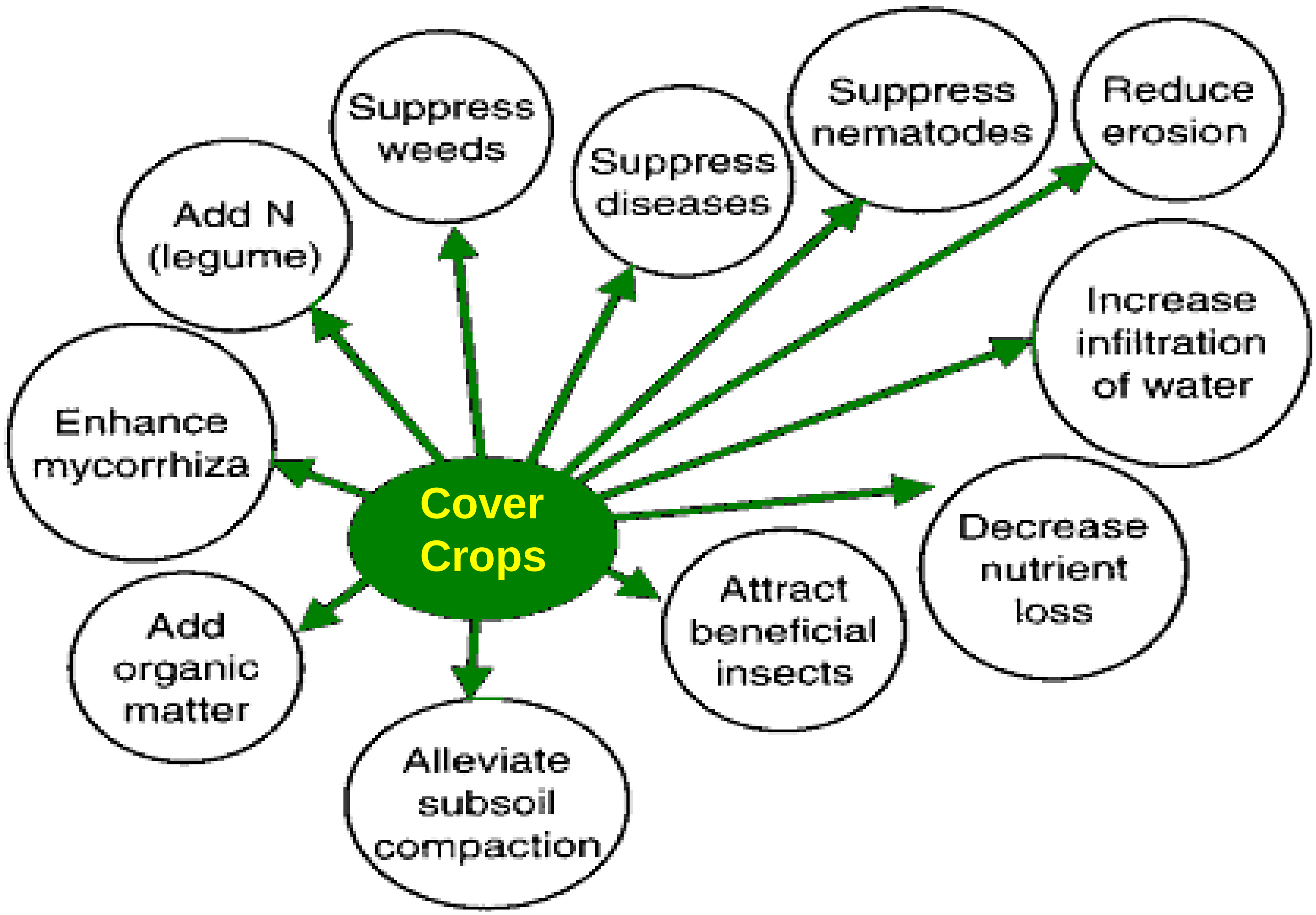
Cover crops are multi-functional

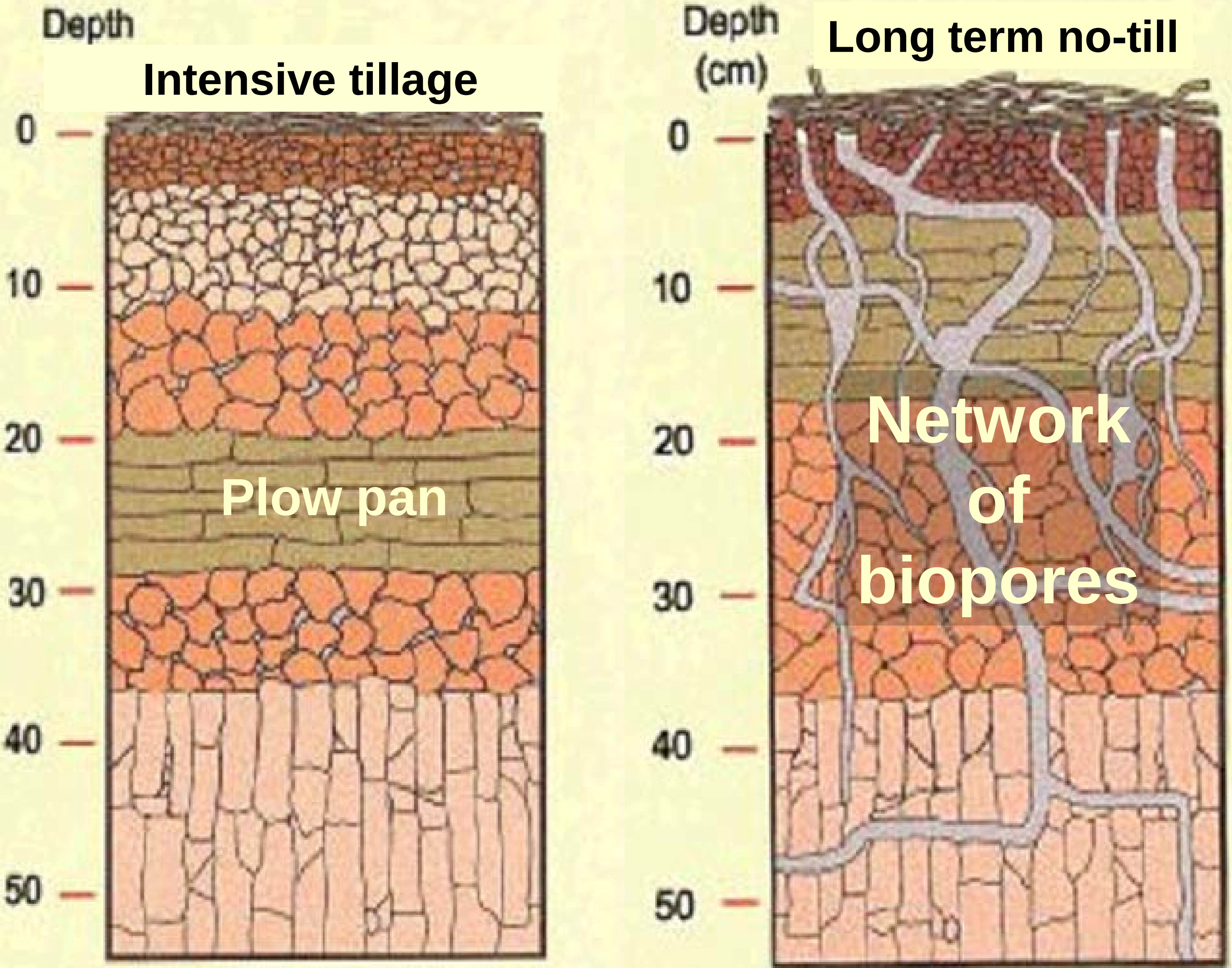


Adapted from Magdoff and Weil (2004)

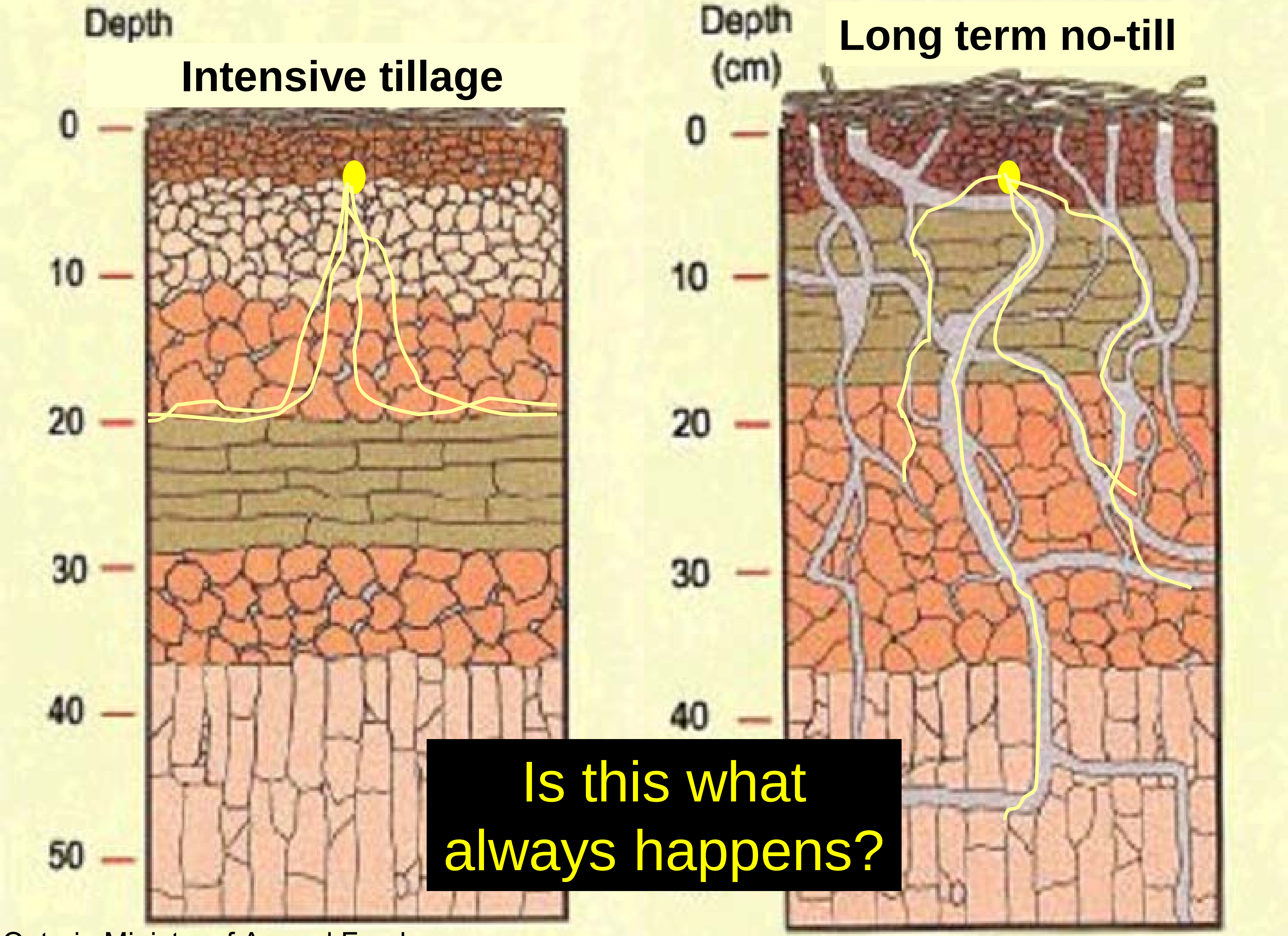
Most ag inputs have 1 target effect

Adapted from Magdoff and Weil (2004)


