Organic Cash Grain Yields and Economics

Brian Caldwell and Matt Ryan, Cornell University

NOFA-NY Winter Conference 1-27-13

Outline

- Crop yield and profitability in the Cornell Organic Grain Cropping Systems Experiment (2005-2011)
- Insights from other long-term organic grain crop experiments
- Weed management and achieving yield potential

OCS Grain Experiment

- Uses the base rotation followed by most organic cash grain farmers in our region
- Initially—focus on the transition period
- Now—what are the best long-term sustainable approaches?
- Evolution, adaptive management
- A limitation—does not include sod forage or hay crop

OCS Grain Experiment

- Initiated at Musgrave Research Farm in 2005
- Three year rotation of (Corn-Soybean-Spelt)
- Two crop rotation entry points (A and B)
- Four treatments
  1. High Fertility (HF)
  2. Low Fertility (LF)
  3. Enhanced Weed Management (EWM)
  4. Reduced Tillage (RT)

Farmer Goals

Achieve:

- HF: High yield through heavy fertilization?
- LF: High returns by reducing inputs?
- EWM: Better long-term results through enhanced weed management?
- RT: Better crop growth through reduced tillage?

Basic Cash Grain Rotation

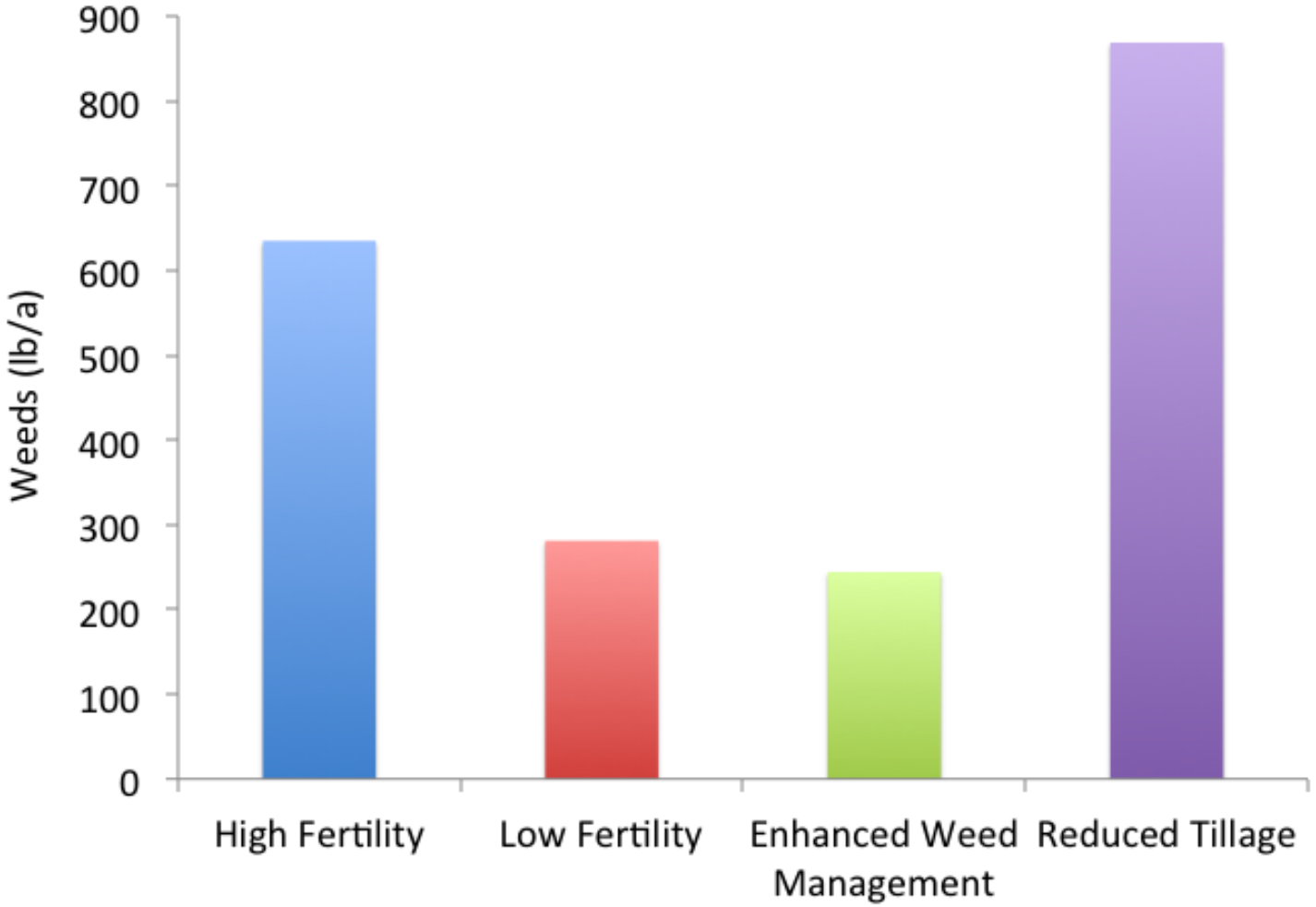
- Soybean/Spelt → Spelt/Clover → Corn → Soybeans
- After harvest, planted to winter spelt (early October)
- Spelt is undersown with medium red clover in March
- After spelt harvest, clover continues to grow
- Clover is plowed under the following spring before planting corn
- Two of the 3 crops are grown each year