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



Ontario Ministry of Ag and Food



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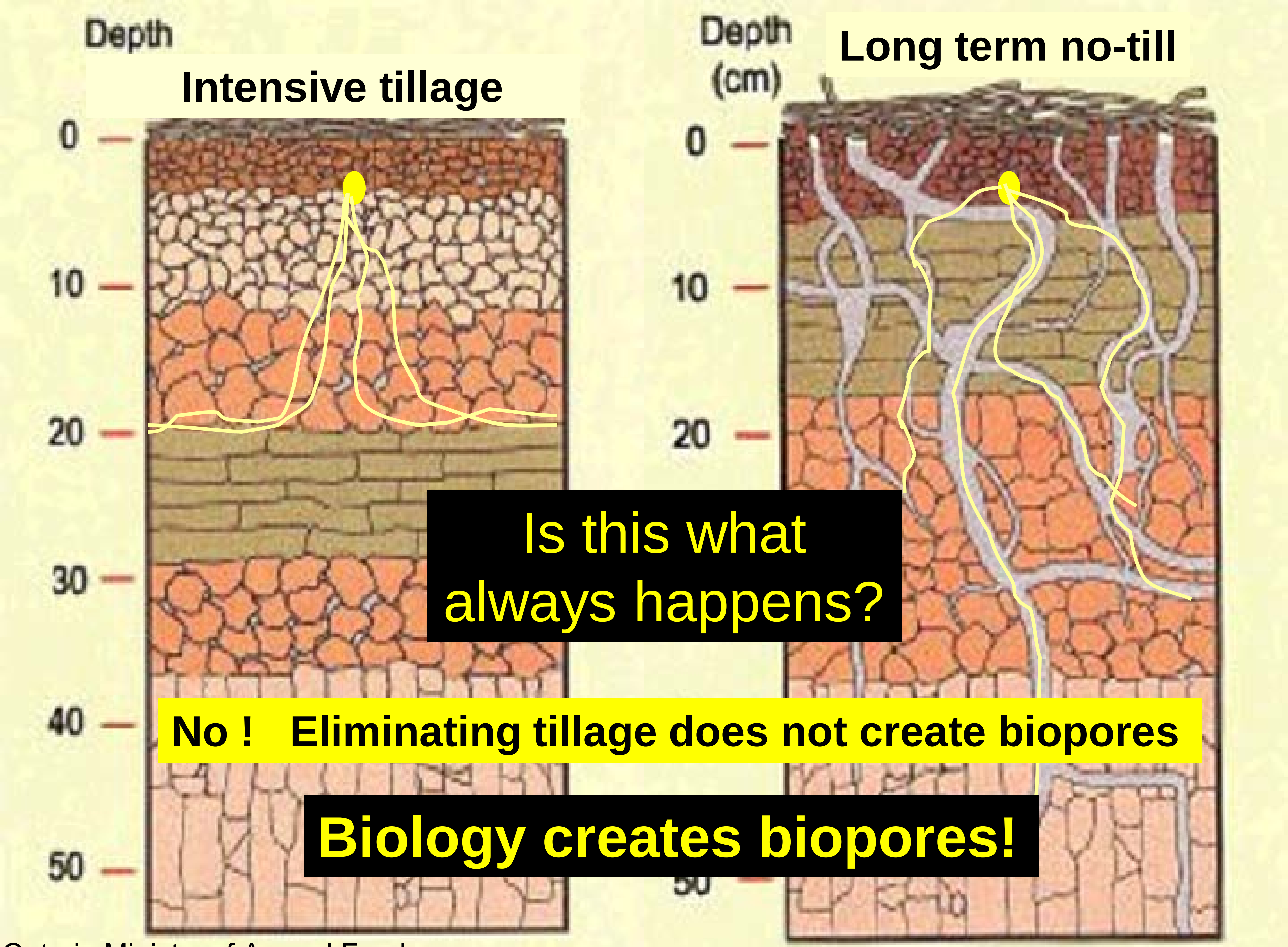

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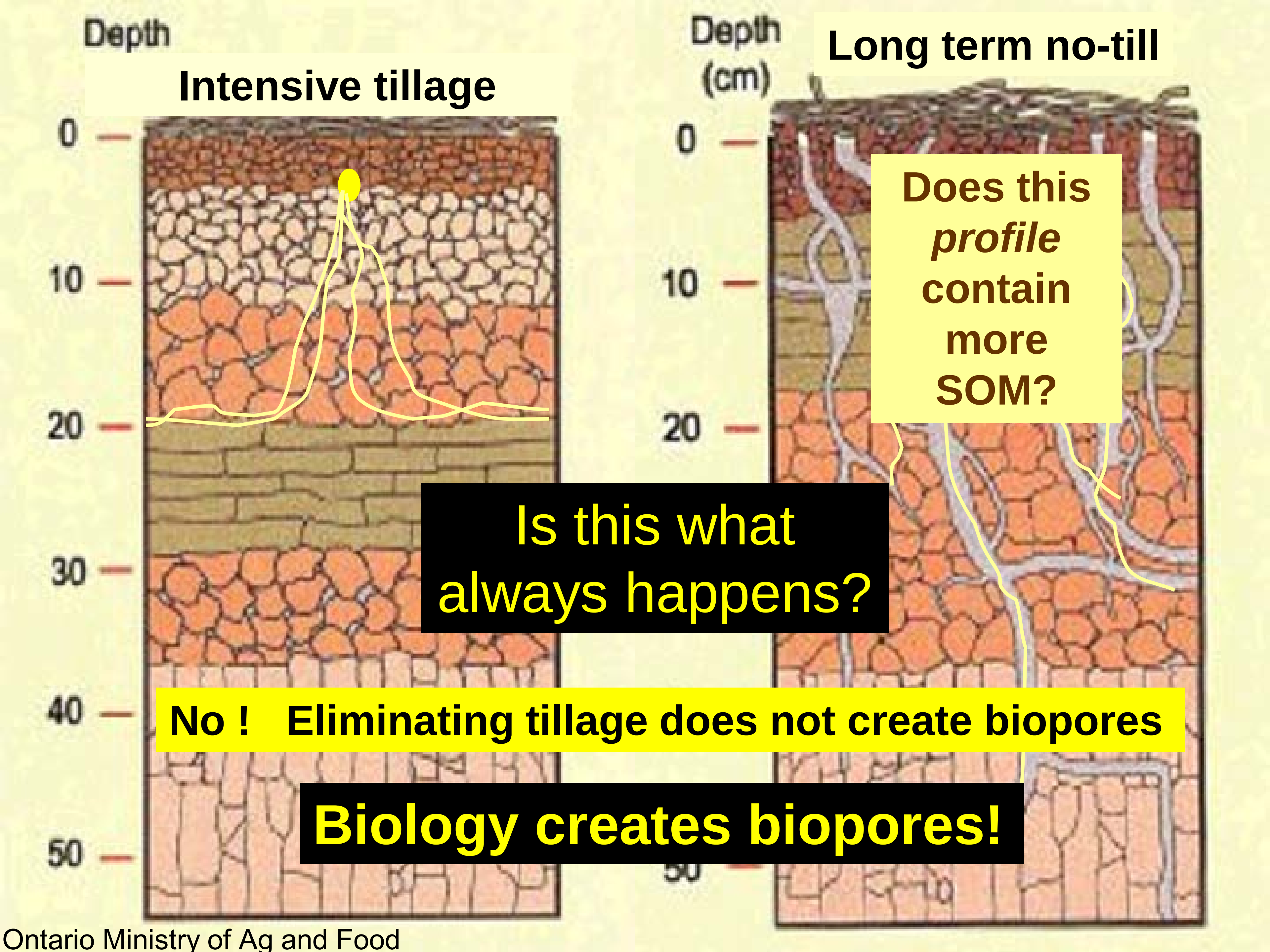
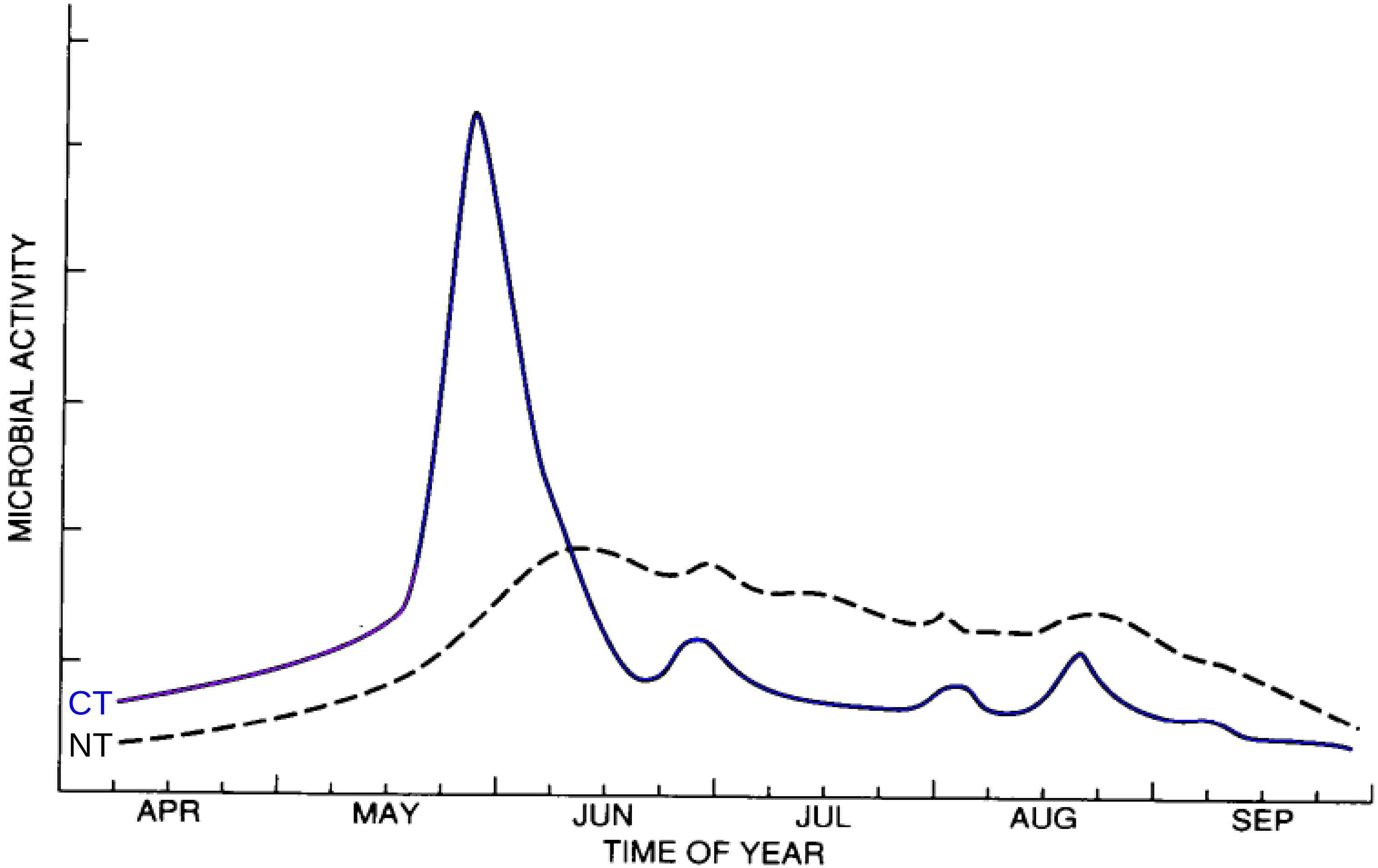
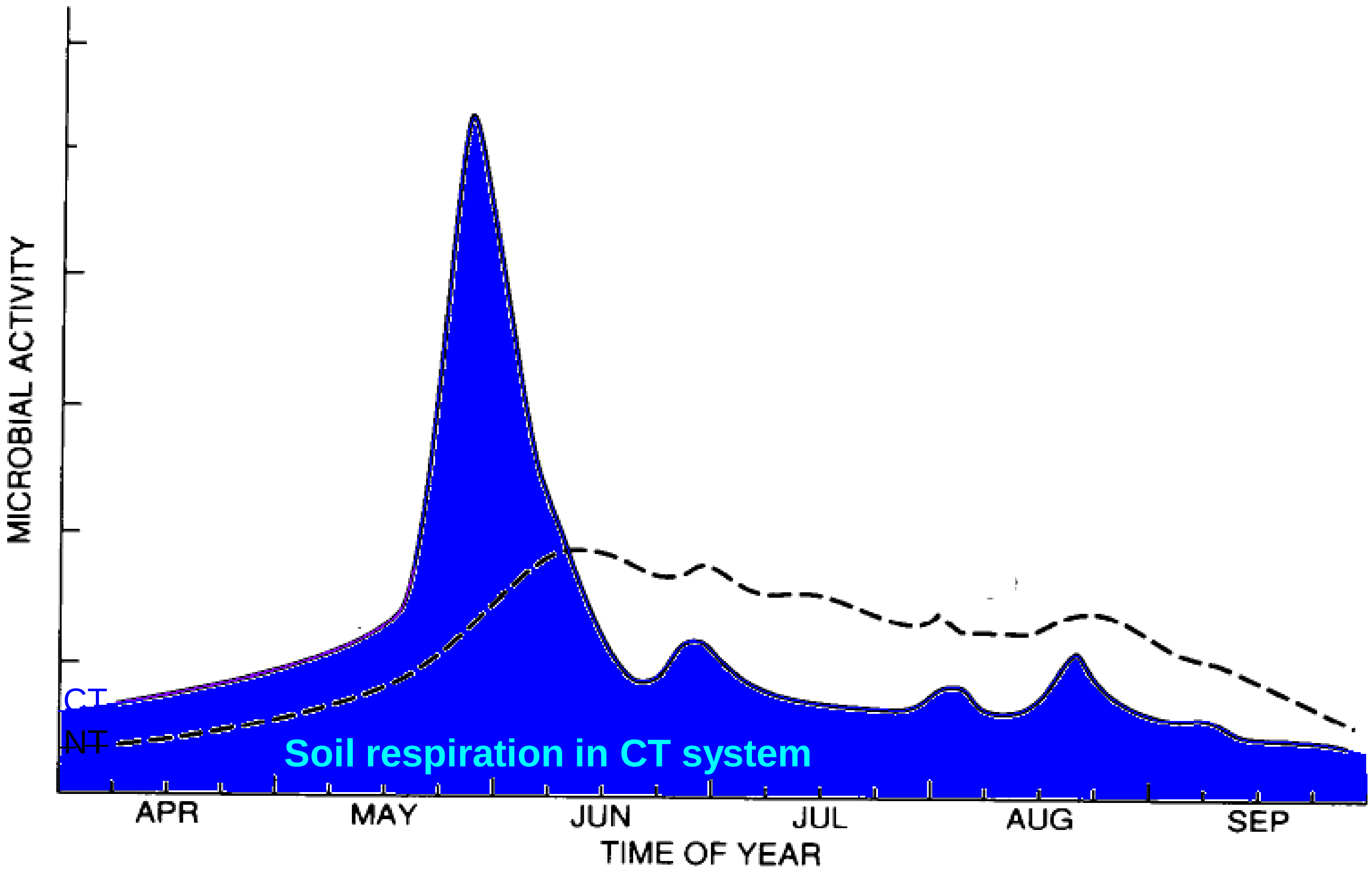