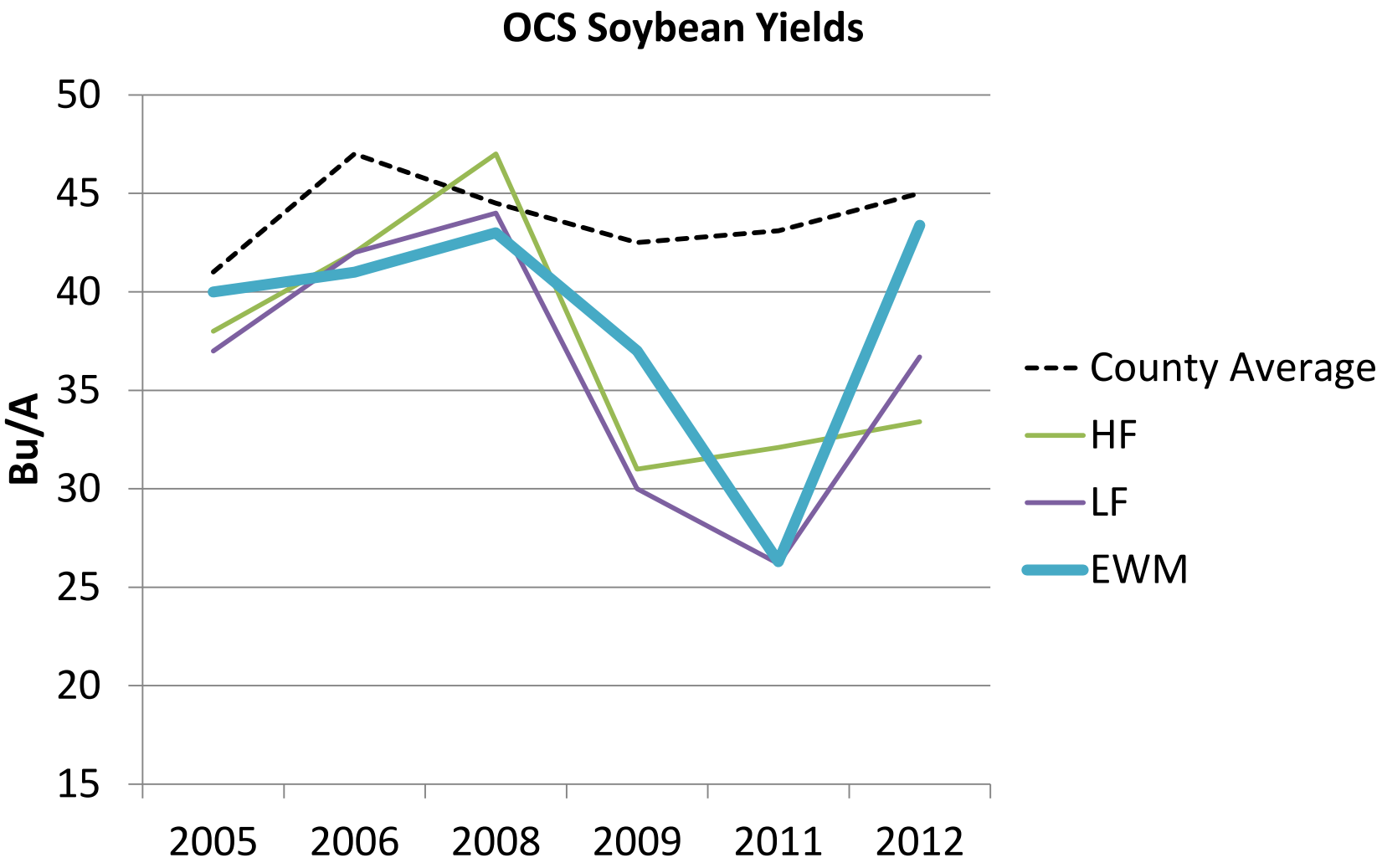

CANANDAIGUA
SOCCER

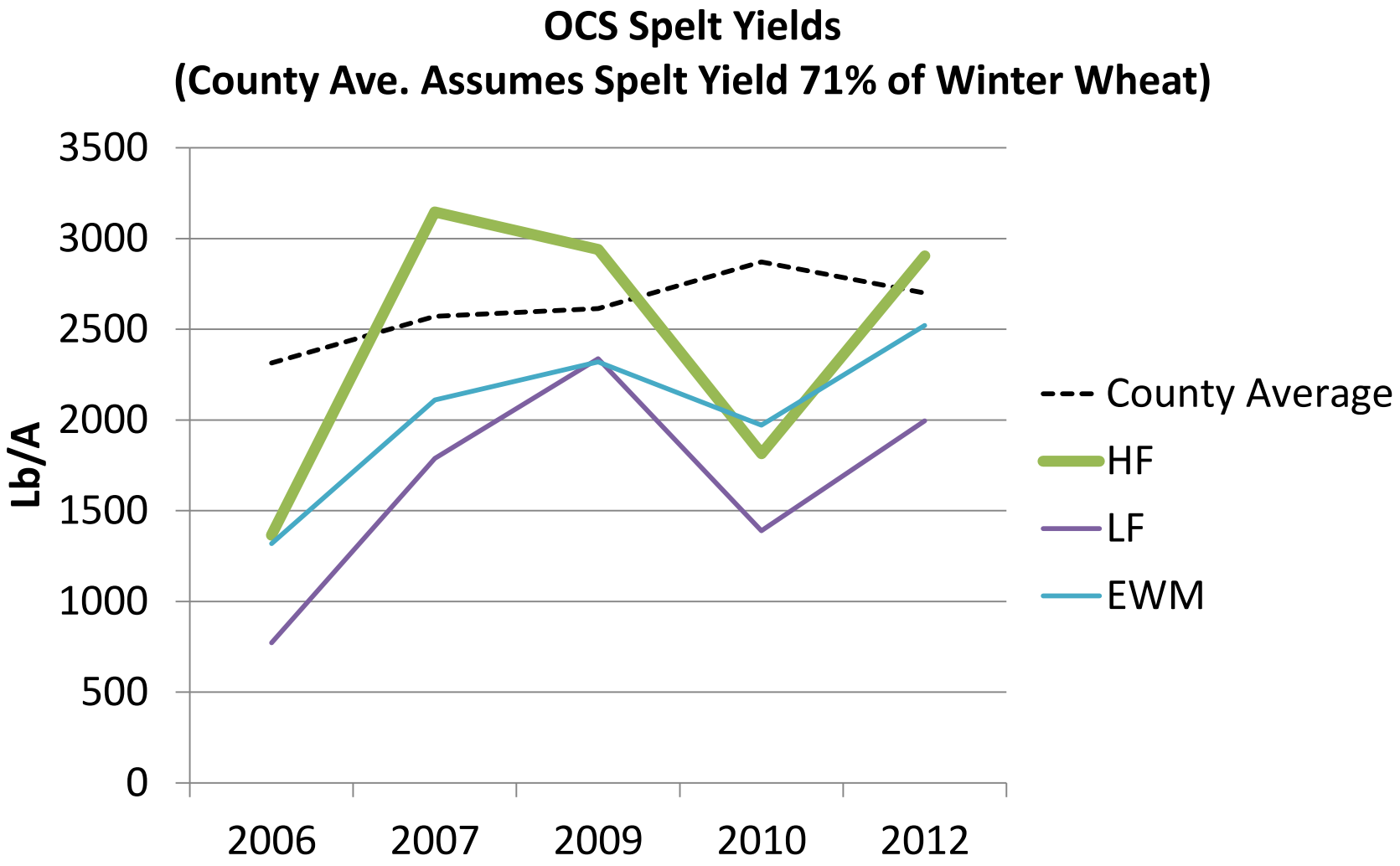
Problems with RT system

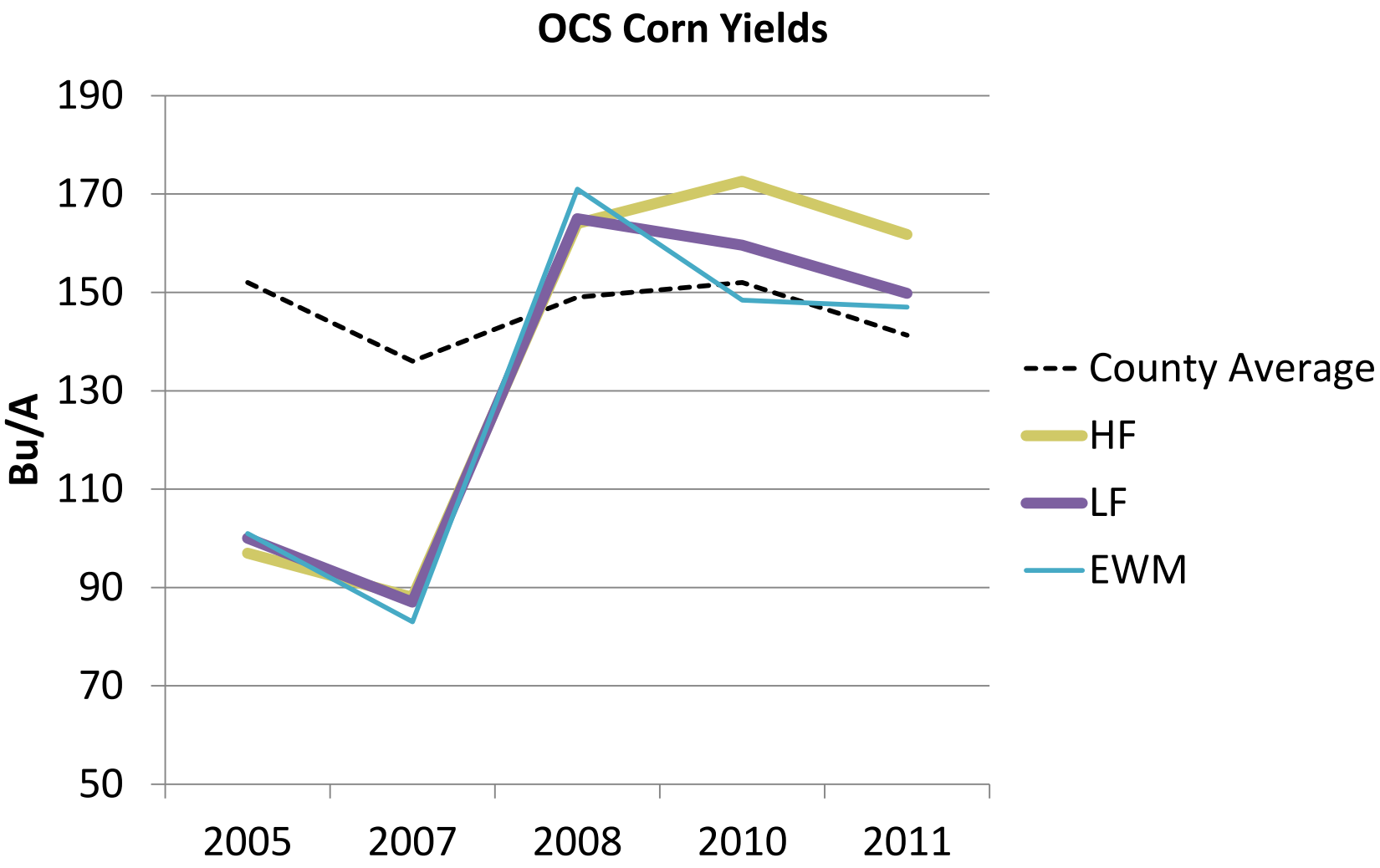
- Ridge scraper, planter, and cultivators didn't track well
- Example of a steep learning curve!

Weed biomass across systems



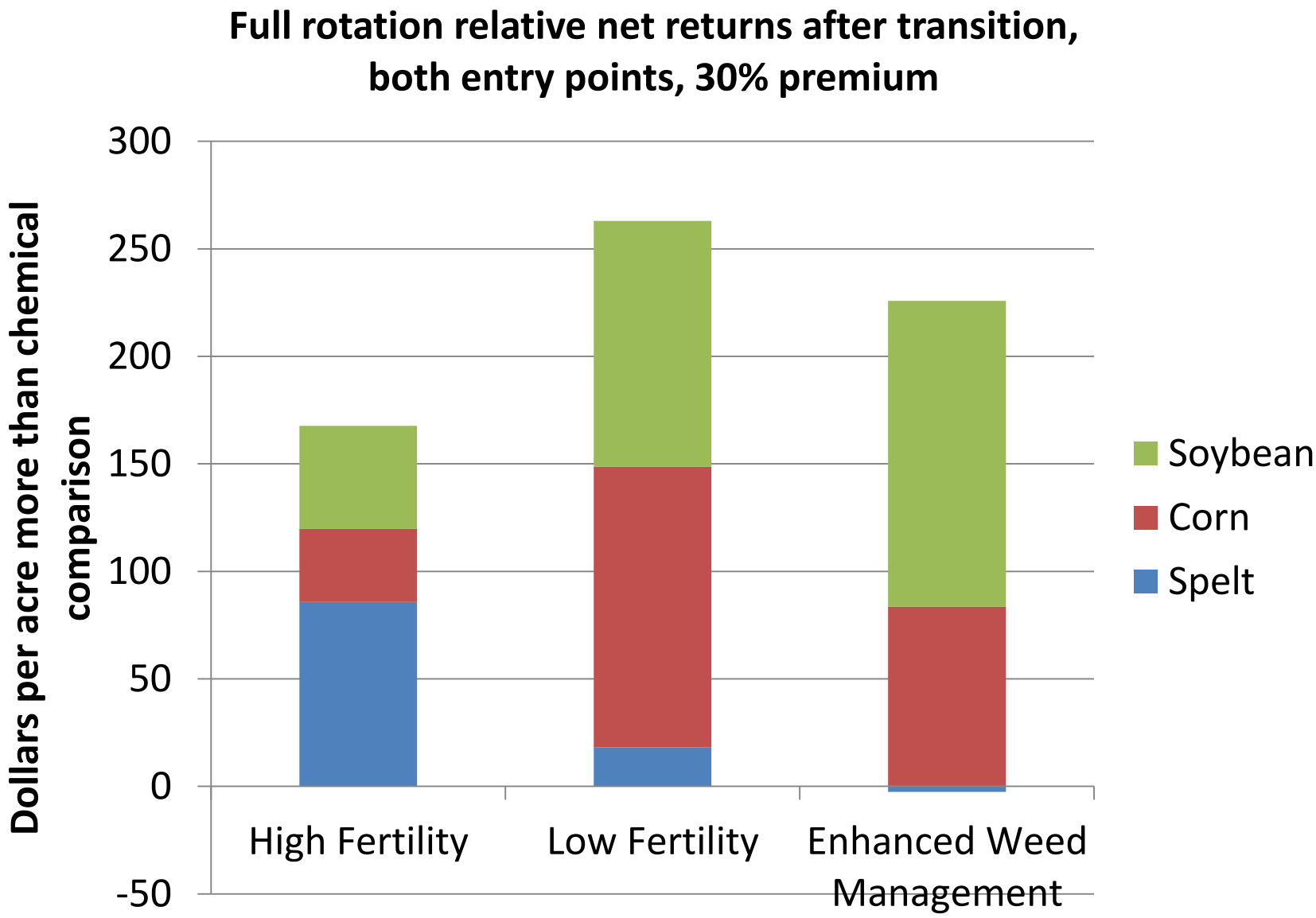

OCS Soybean Yields
Bu/A
50
45
40
35
30
25
20
15
2005
2006
2008
2009
2011
2012
County Average
HF
LF
EWM


OCS Spelt Yields
(County Ave. Assumes Spelt Yield 71% of Winter Wheat)
Lb/A
3500
3000
2500
2000
1500
1000
500
0
2006
2007
2009
2010
2012
County Average
HF
LF
EWM


OCS Corn Yields
190
170
150
130
110
90
70
50
Bu/A
2005
2007
2008
2010
2011
County Average
HF
LF
EWM

Economics during transition

- Large losses possible—goal is very modest net returns
- Avoid heavy input costs
- If you have the equipment and markets, put it in legume sod
- Avoid corn unless there is a legume sod plowdown before it


Full rotation relative net returns after transition, both entry points, 30% premium
Dollars per acre more than chemical comparison
300
250
200
150
100
50
0
-50
High Fertility
Low Fertility
Enhanced Weed Management
Soybean
Corn
Spelt

Economics, Weeds, and Fertility

- Economics—compost applied to spelt increased net returns but applied to corn or soybeans on this soil, it lowered them
  - Initial soil test levels—pH high, P and K—low to medium, OM 2.75%
- Weeds—added compost increased them!