Depth
Intensive tillage
0
10
20
30
40
50
Depth (cm)
Long term no-till
0
10
20
Does this *profile* contain more SOM?
Is this what always happens?
No ! Eliminating tillage does not create biopores
Biology creates biopores!
Ontario Ministry of Ag and Food

Effect of tillage on microbial activity



Havlin et al. (1999)

Effect of tillage on microbial activity



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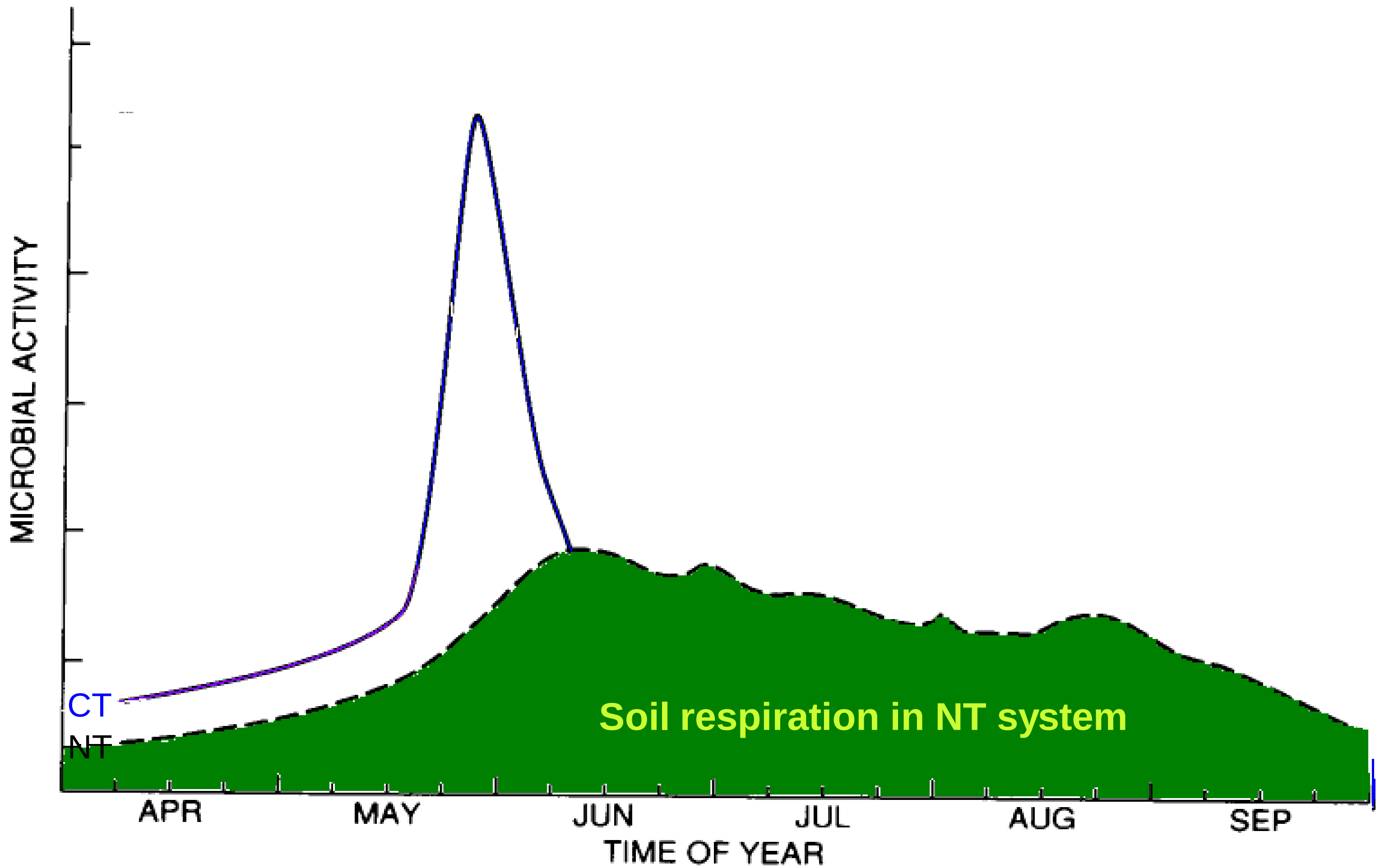

Havlin et al. (1999)

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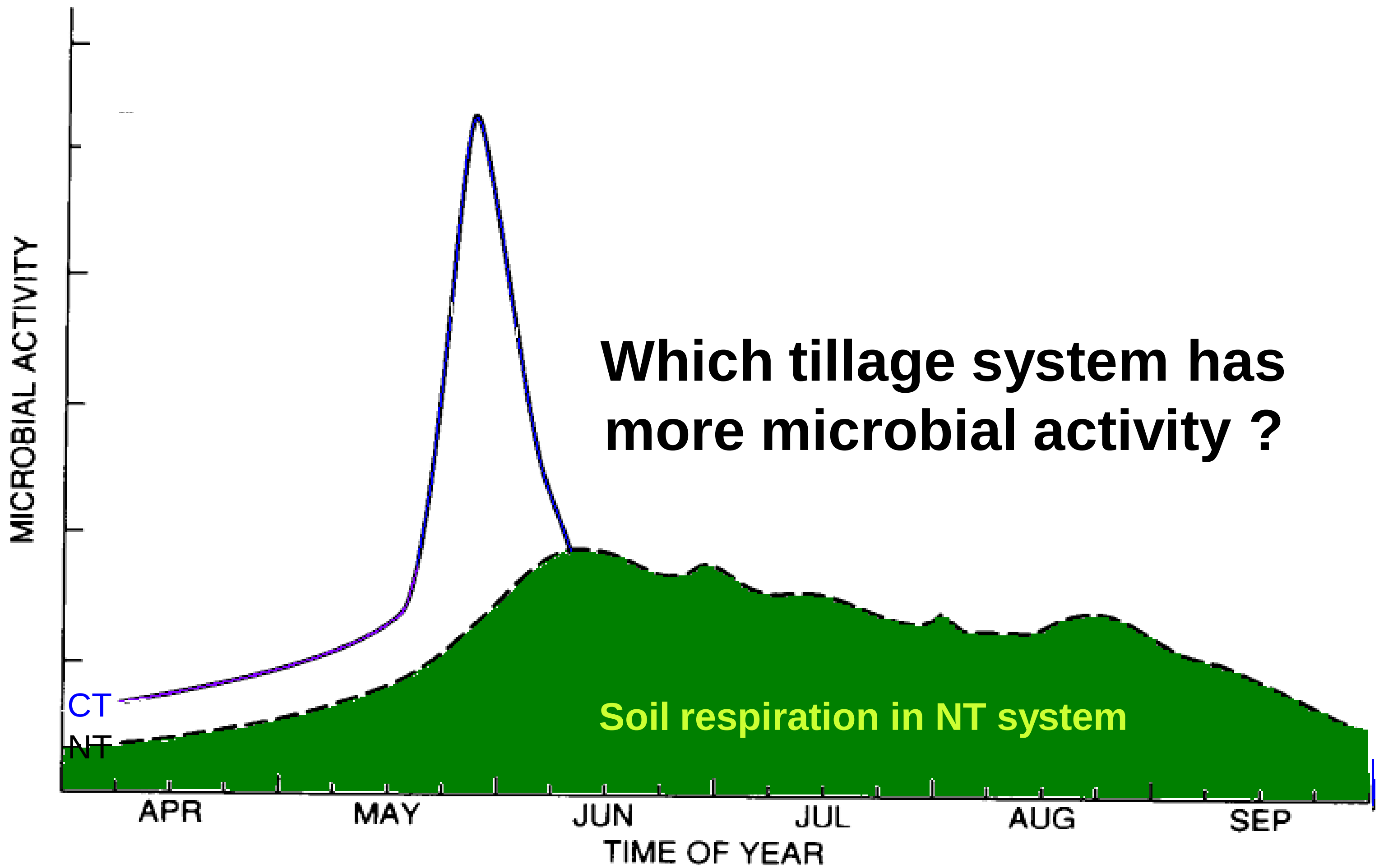
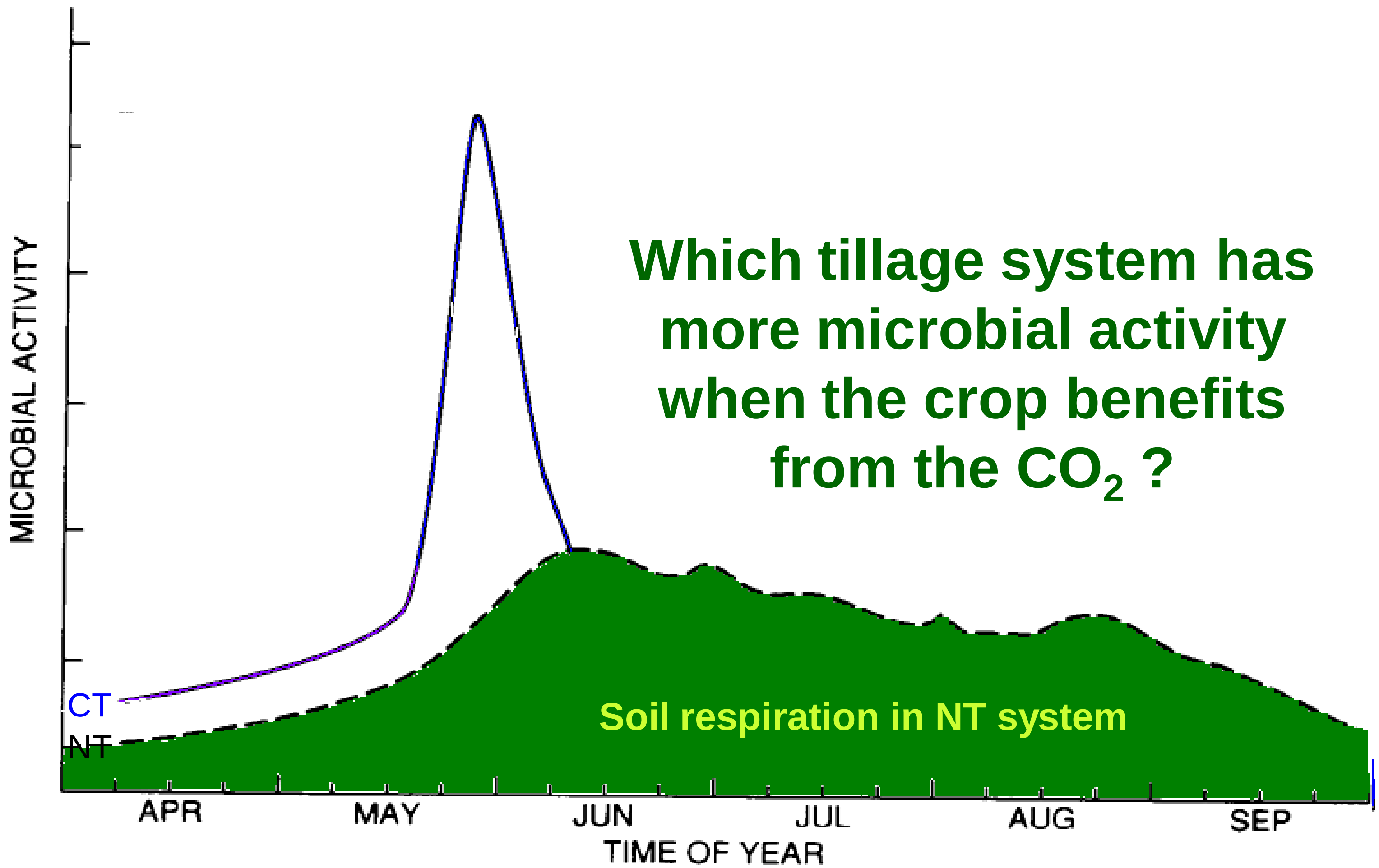


Which tillage system has more microbial activity ?

Havlin et al. (1999)

Effect of tillage on microbial activity



Havlin et al. (1999)

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Agriculture Ecosystems & Environment

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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

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Received 1 February 2006; received in revised form 24 April 2006; accepted 3 May 2006
Available online 27 June 2006

Abstract

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, even though crop roots often extend much deeper. In the few studies where sampling extended deeper than 30 cm, conservation tillage has shown no consistent accrual of SOC, instead showing a difference in the distribution of SOC, with higher concentrations near the surface in conservation tillage and higher concentrations in deeper layers under conventional tillage. These contrasting results may be due to tillage-induced differences in thermal and physical conditions that affect root growth and distribution. Long-term, continuous gas exchange measurements have also been unable to detect C gain due to reduced tillage. Though there are other good reasons to use conservation tillage, evidence that it promotes C sequestration is not compelling.

Keywords: Carbon sequestration; Tillage; Organic matter; Sampling depth

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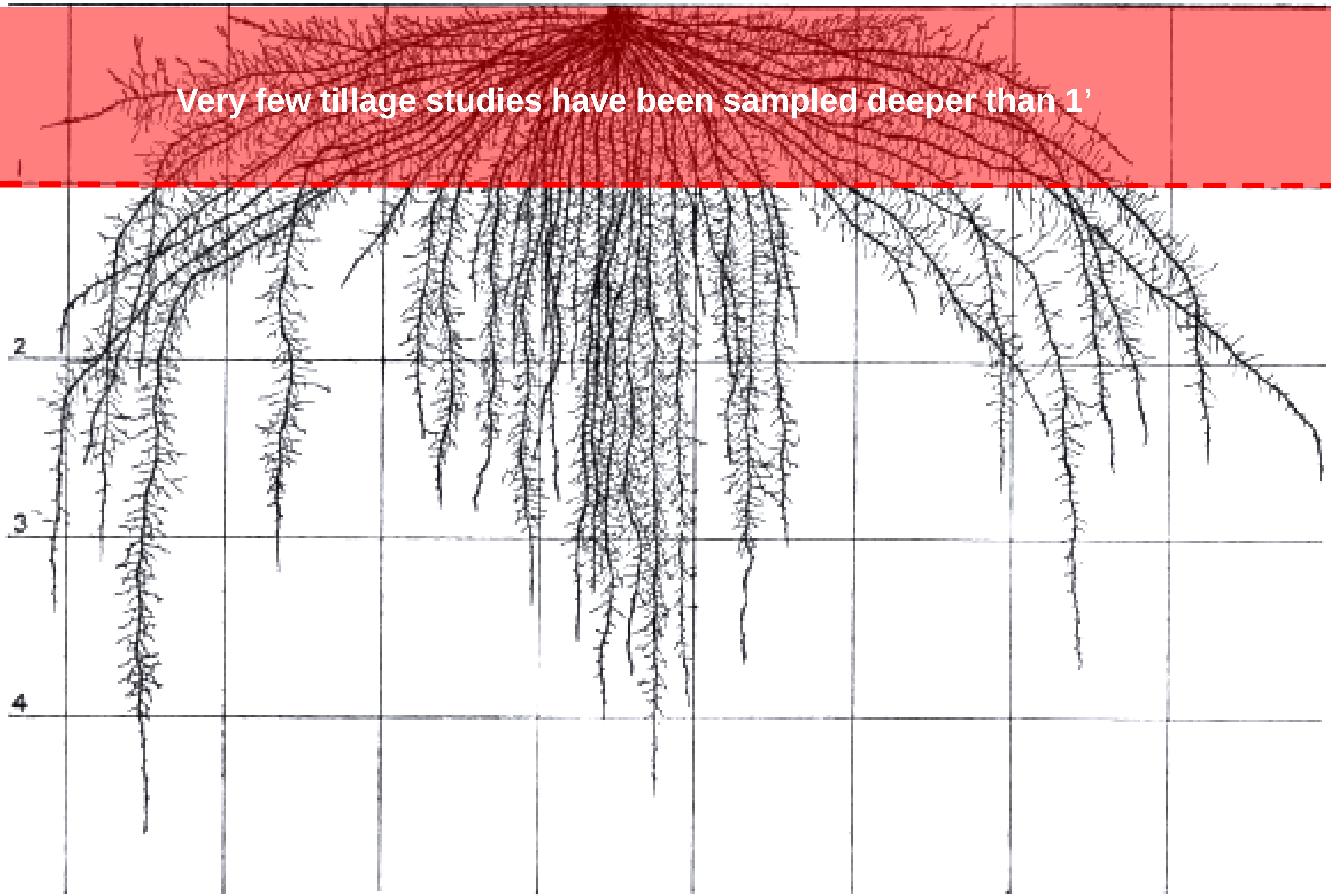
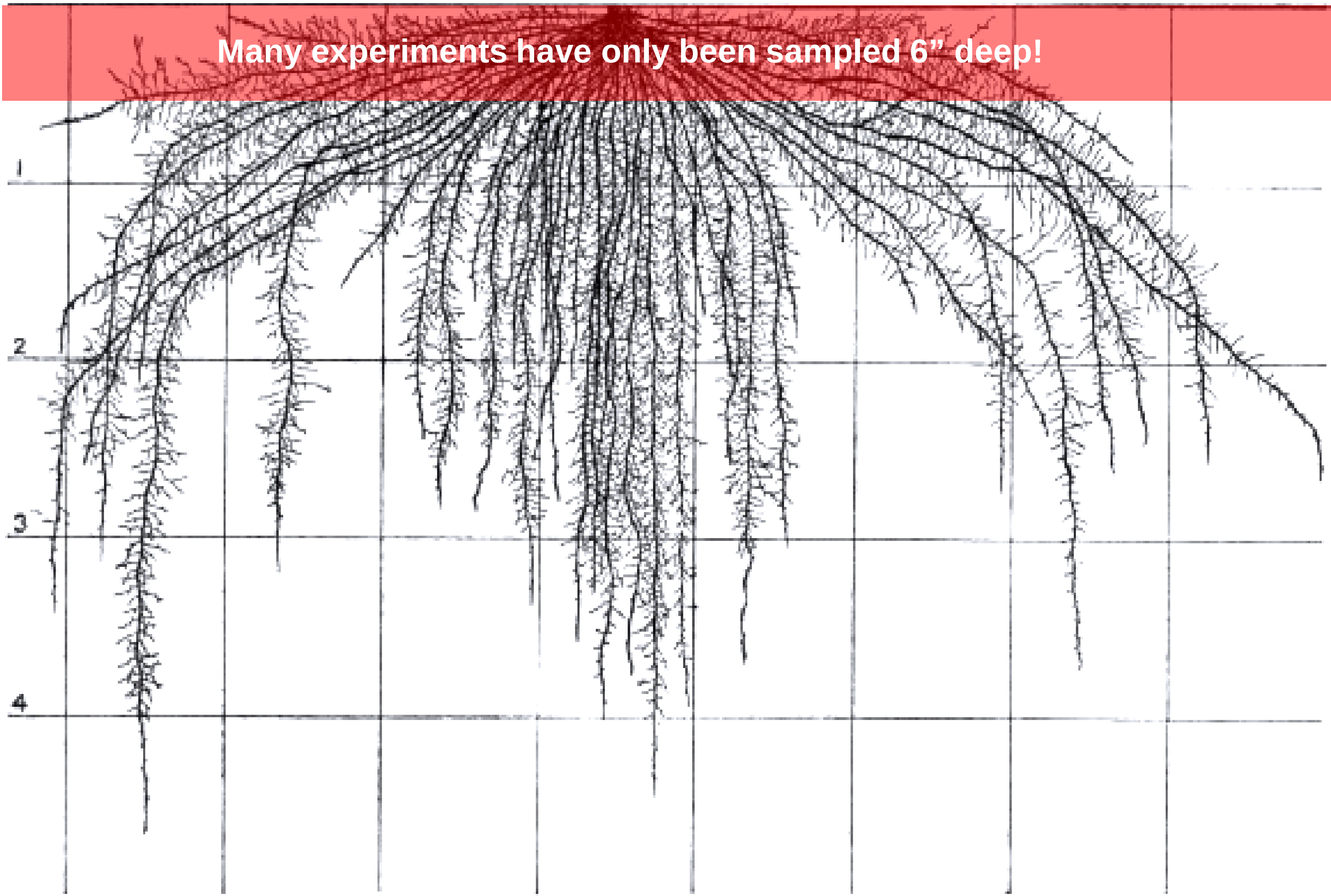


Very few tillage studies have been sampled deeper than 1’
1
2
3
4


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

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

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. These findings implicate fertilizer N in promoting 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 a serious decline in their content of N and 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*

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·ha^{-1}·yr^{-1}. We evaluated the impacts on two major processes that determine the soil C balance, the rates of organic-carbon (OC) inputs and decay, at four levels of N fertilization, 0, 90, 180, and 270 kg/ha, in two long-term experimental sites in Mollisols in Iowa, USA. We compared the corn–soybean system with other experimental cropping systems fertilized with N in the corn phases only: continuous corn for grain; corn–corn-oats (*Avena 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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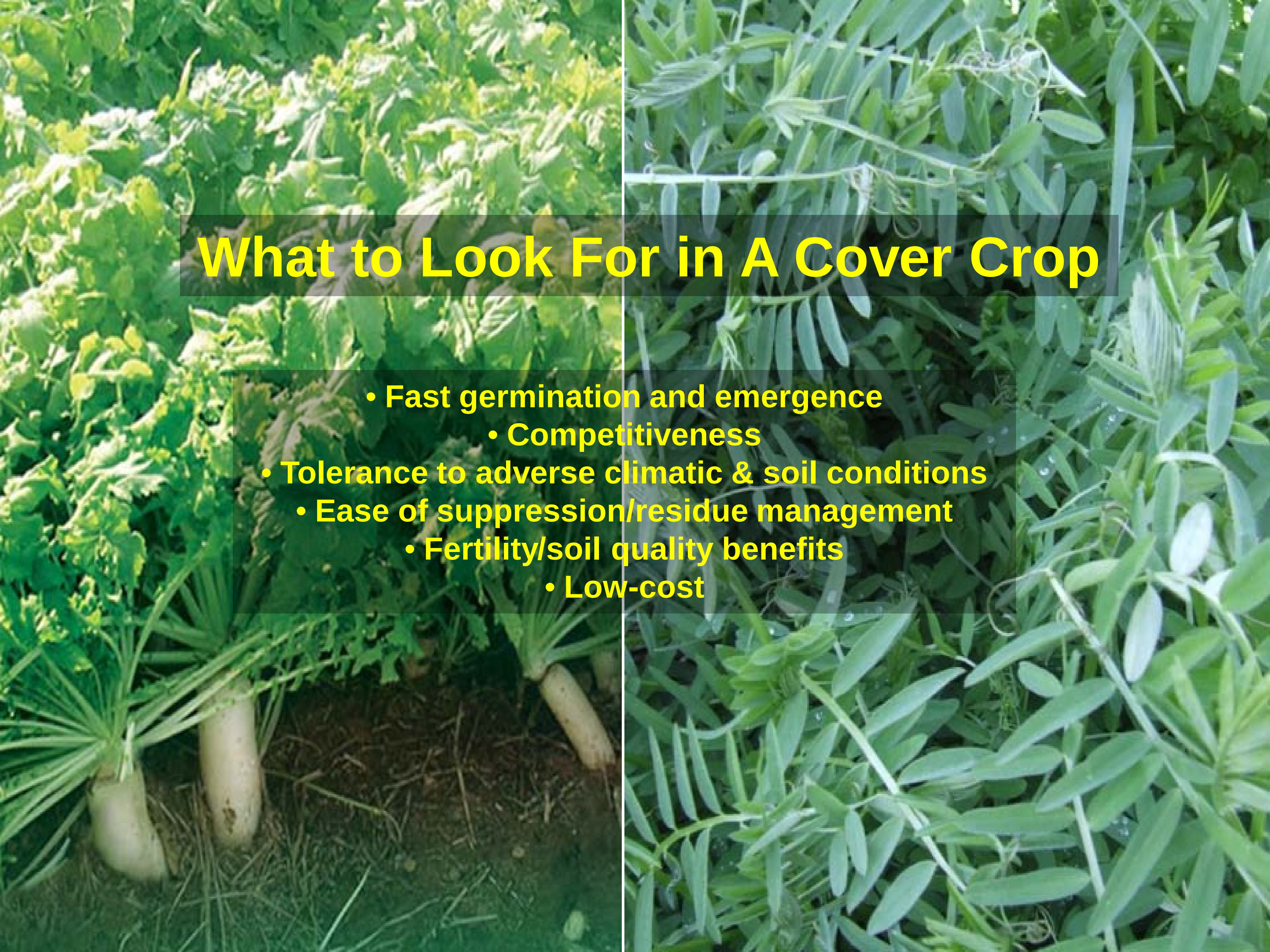
Cover crops are a great way to add more belowground organic inputs to cropping systems

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.*


20 years of similar tillage intensity and C inputs

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


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*

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?
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?
What's my contingency plan—and risks—if the cover crop doesn't establish or doesn't die on schedule?
Do I have the needed equipment and labor?