Conclusions

- After the transition period, a good stand of red clover plowed down in the spring before planting of corn can provide the necessary N for a good crop on this soil type
- Spelt responded to extra fertility
- Conversely, adding organic fertilizer to corn (beyond starter) did not increase yields and lowered net returns
- Added fertility increased weeds
- Perhaps we are learning how to reduce tillage successfully

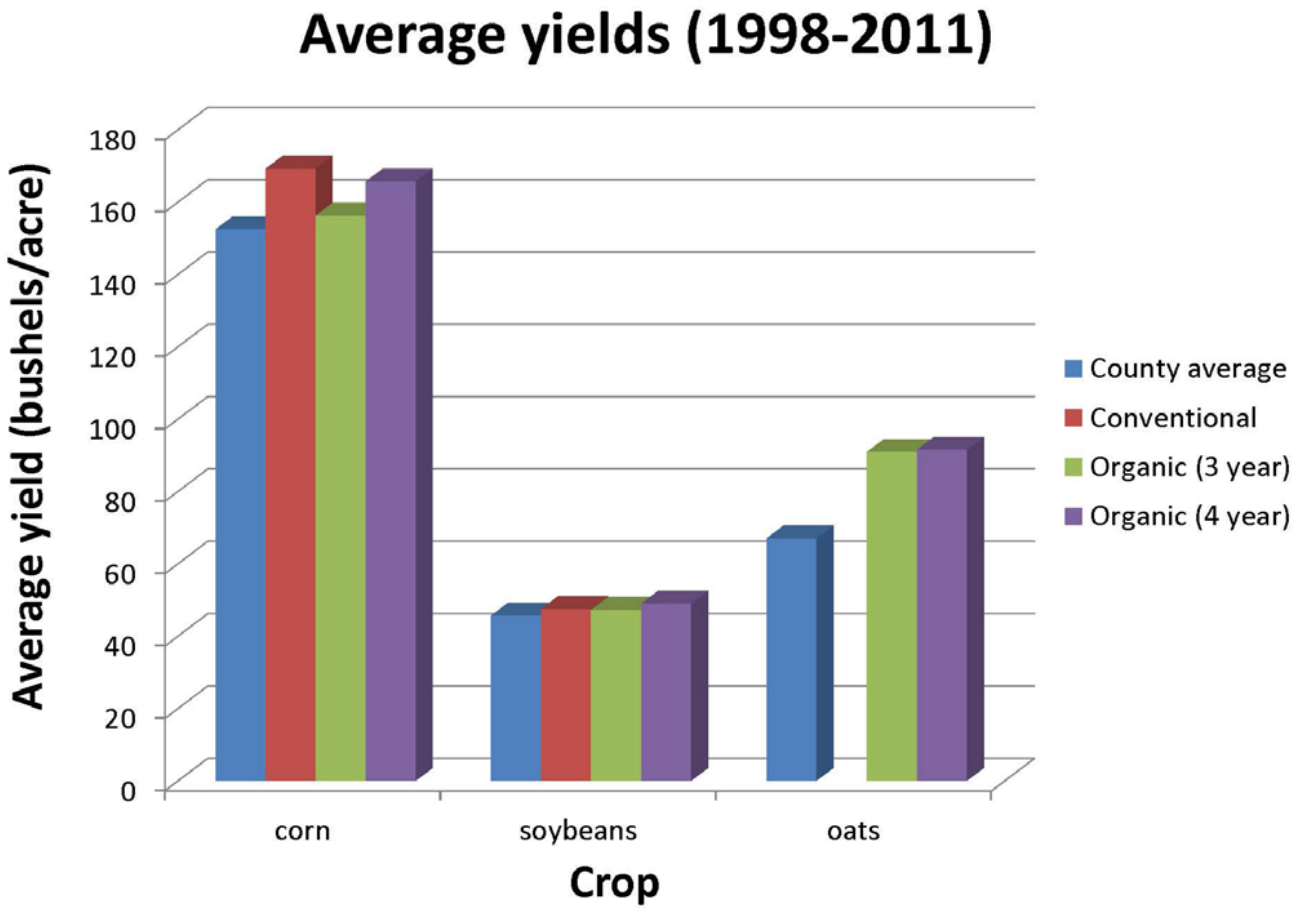
Suggestive Results from 2012

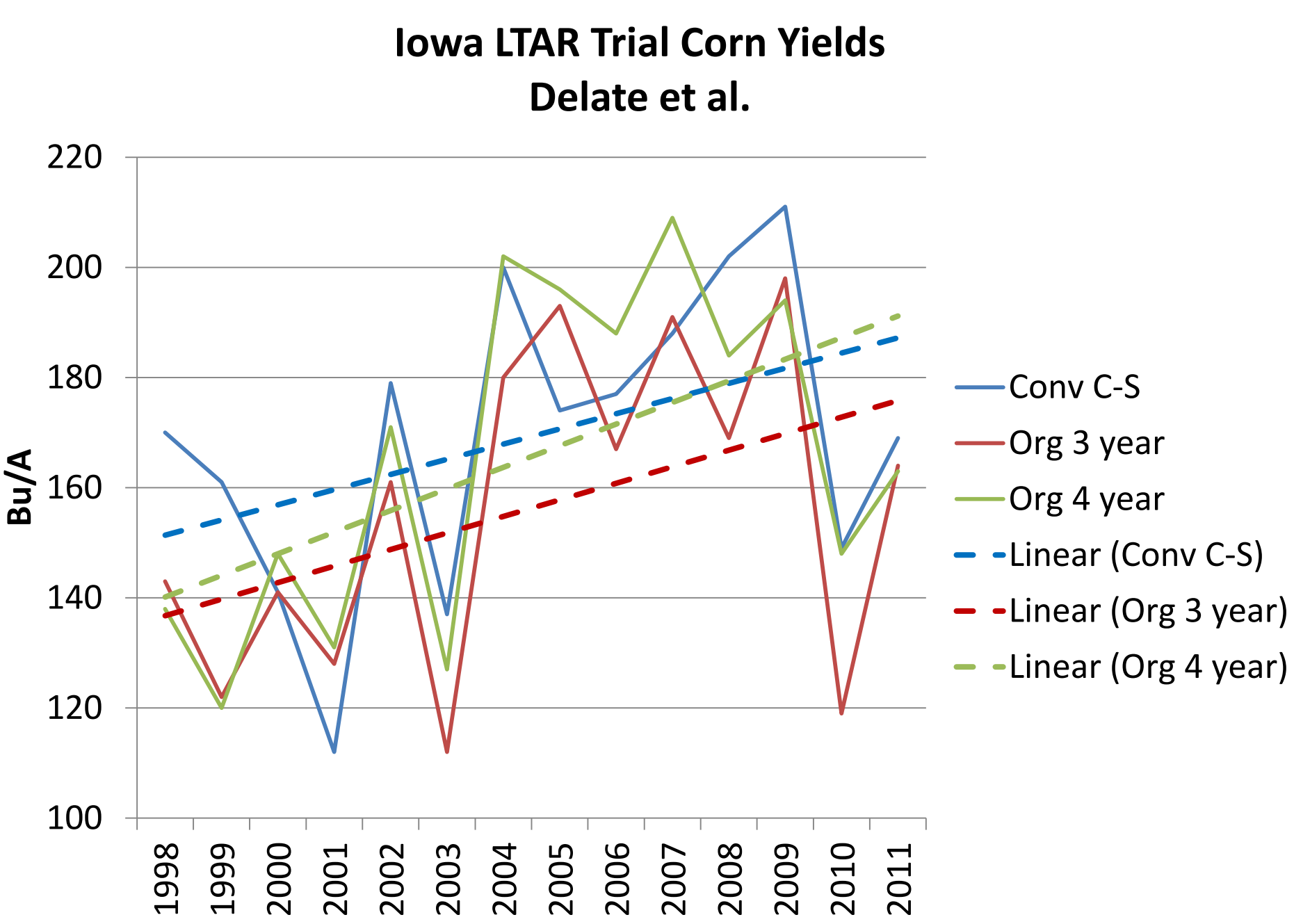
- Weed-free subplots enabled us to see potential yields without weed competition
- Preliminary--weeds appeared to reduce yields more than we had thought
- Soybeans—almost 50% in HF plots; 25% in EWM plots
- The upside is that potential yields seemed high, since we still got 33 (HF) and 43 (EWM) bushel yields
- We need to analyze these results further and repeat the trial

Insights from other long-term organic grain trials?

- Overcoming challenges during the transition to organic
- Similar corn yields, but more weeds in High Fertility than Low Fertility
- Greater soybean yield in weed-free plots

Results from Iowa Long-Term Agroecological Research (LTAR) Experiment



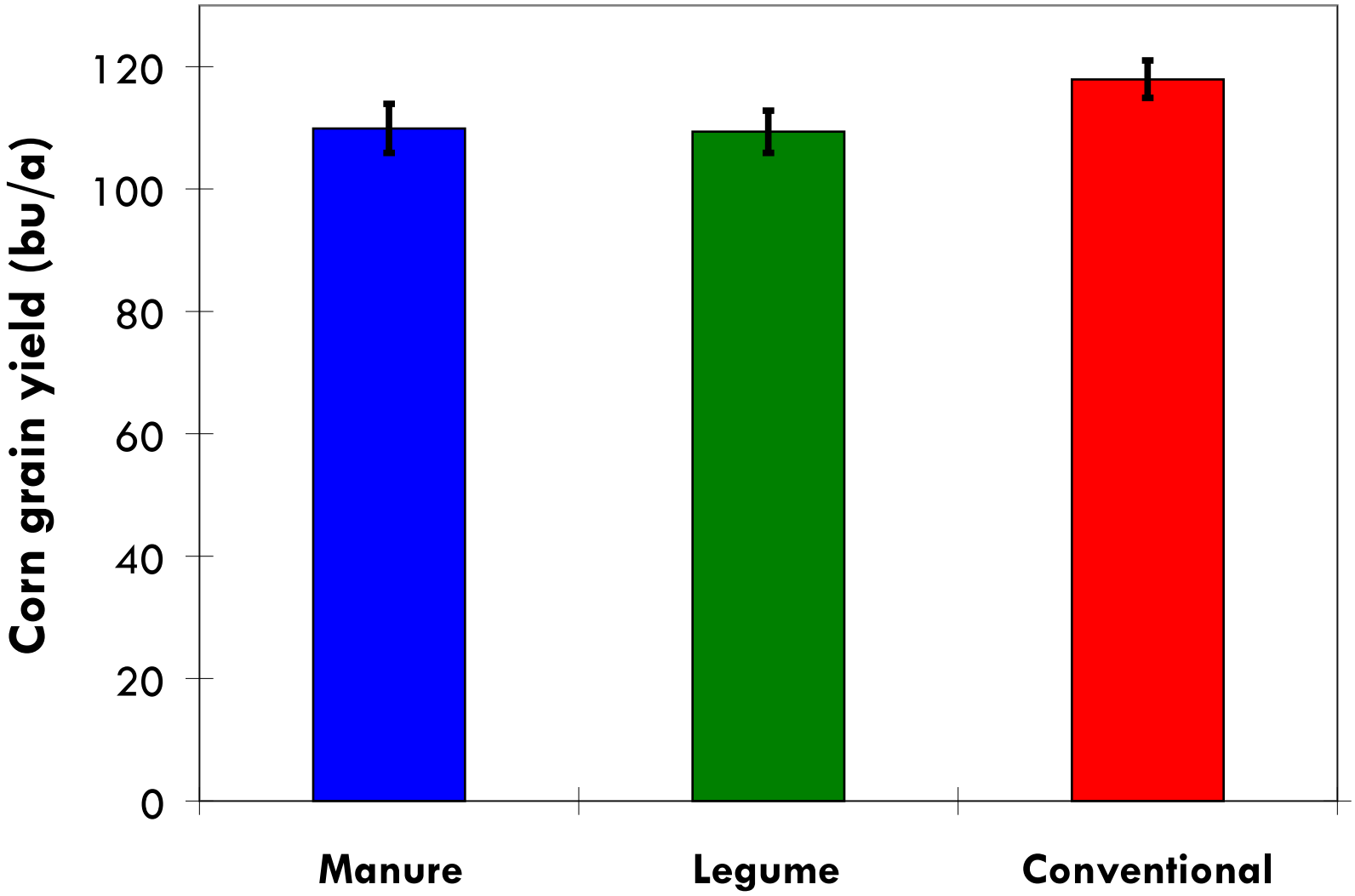

Iowa LTAR Trial Corn Yields
Delate et al.
Bu/A
220
200
180
160
140
120
100
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Conv C-S
Org 3 year
Org 4 year
Linear (Conv C-S)
Linear (Org 3 year)
Linear (Org 4 year)

The Rodale Farming Systems Trial

Long-term cropping systems experiment in Pennsylvania established in 1981

	Manure organic	Legume organic	Conventional
Nitrogen source	Manure and legumes	Legume cover crops	Mineral
Weed control	Cultivation	Cultivation	Herbicides
Primary tillage	Moldboard	Moldboard	Chisel
Planting date	Late	Late	Early
Cover crops	Rye and Hairy vetch	Rye and Hairy vetch	None

Corn Yield and Weed Biomass across cropping systems (1981-2007)



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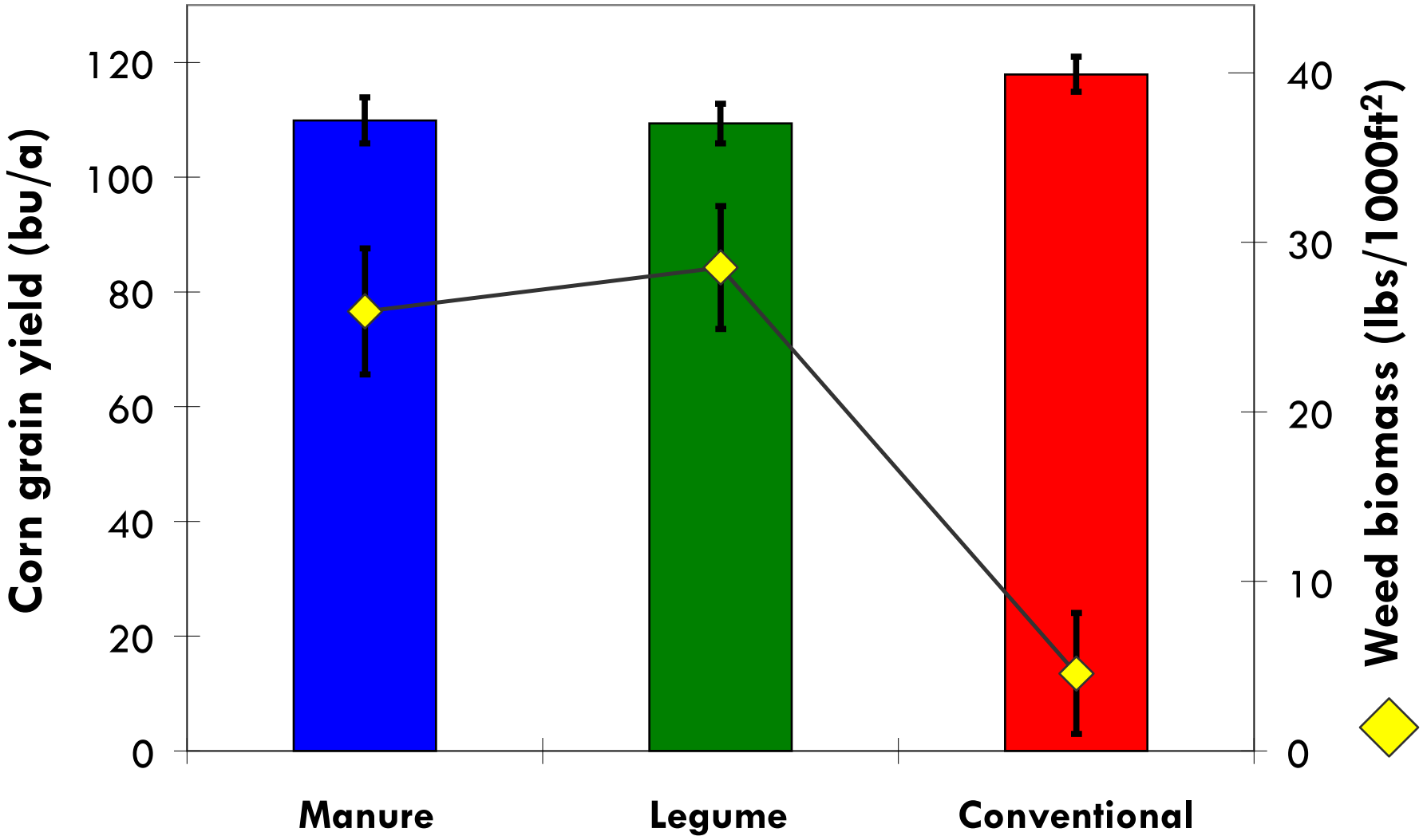
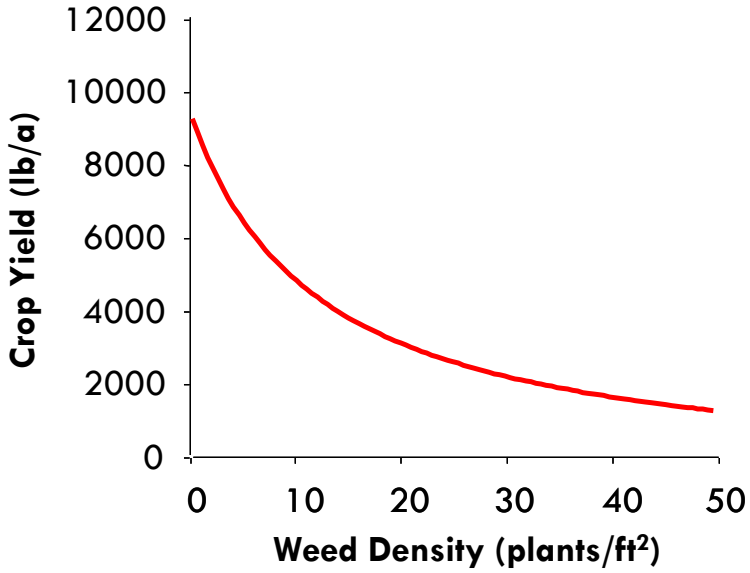