Other key considerations

Be realistic about potential cover crop challenges

Managing cover crops profitably, 3rd edition

Chart 3A CULTURAL TRAITS

	Species	Aliases	Type[1]	Hardy through Zone[2]	Tolerances: heat	drought	shade	flood	low fert	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
NONLEGUMES	Barley *p. 77*		WA	7						U	6.0–8.5	F, W, Sp	38F
NONLEGUMES	Oats *p. 93*	spring oats	CSA	8						U	4.5–7.5	LSu, ESp W in 8+	38F
NONLEGUMES	Rye *p. 98*	winter, cereal, or grain rye	CSA	3						U	5.0–7.0	LSu, F	34F
NONLEGUMES	Wheat *p. 111*		WA	4						U	6.0–7.5	LSu, F	38F
NONLEGUMES	Buckwheat *p. 90*		SA	NFT						U/SU SU	5.0–7.0	Sp to LSu	50F
NONLEGUMES	Sorghum–sudan. *p. 106*	Sudax	SA	NFT						U	6.0–7.0	LSp, ES	65F
BRASSICAS	Mustards *p.81*	brown, oriental white, yellow	WA, CSA	7						U	5.5–7.5	Sp, LSu	40F
BRASSICAS	Radish *p. 81*	oilseed, Daikon, forage radish	CSA	6						U	6.0–7.5	Sp, LSu, EF	45F
BRASSICAS	Rapeseed *p. 81*	rape, canola	WA	7						U	5.5–8	F, Sp	41F
LEGUMES	Berseem clover *p. 118*	BIGBEE, multicut	SA, WA	7						U/SU SU	6.2–7.0	ESp, EF	42F
LEGUMES	Cowpeas *p. 125*	crowder peas, southern peas	SA	NFT						SU/C	5.5–6.5	ESu	58F
LEGUMES	Crimson clover *p. 130*		WA, SA	7						U/SU	5.5–7.0	LSu/ESu	
LEGUMES	Field peas *p. 135*	winter peas, black peas	WA	7						C	6.0–7.0	F, ESp	41F
LEGUMES	Hairy vetch *p. 142*	winter vetch	WA,CSA	4						C	5.5–7.5	EF, ESp	60F
LEGUMES	Medics *p. 152*		SP, SA	4/7						P/Su	6.0–7.0	EF, ESp, ES	45F
LEGUMES	Red clover *p. 159*		SP, B	4						U	6.2–7.0	LSu; ESp	41F
LEGUMES	Subterranean cl. *p. 164*	subclover	CSA	7						P/SP	5.5–7.0	LSu, EF	38F

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	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*	w									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*	br w									5.5–7.5	Sp, LSu	40F
	Radish *p. 81*	oil f									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*	cr se									5.5–6.5	ESu	58F
	Crimson clover *p. 130*										5.5–7.0	LSu/ESu	
	Field peas *p. 135*	v									6.0–7.0	F, ESp	41F
	Hairy vetch *p. 142*	v									5.5–7.5	EF, ESp	60F
	Medics *p. 152*										6.0–7.0	EF, ESp, ES	45F
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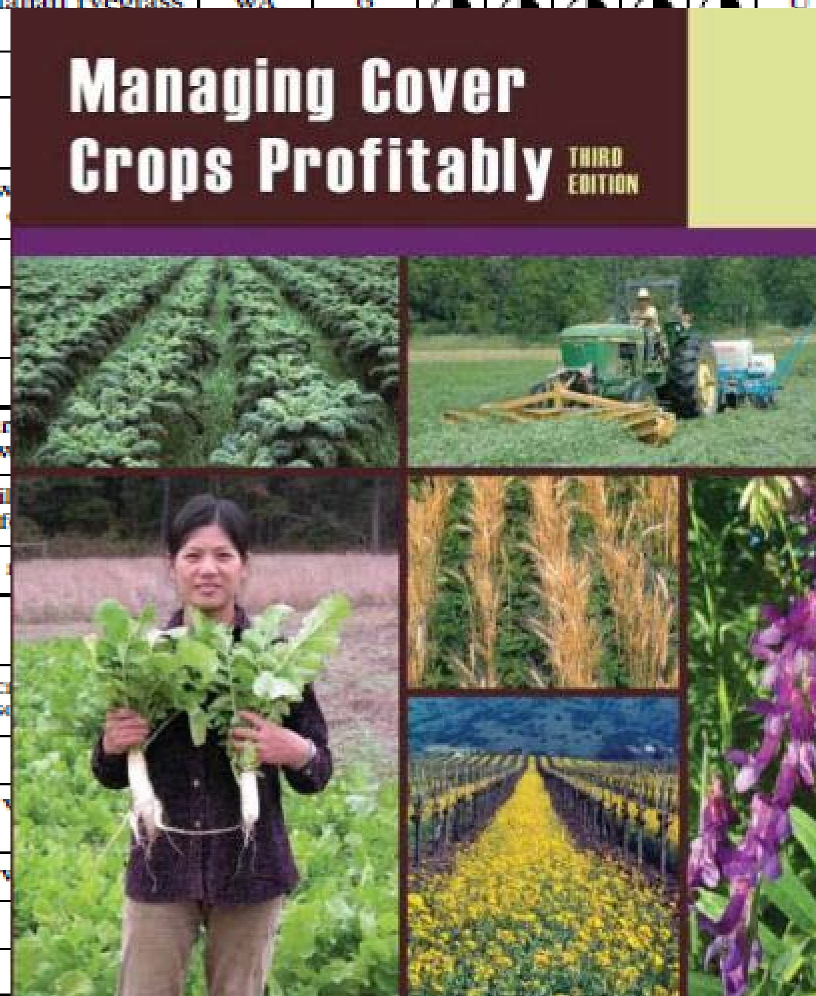
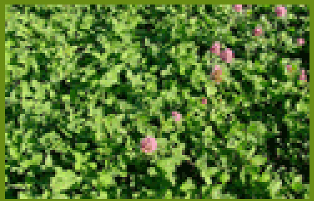


Midwest Cover Crops Council





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About Us

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Mission and vision

Supporters

MCCC meetings

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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?

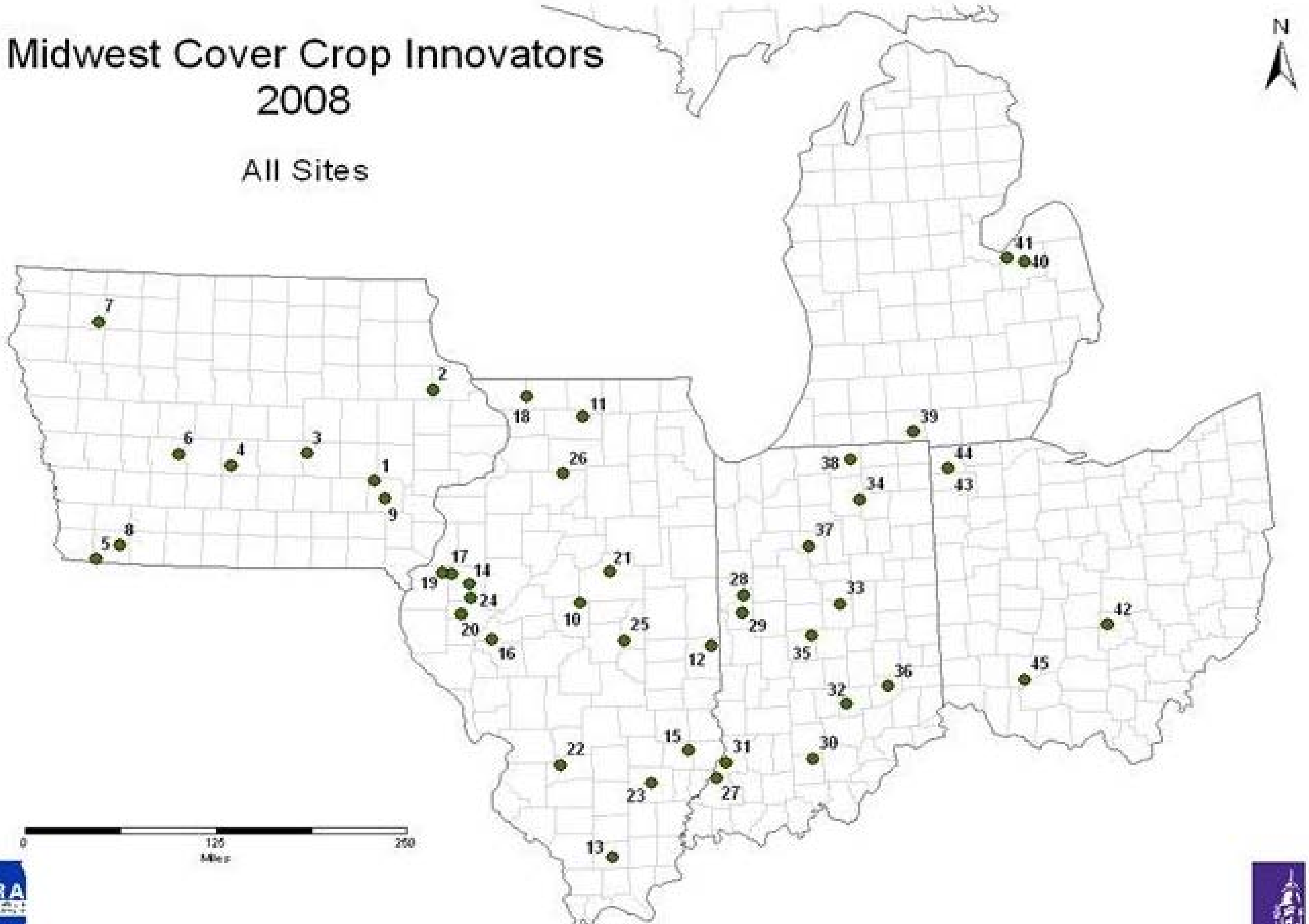
NEWS

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.

How much N can frost seeded red clover fix ??

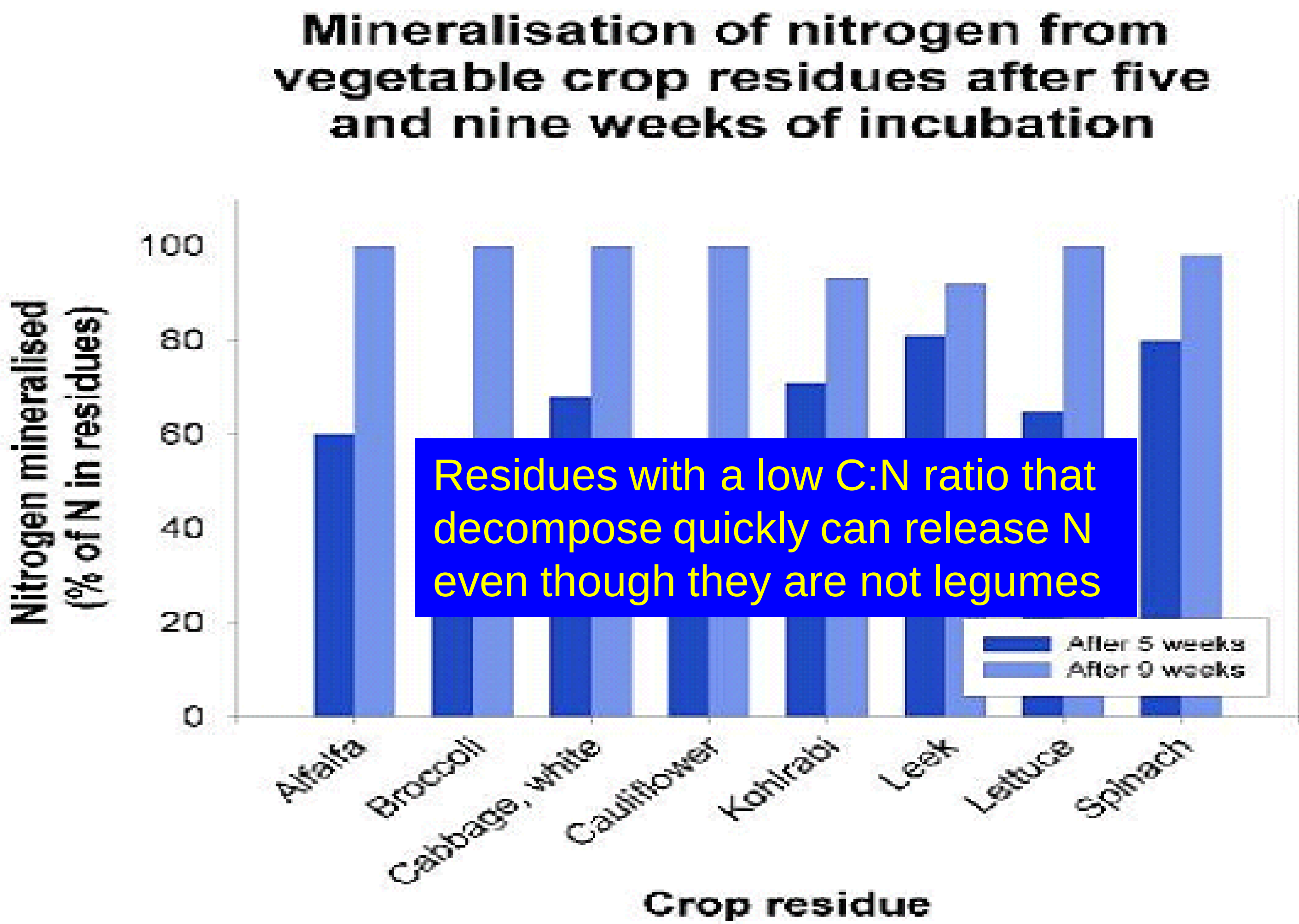
Year	Legume	Lbs. DM/a	Total lbs. N/a
1991	Red clover	4456	128
1992	Red clover	3918	110
1993	Red clover	4125	119
1994	Hairy vetch	4459	146
1995	Red clover	3407	100
1996	Red clover	5049	147
1997	Hairy vetch	2110	84
1998	Red clover	4458	109
1999	Red clover	7607*	265
Mean		4399	134

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 most 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.