Crop yield and weed relationship



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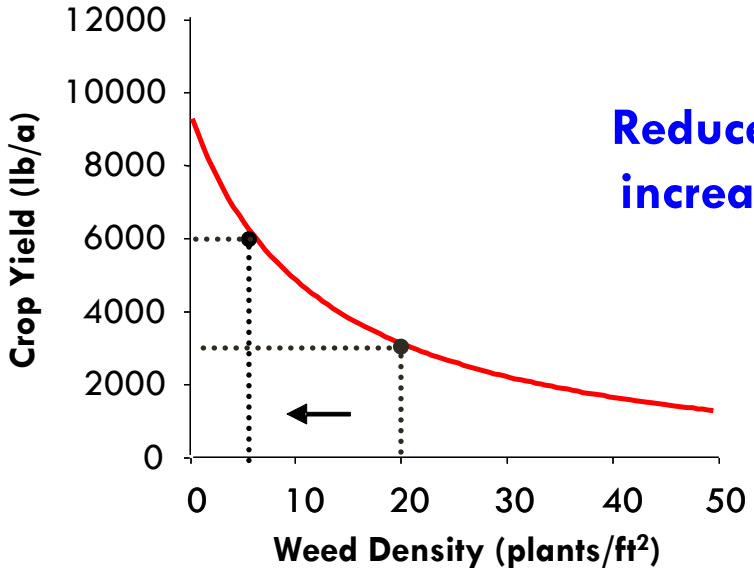
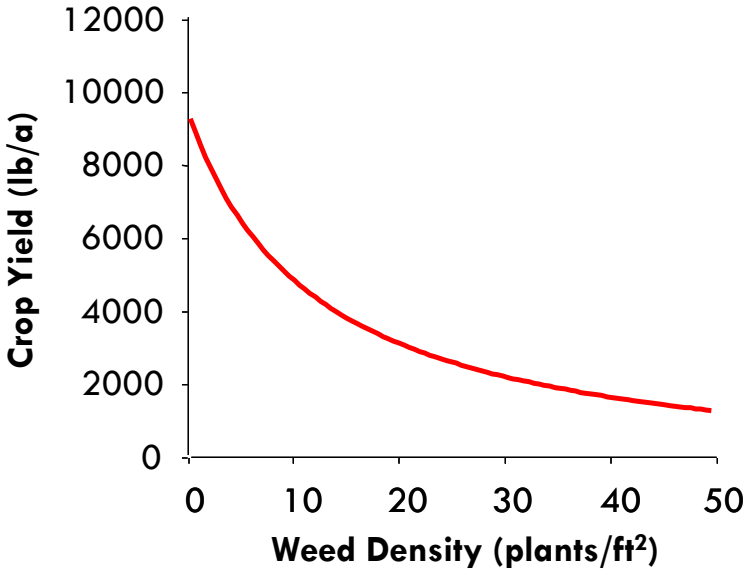
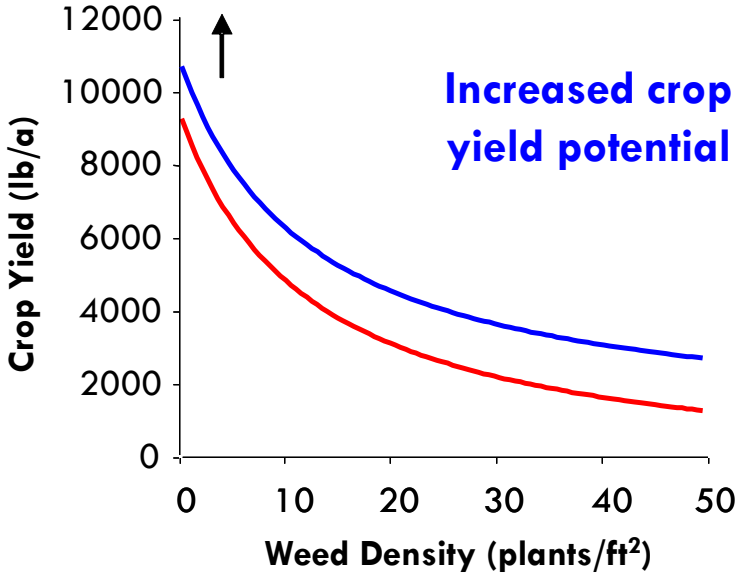
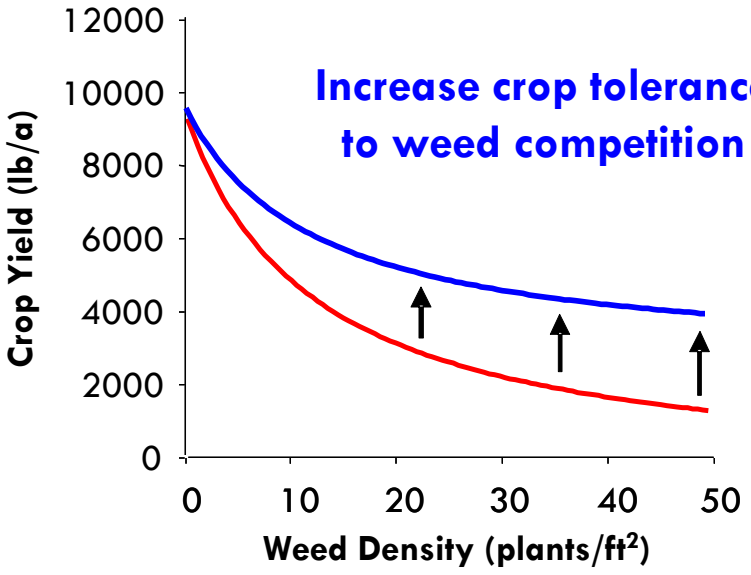


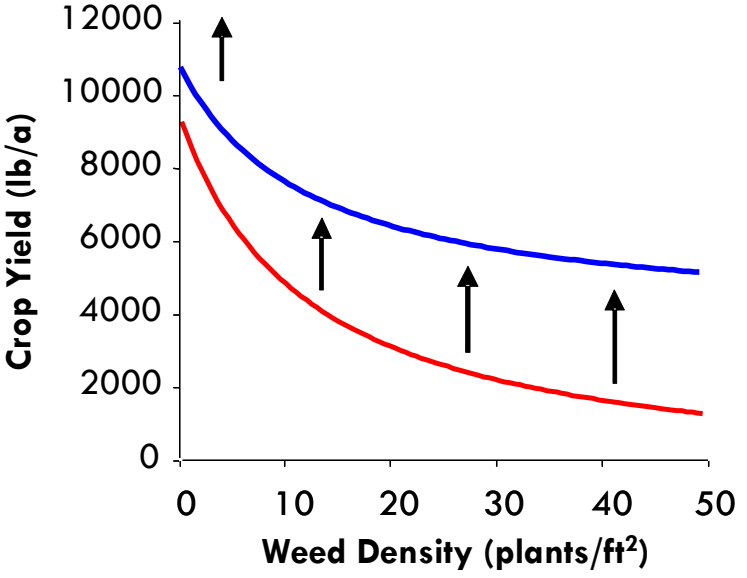
Reduce density and increase crop yield

Crop yield and weed relationship

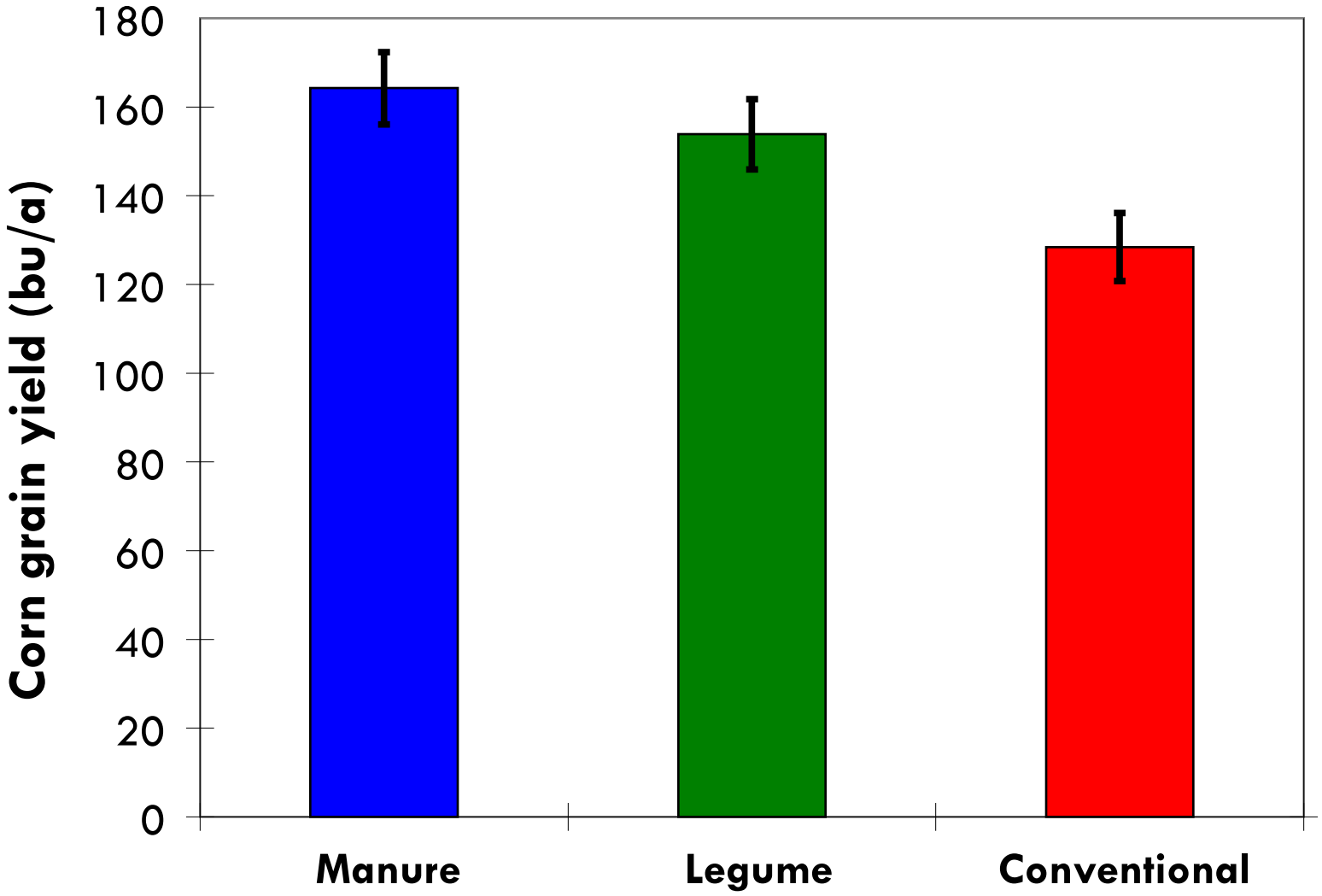








Weed-Free Corn Yield and Soil Carbon across cropping systems (2005-2006)



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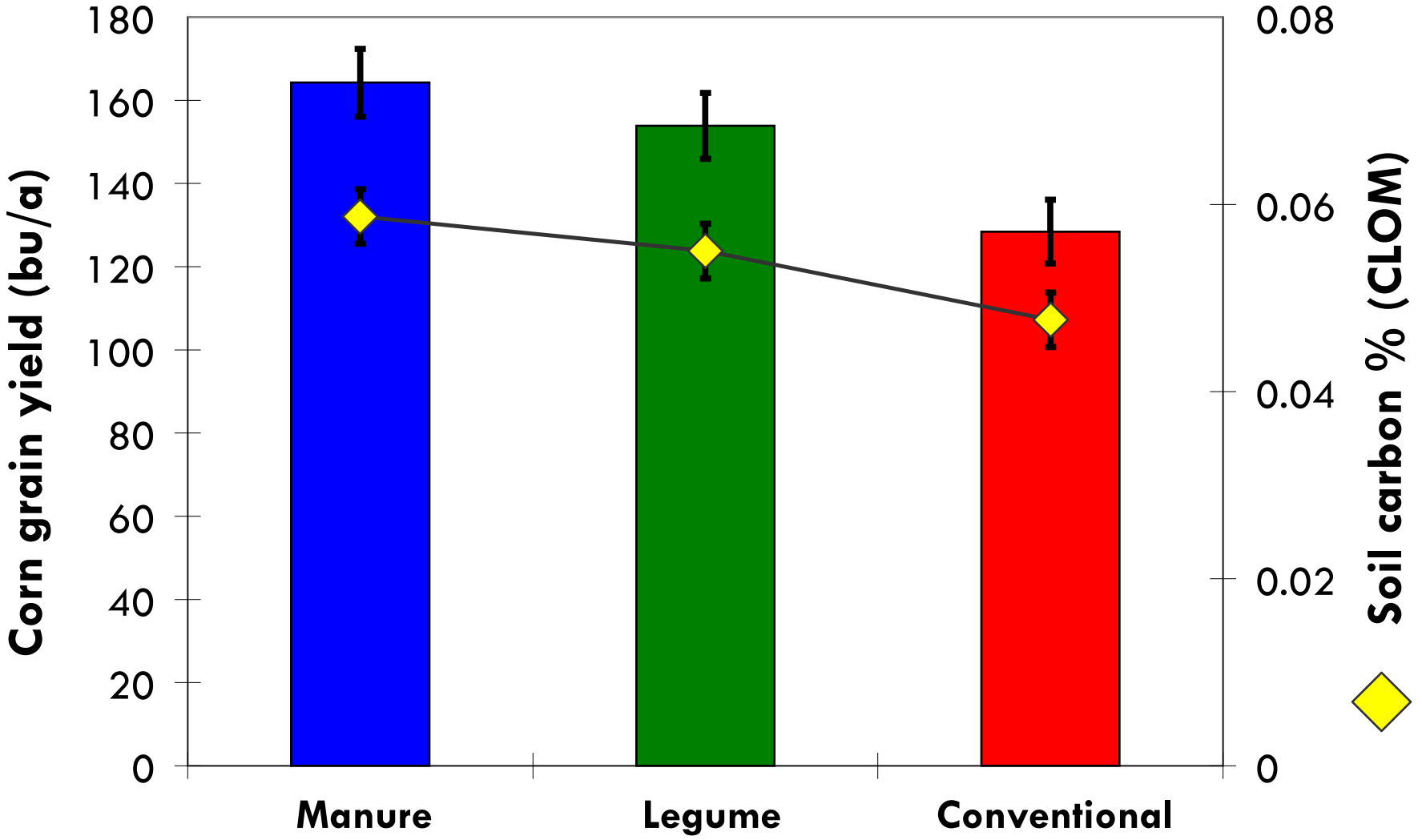


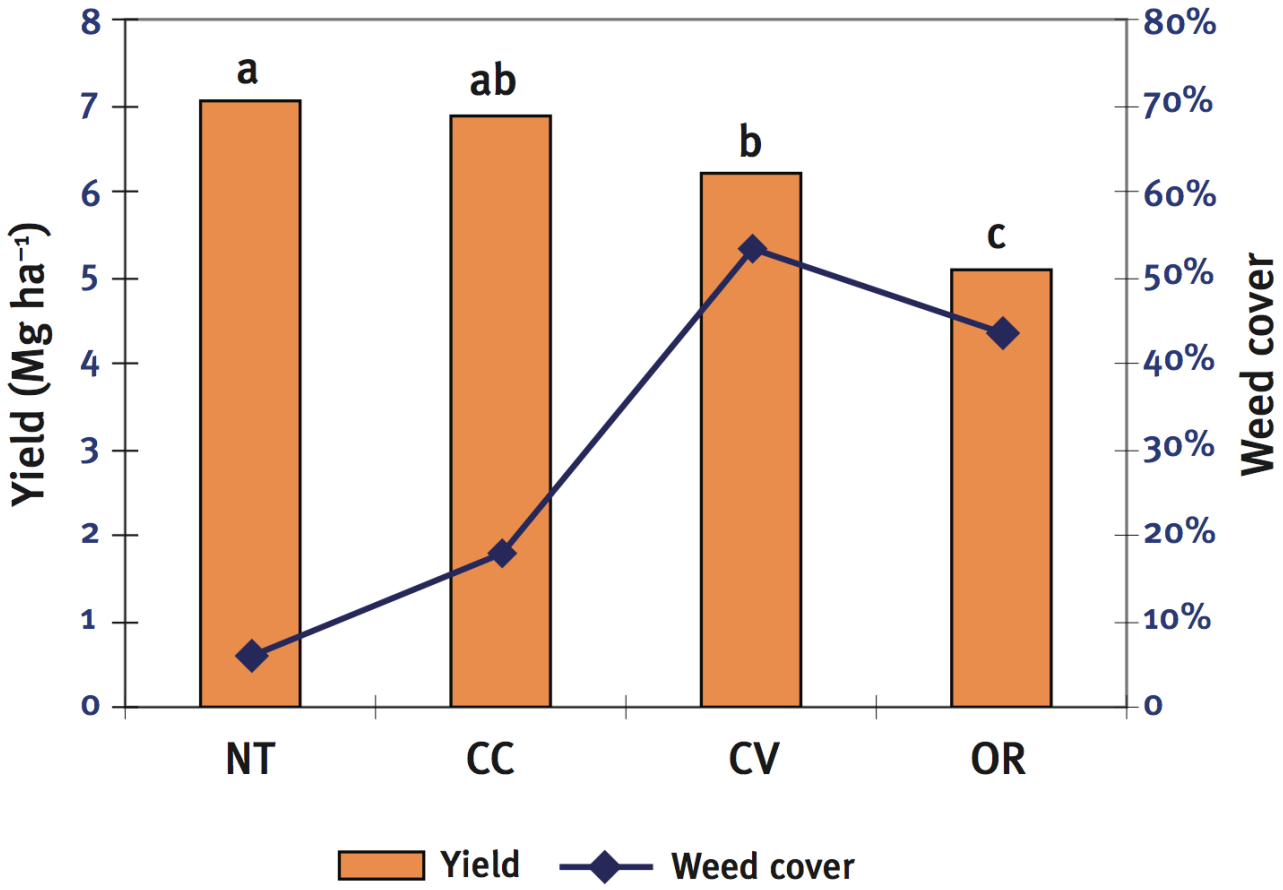
Results from 8-year experiment in Maryland

- Compared 4 systems (2-year corn, wheat/soybean rotation)
  - No-tillage (no cover crop)
  - Cover crop (no-till with hairy vetch cover crop)
  - Crownvetch (no-till with perennial legume living cover crop)
  - Organic (chisel plow with hairy vetch cover crop and manure)
- After 8 years, they grew corn across all treatments using conventional practices for 3 year uniformity trial
- Results showed soil in organic plots was capable of greater crop production than soil in other treatments

Teasdale, J.R., C.B. Coffman, and R.W. Mangum. 2007. Potential long-term benefits of no-tillage and organic cropping systems for grain production and soil improvement. Agronomy Journal 99:1297-1305.

Figure 1

Average corn yield and percentage of area covered by weed vegetation at weed maturity in the no-tillage (NT), cover crop (CC), crownvetch (CV), and organic (OR) systems (1994 to 2002).

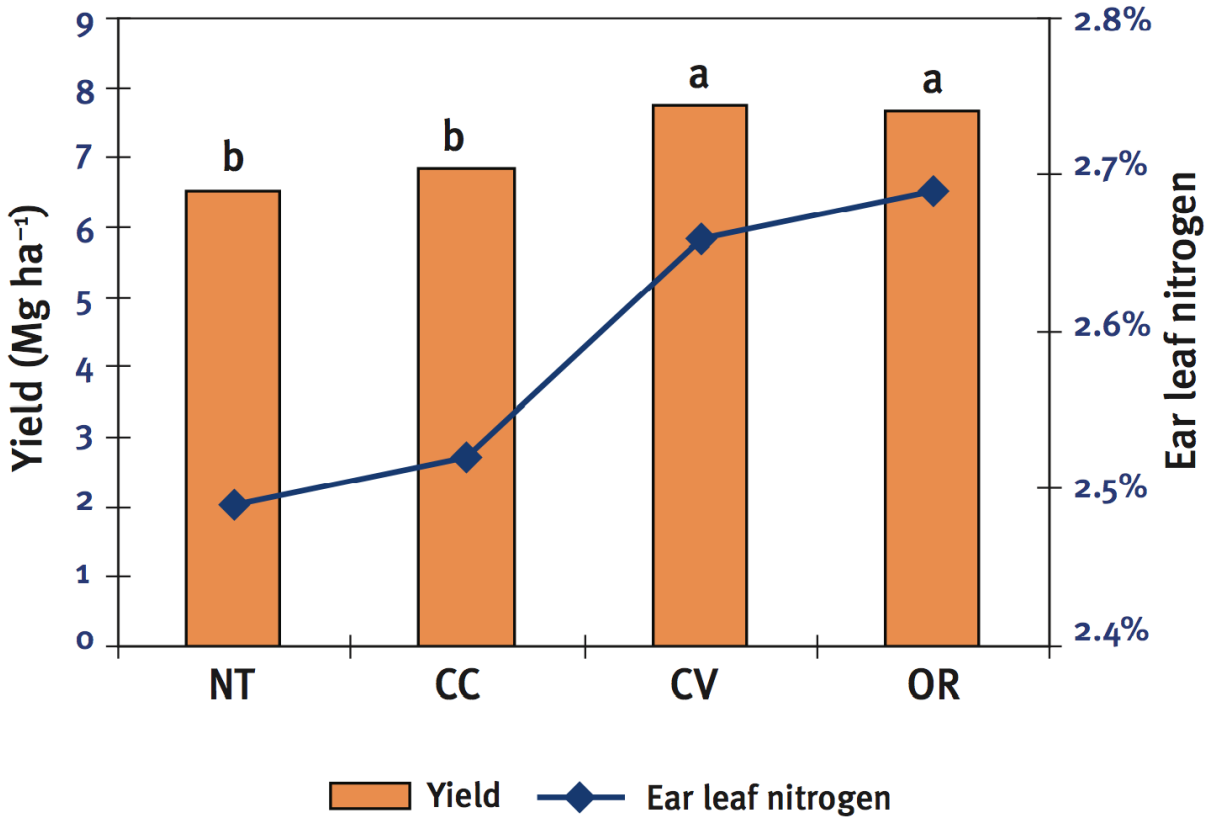


Notes: Bars with the same letters are not significantly different ($p < 0.05$). All weed cover symbols are significantly different from each other. Corn grain conversion: 6.27 Mg ha^{-1} = 100 bushels ac^{-1}.