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

Forage brassicas have good cover crop potential

Ethiopian

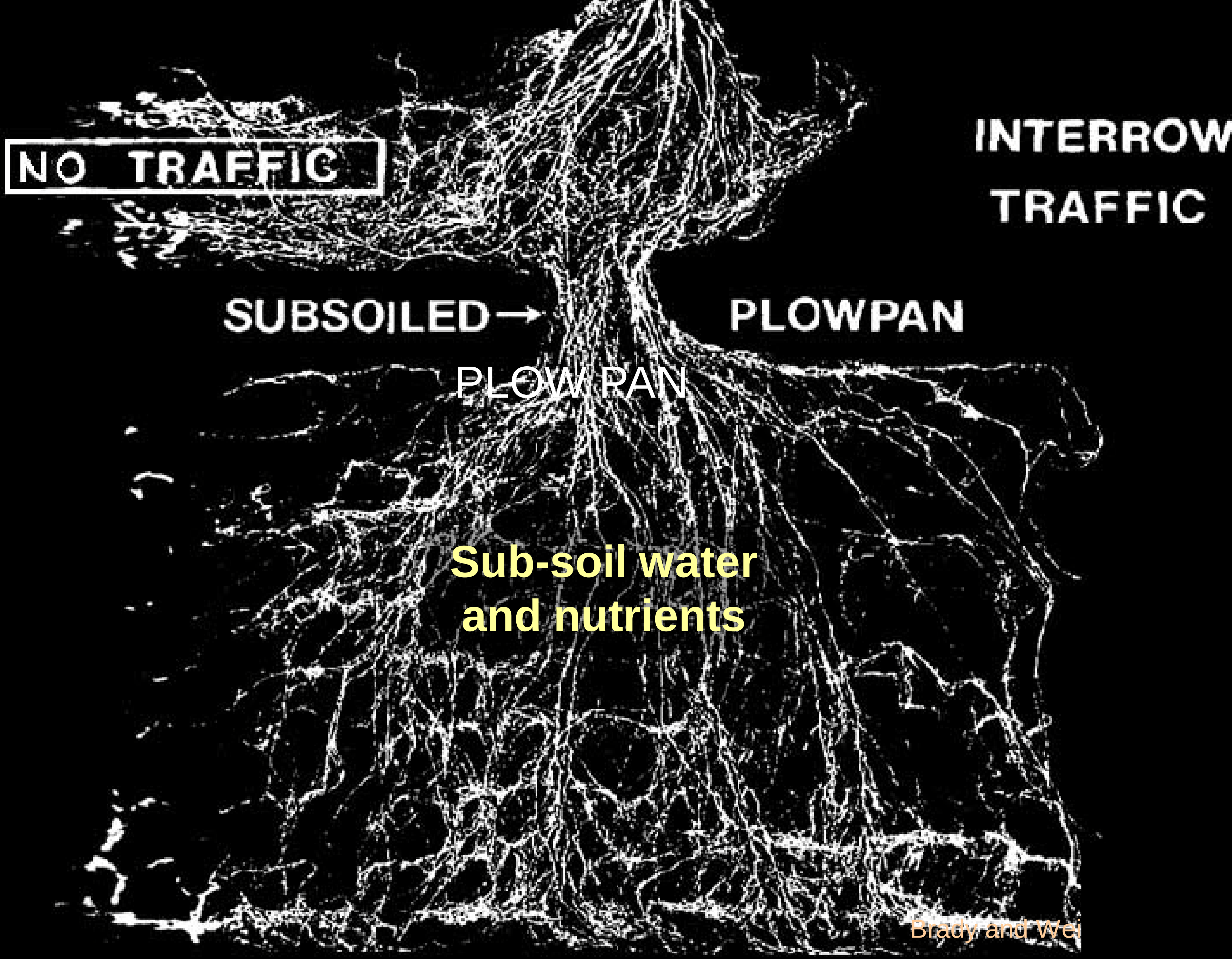
fred

Hu

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

PLOW PAN

Compacted layers can severely limit root growth


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

Which solution would you use ?

Visual evidence of biodrilling

Canola root

WIU Allison Organic Research Farm – September 2007


January


Please plant me no-till
next spring !!

The experiment was planted to corn
Blue River 66P32
30,000 seeds/acre
on May 29 2008

No N was added

Weed pressure appeared lower in the radish rows but there were no clear differences between the treatments with respect to crop appearance

Some very interesting yield results !!

Treatment	Rep	Yield monitor (bu/acre)	Trt Average
clover/oats	1	160.3	
clover/oats	2	164.3	160.8
clover/oats	3	157.9	
clover/**radish**	1	170.6	
clover/**radish**	2	178.4	174.6
clover/**radish**	3	174.7	
clover/**radish**/oats	1	179.0	
clover/**radish**/oats	2	191.4	170.2
clover/**radish**/oats	3	140.4	
radish	**1**	187.0	
radish	**2**	178.7	183.5
radish	**3**	184.8	

Some slightly less impressive but more realistic yield results !!

Treatment	Rep	Weigh wagon (bu/acre)	Trt Average
clover/oats	1	132.1	
clover/oats	2	133.9	131.9
clover/oats	3	129.6	
clover/**radish**	1	137.2	
clover/**radish**	2	144.7	142.2
clover/**radish**	3	144.7	
clover/**radish**/oats	1	145.4	
clover/**radish**/oats	2	156.5	139.5
clover/**radish**/oats	3	116.5	
radish	**1**	150.4	
radish	**2**	147.5	149.0
radish	**3**	149.0	

What is this??

What is this??

- Annual 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

Aerial Seeding Turnips, Oats and Rye
8-20-2001

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

Nov
Turni

See
T
Oats 1 Bu.
40 LBS N

00
l Rye-

15

Rye 1 1/2 Bu.
40 LBS N

11/30/00

Protein 16.59
RFV 114

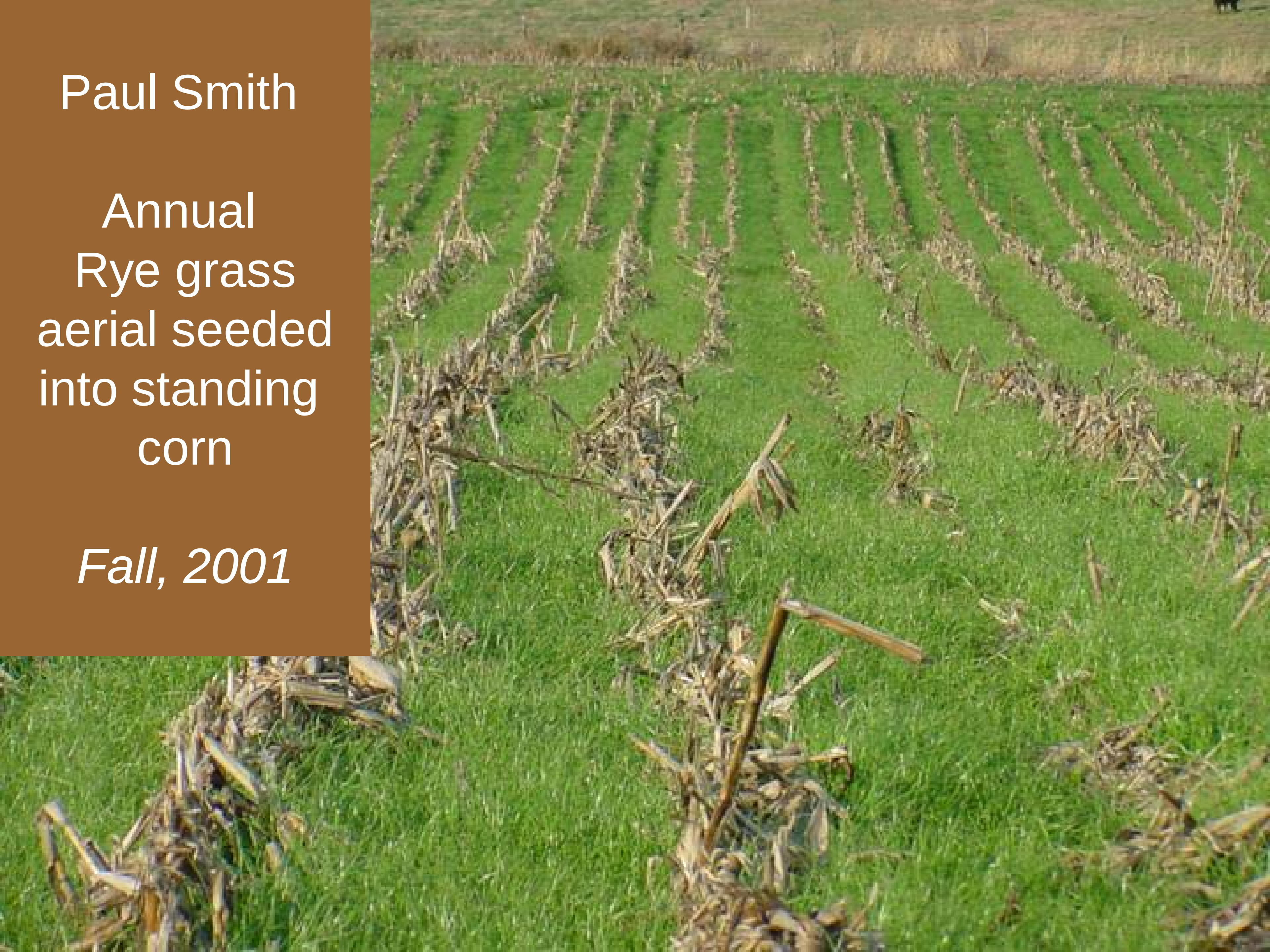
01/19/2001

Protein 12.79
RFV 92

Paul Smith

Annual
Rye grass
aerial seeded
into standing
corn

Fall, 2001



John Hebert
Inspecting
Ryegrass
No-till into
corn stubble
Fall, 2001

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.

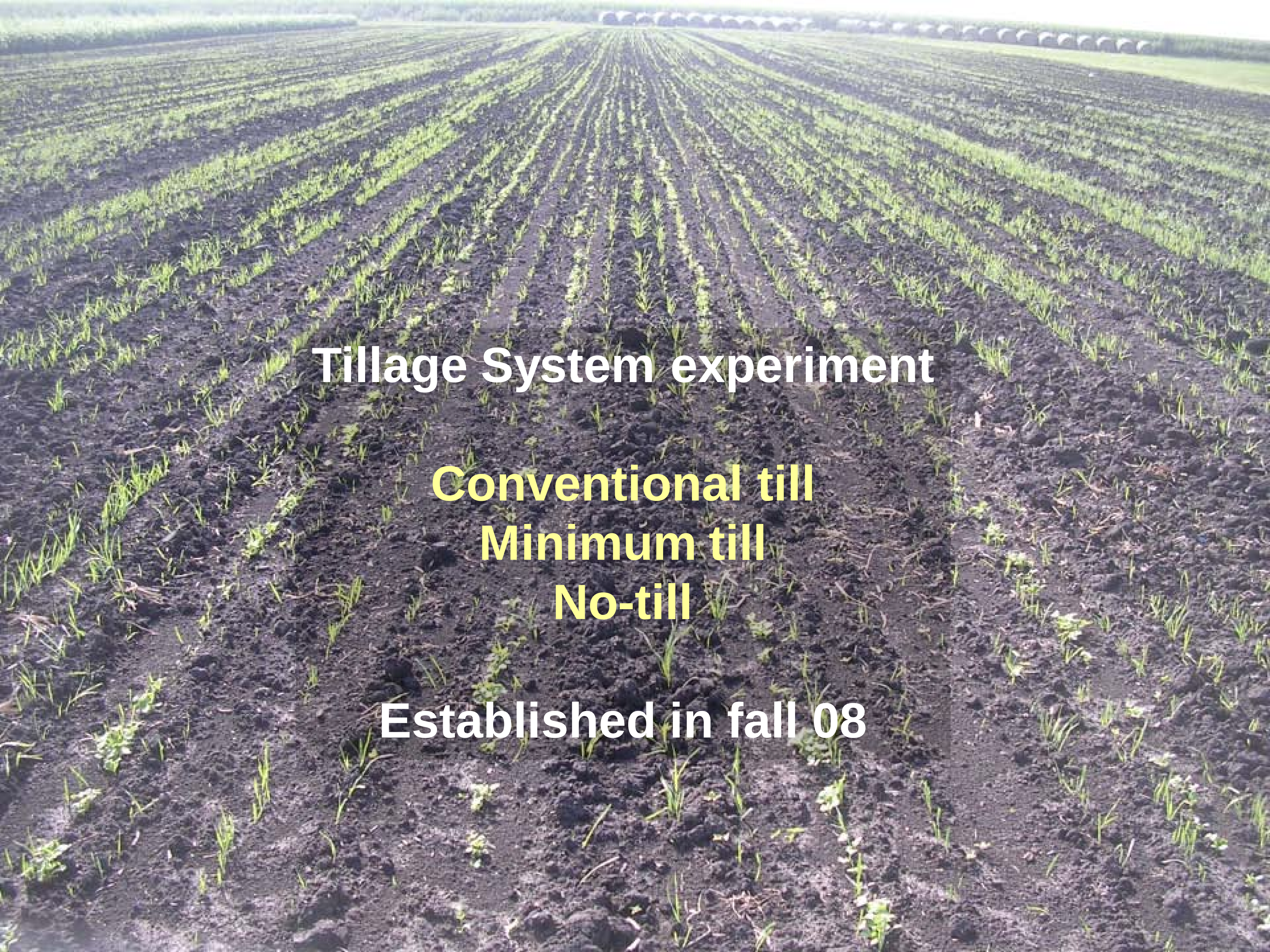
It’s hydraulic driven and has an individual hydraulic drive on each wheel, you can turn both the front and rear set of wheels. There is a variable speed drive that synchronizes the ground speed with the seed box flutes turning so the seed drop flow is coordinated with the ground speed. And you can disengage 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
Conventional till
Minimum till
No-till
Established in fall 08