Teasdale, J.R., C.B. Coffman, and R.W. Mangum. 2007. Potential long-term benefits of no-tillage and organic cropping systems for grain production and soil improvement. Agronomy Journal 99:1297-1305.

Figure 2

Corn grain yield and ear leaf nitrogen at silking averaged over the years of the uniformity trial (2003 to 2005).



Notes: No-tillage corn was grown over all plots that had a history of the no-tillage (NT), cover crop (CC), crownvetch (CV), and organic (OR) systems from 1994 to 2002. Yield bars with the same letter are not significantly different ($p < 0.05$). Differences between ear leaf nitrogen symbols follow the same letter designations as yield bars. Corn grain conversion: 6.27 Mg ha^{-1} = 100 bushels ac^{-1}.

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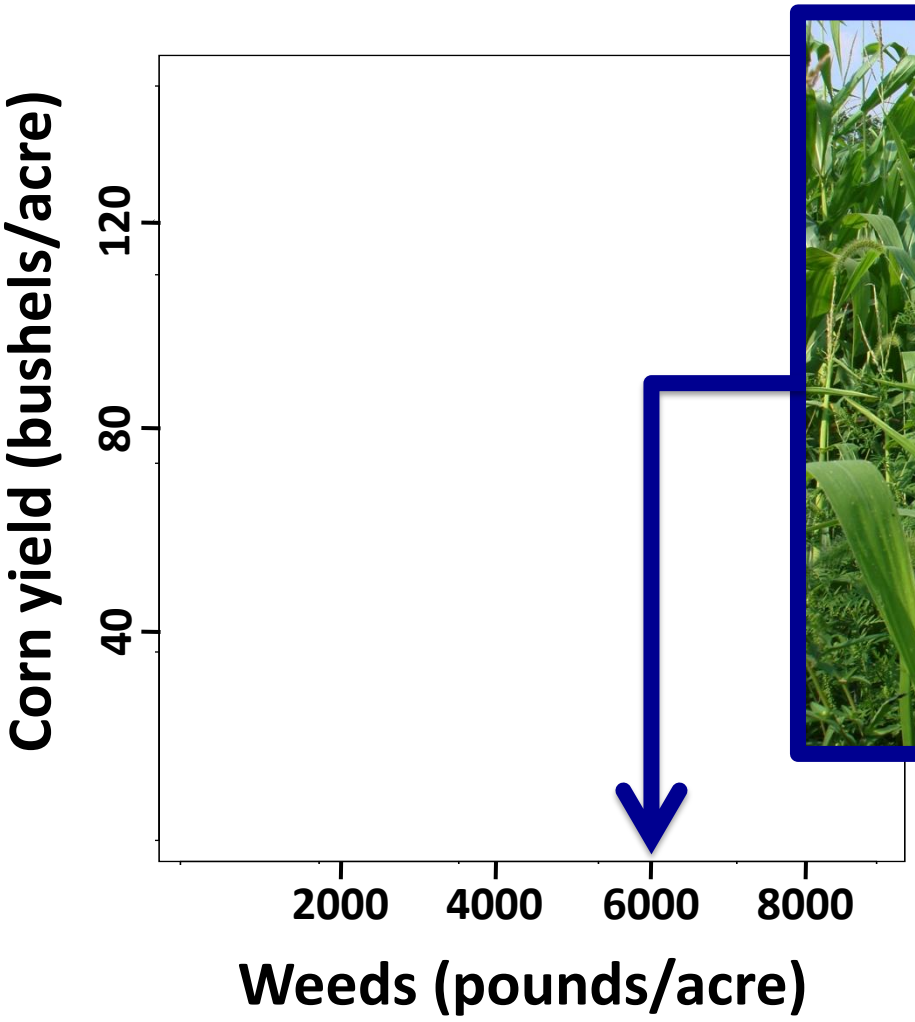
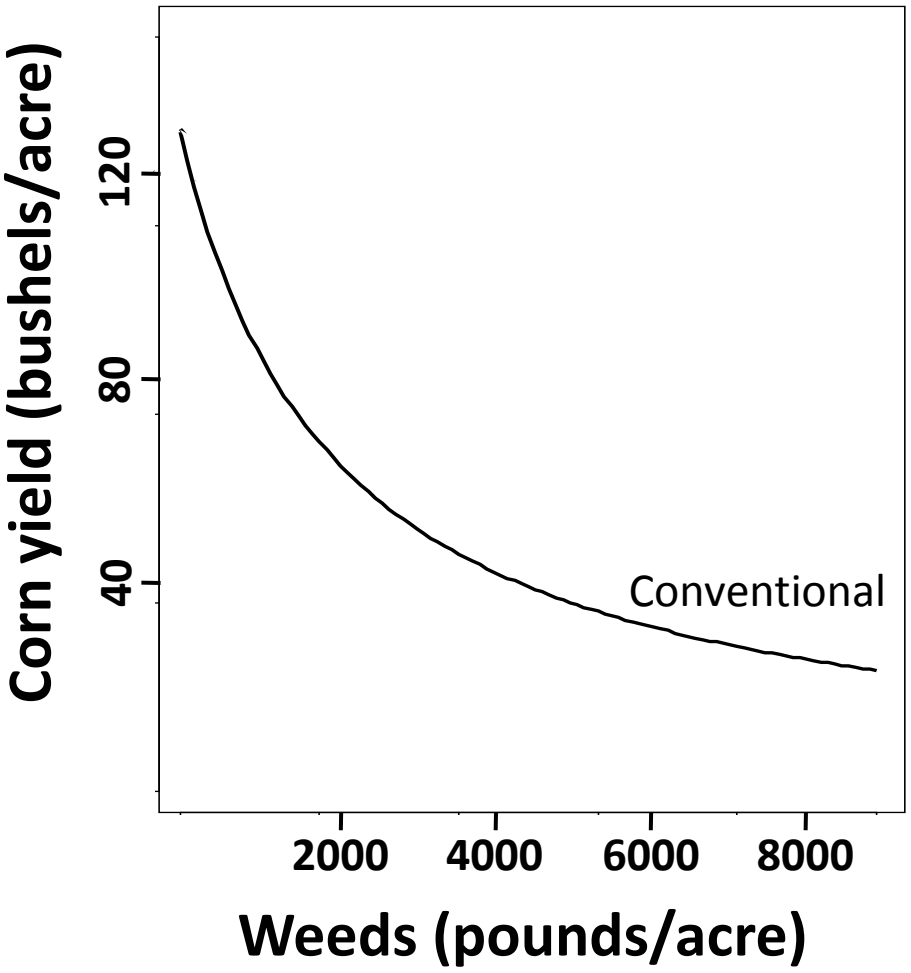
Relationship between corn yield and weed biomass in the Rodale Farming Systems Trial (1981-2007)



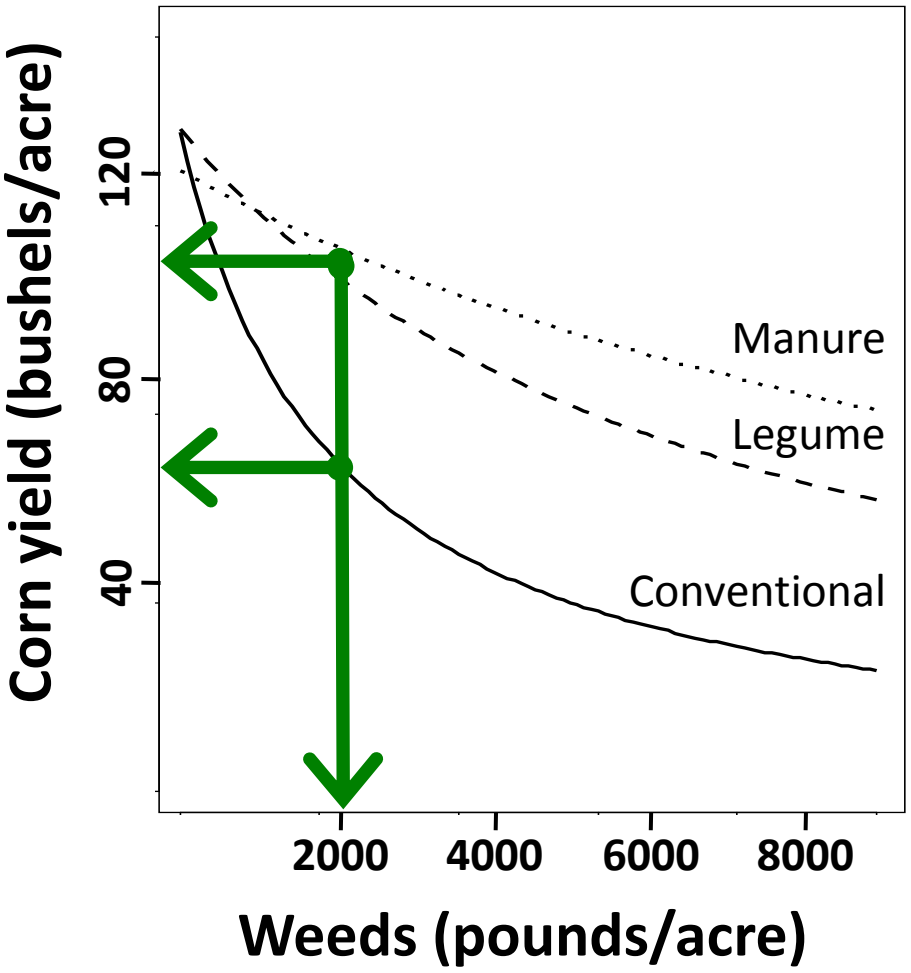
6000 lbs/a
is a lot of weeds

Relationship between corn yield and weed biomass in the Rodale Farming Systems Trial (1981-2007)



Weeds in organic corn were less competitive

Relationship between corn yield and weed biomass in the Rodale Farming Systems Trial (1981-2007)



Weeds in organic corn were less competitive

Why?