September 2008


October 2008

November 2008

January 2009


March 2009

April 2009


May 2009

Late May 2009

Early June 2009

Early June 2009

Early June 2009

~1 week after planting


~2 weeks after planting

July 2009


Early August 2009

Late August 2009


Late September 2009


Early November 2009
Plot yields ranged from 51.6 to 58.6 bu/ac
No significant differences between systems

Early September 2009

Early September 2009

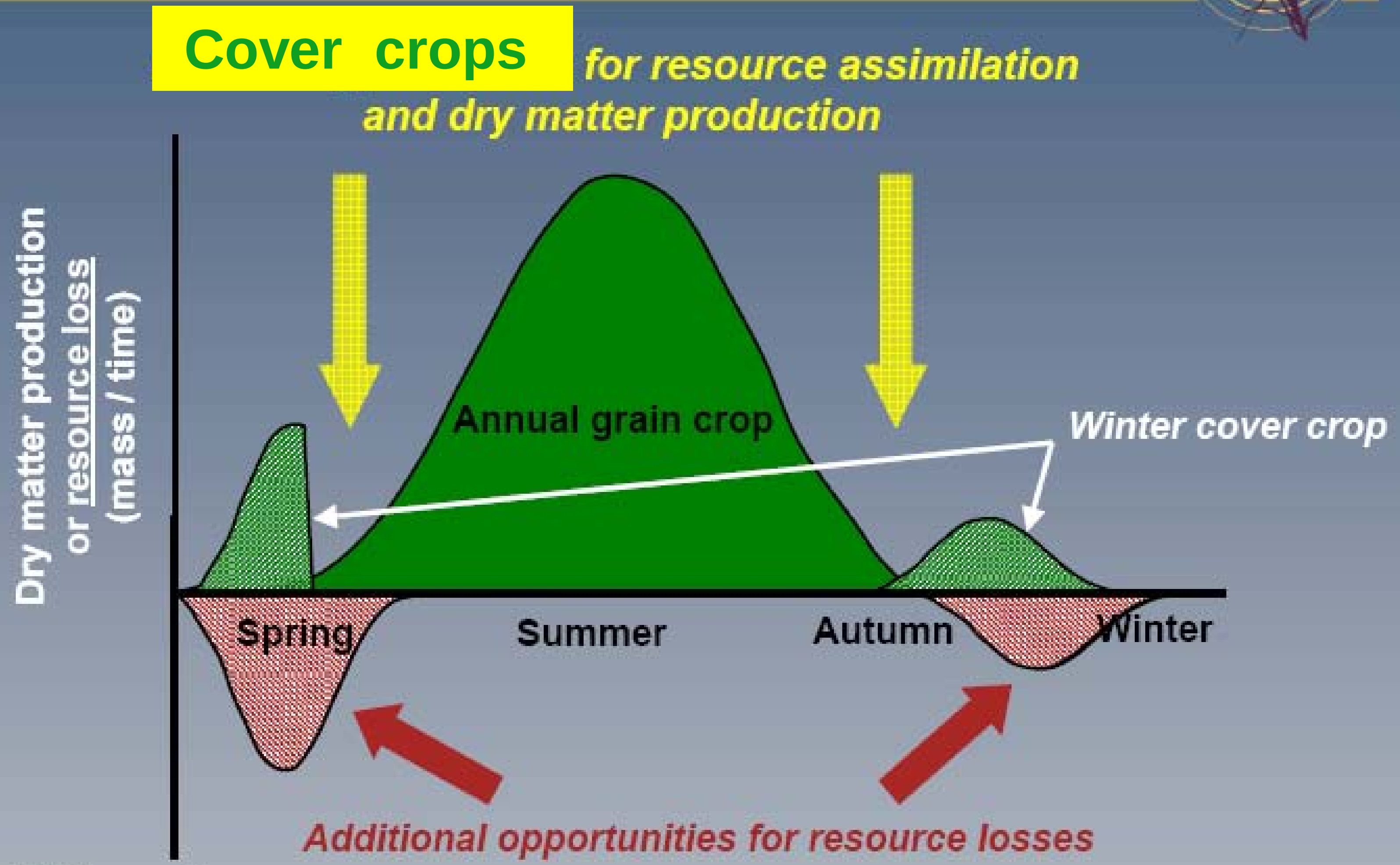
Early November 2009

Tillage radish drilled in early September (~ 10 lbs/ac)


Tillage radish on 30” rows with oats on 7.5” rows

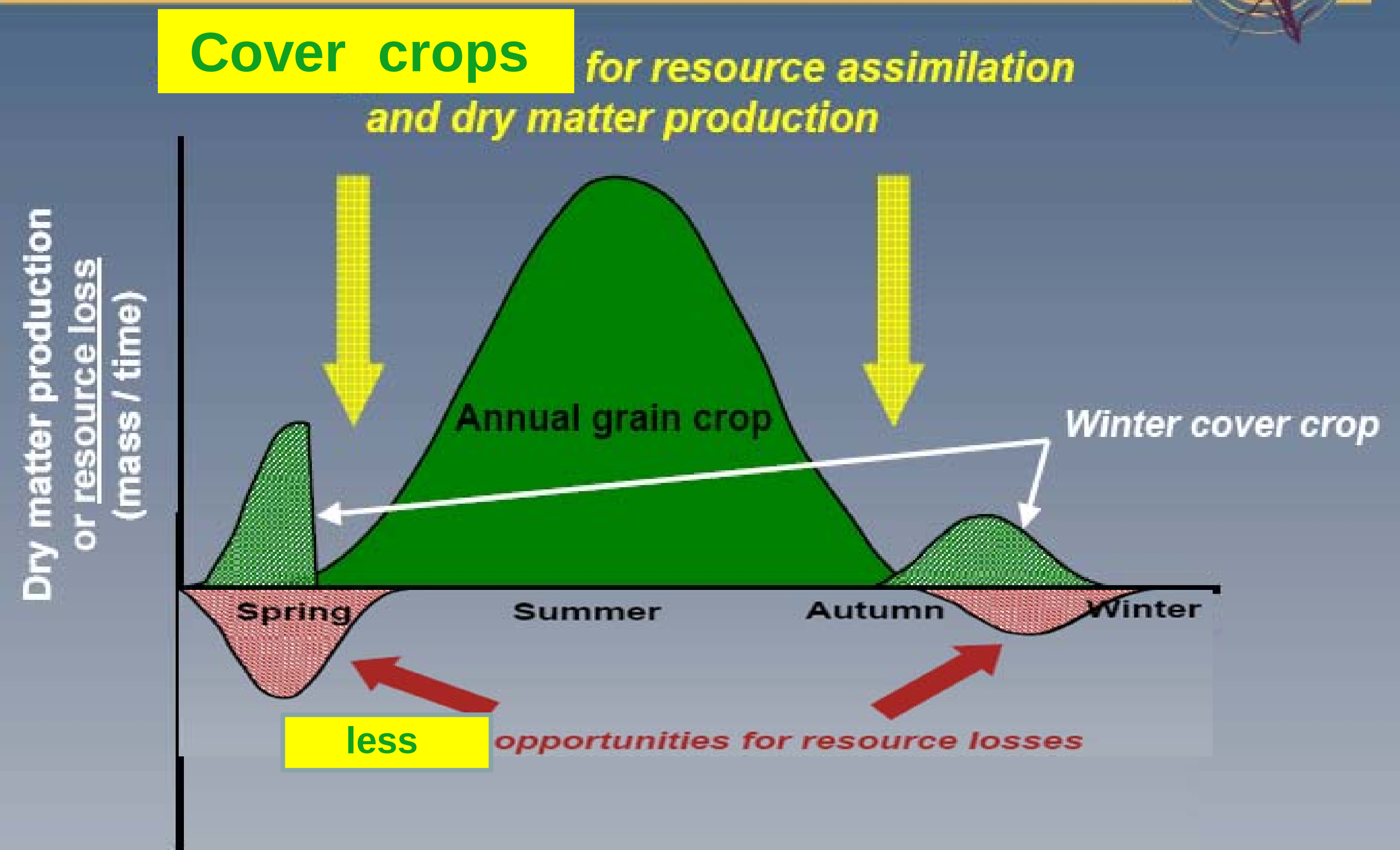
Biomass Production

Annual Cropping Systems



after A.H. Heggenstaller

Biomass Production
Annual Cropping Systems



after A.H. Heggenstaller

U of I on-farm covercrop research

(grain yields = bu/acre)

Location	Cover Crop	Grain Crop	0 lb N/ac	60 lb N/ac	180 lb N/ac	240 lb N/ac
Hortin	**Hairy Vetch**	**Corn**	**169**	$\boxed{\textbf{184}}$	**180**	**184**
Hortin	**No CC**	**Corn**	**105**	**142**	**162**	**164**
Hortin	**Rye**	**Corn**	**65**	**102**	**119**	**120**
Hortin	**Hairy Vetch**	**Sorghum**	**90**	$\boxed{\textbf{97}}$	**99**	**100**
Hortin	**No CC**	**Sorghum**	**74**	**87**	**94**	**92**
Hortin	**Rye**	**Sorghum**	**54**	**72**	**77**	**74**

http://frec.cropsci.uiuc.edu/1993/report13/table10.htm

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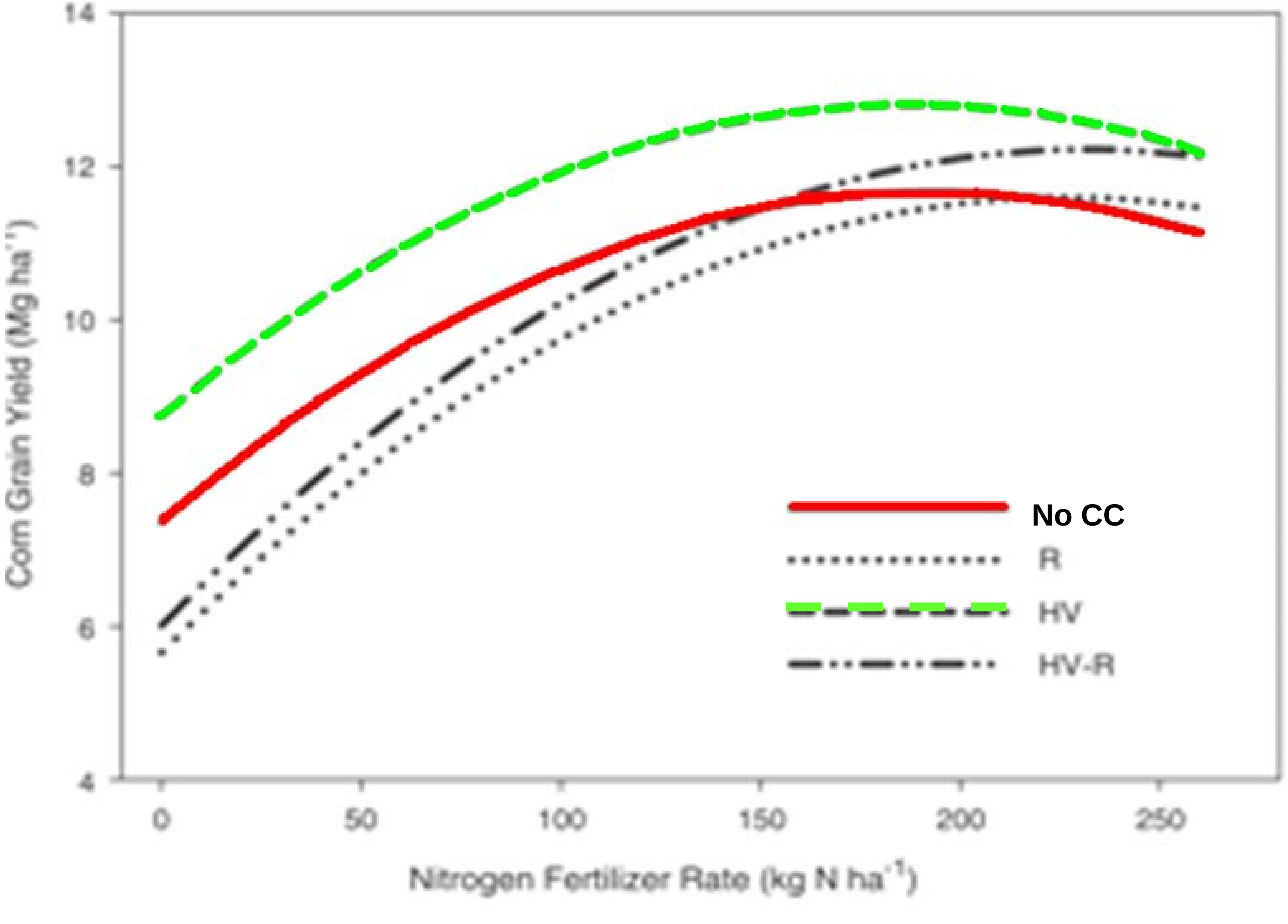
Hortin	Hairy Vetch	Corn	169	184	180	184
Hortin	No CC	Corn	105	142	162	164
Hortin	Rye	Corn	65	102	119	120
Hortin	Hairy Vetch	Sorghum	90	97	99	100
Hortin	No CC	Sorghum	74	87	94	92
Hortin	Rye	Sorghum	54	72	77	74

http://frec.cropsci.uiuc.edu/1993/report13/table10.htm

Cereal rye often suppresses corn and sorghum yields

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



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

Soil Density (g/cm^3)

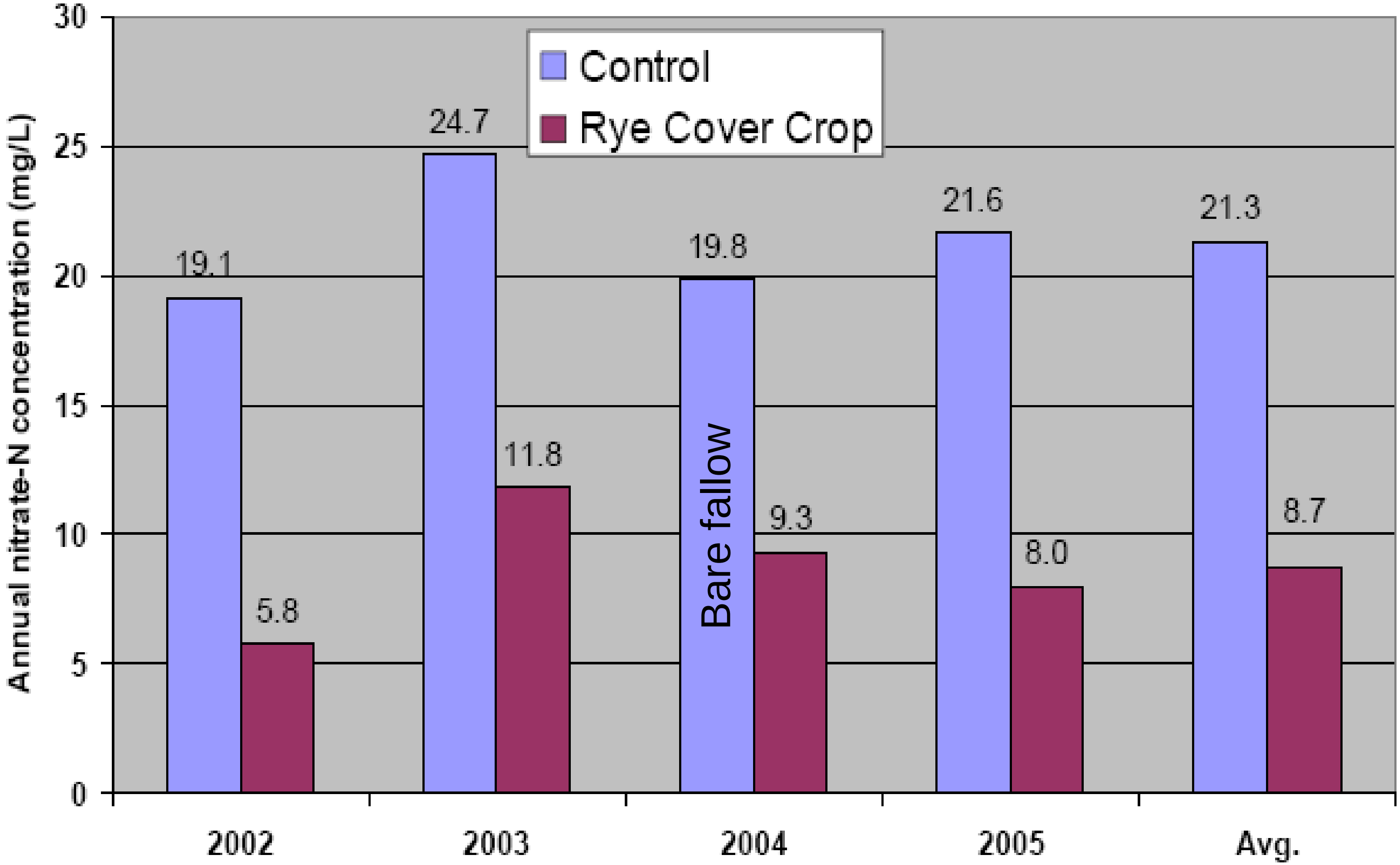
all no-tilled 9+ years

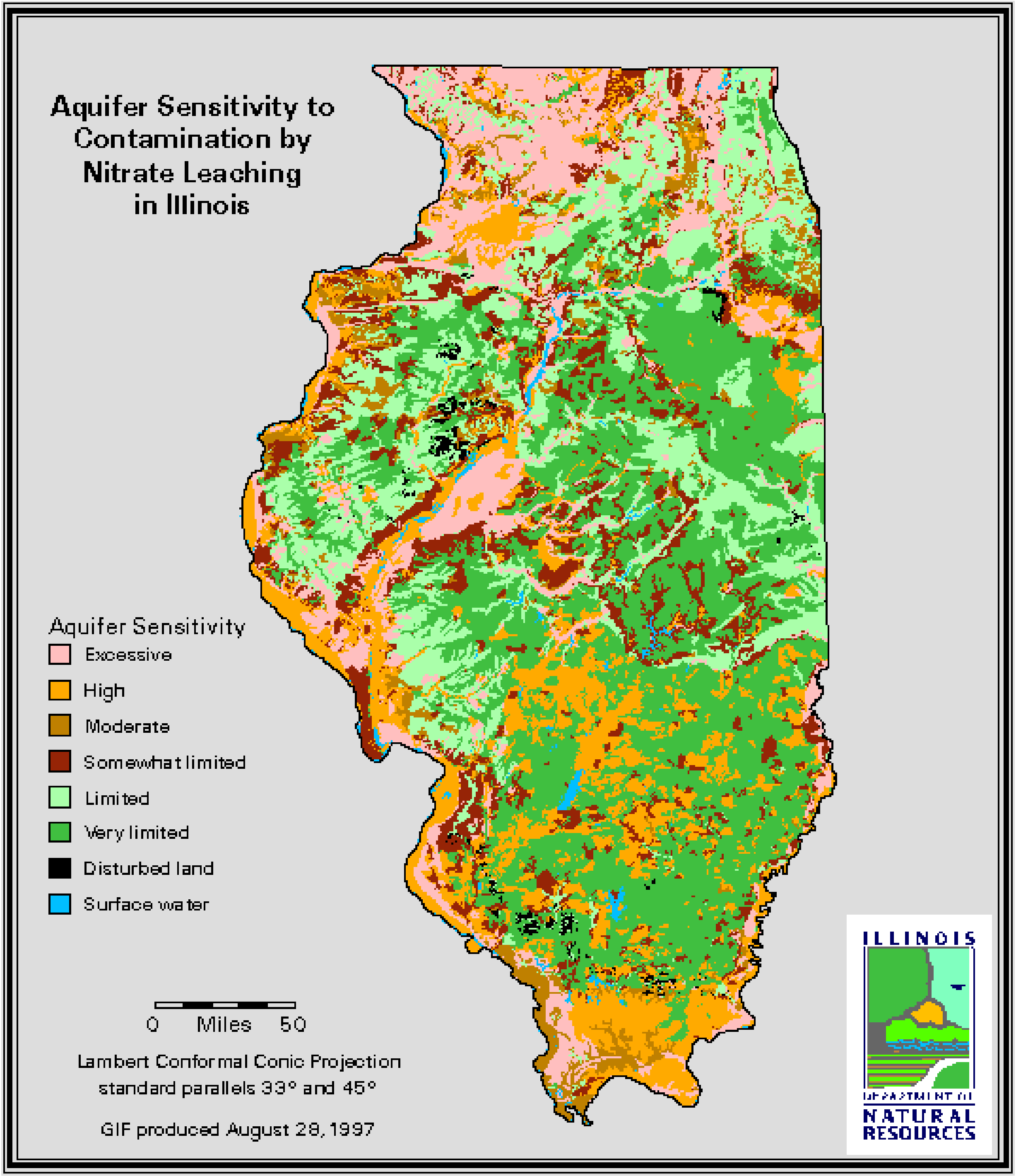
Ryegrass cover crop for 6 years			No cover crop	
10”	1.49*		1.66	
16”	1.58		1.54	
24”	1.48*		1.65	

M Plumer

* sig. .05

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





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

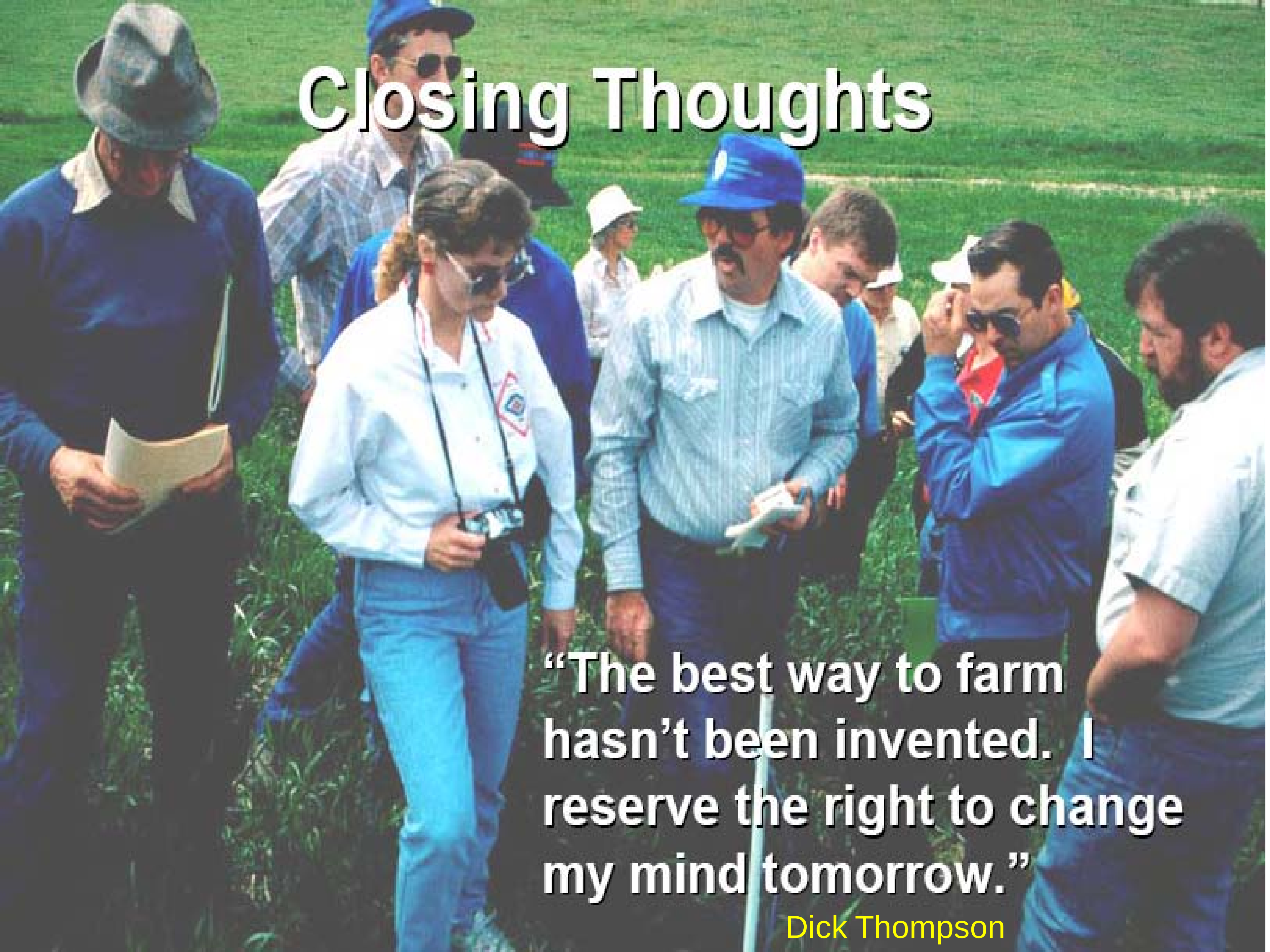
Potential relative reductions in nitrate leaching in Corn Belt for specific corn/soybean mgt. changes

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


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