Why differences in weed-crop competition

- More soil organic matter in organic plots

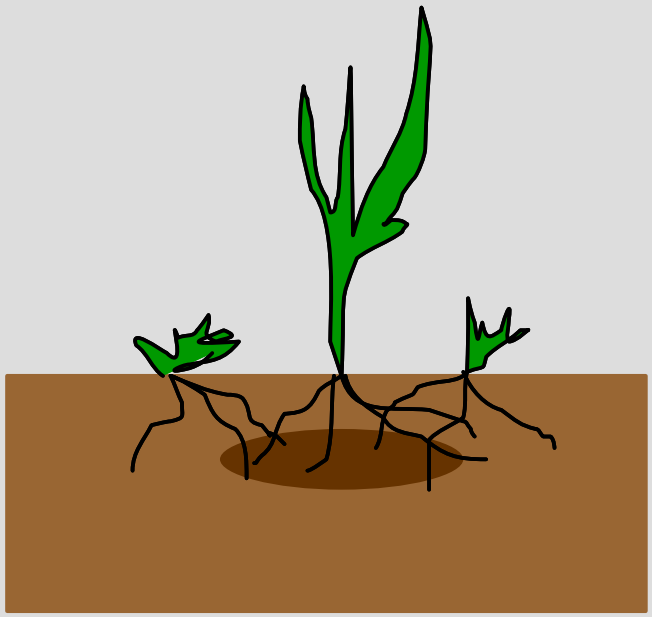
The Rodale Institute

Why differences in weed-crop competition

Niche overlap

Single resource pool

Crop and weeds **similar**

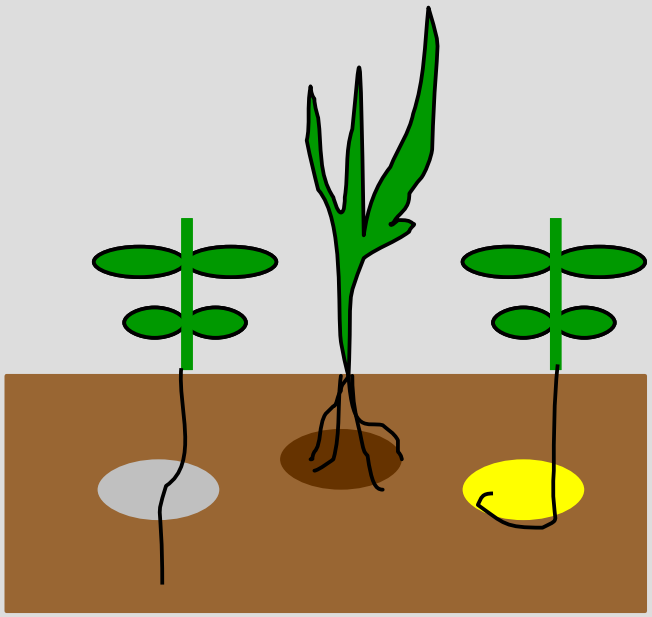


Strong competition

Niche partitioning

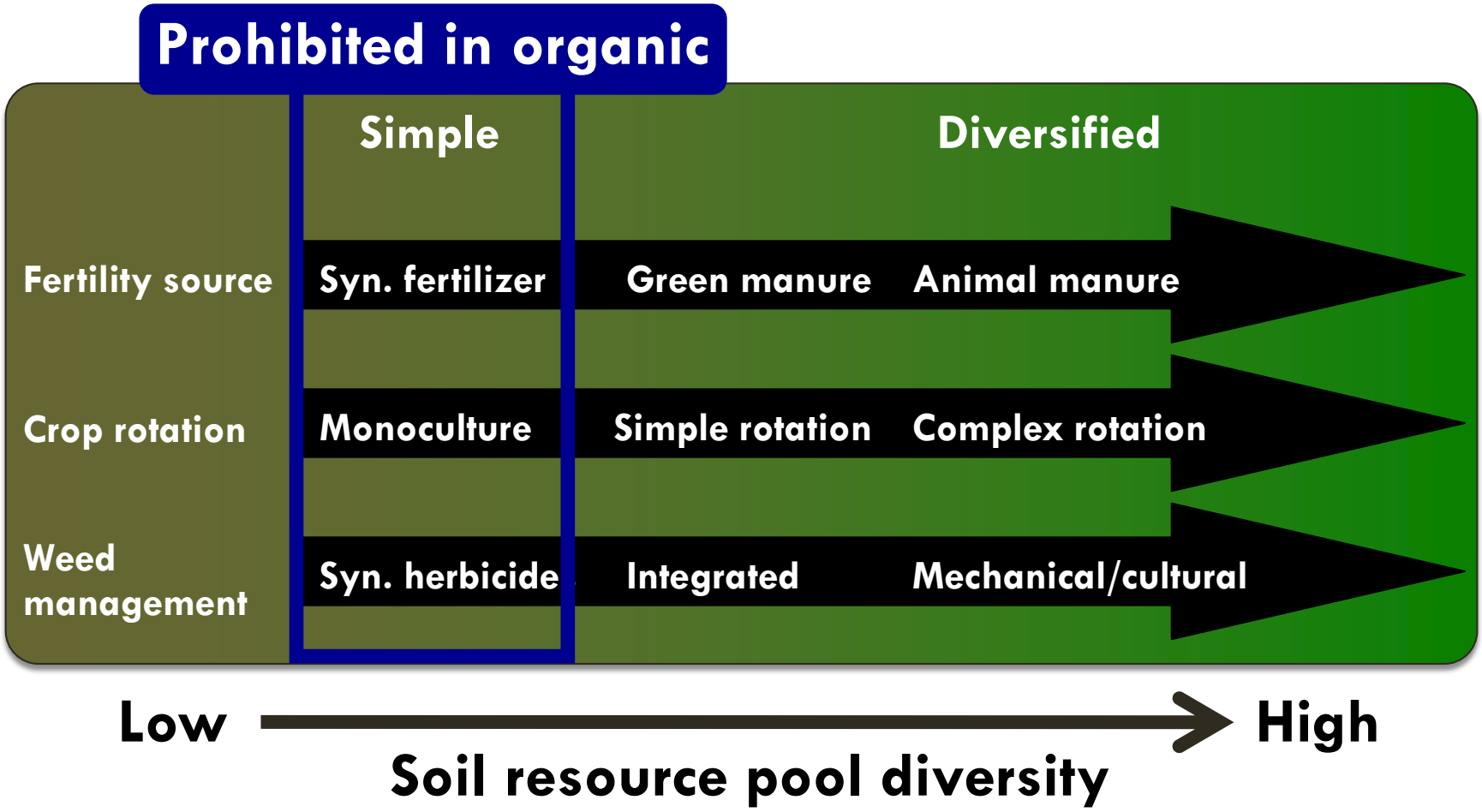
Multiple resource pools

Crop and weeds **differ**



Weak competition

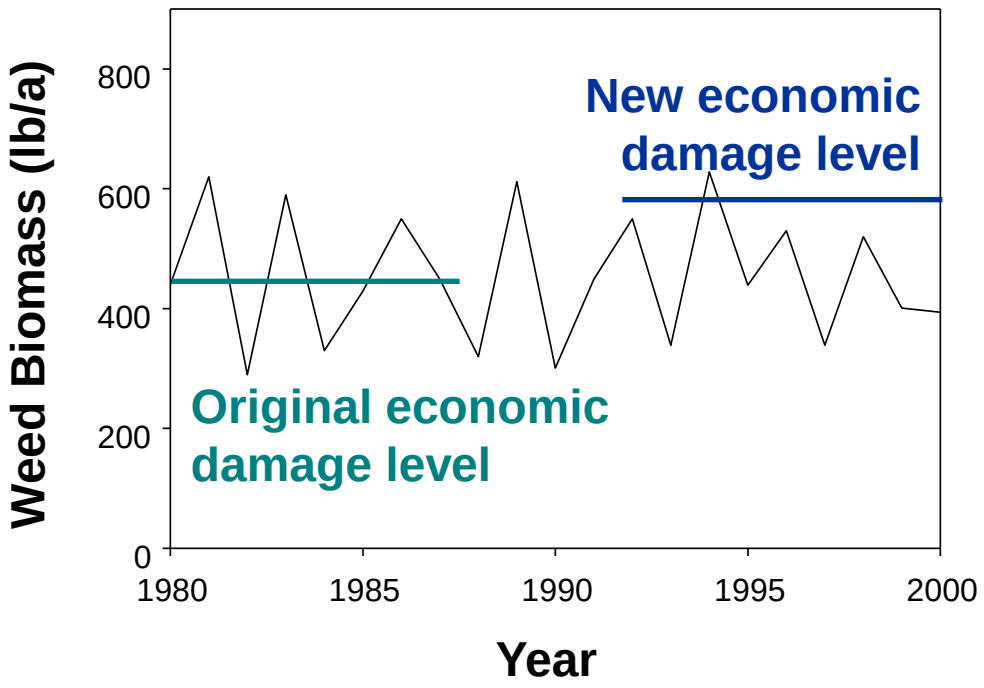
The cropping system continuum



Why differences in weed-crop competition

- More soil organic matter in organic plots
- Different weed community
- Later planting of organic crops
- Nutrient availability more synchronized with crop use
- Weeds growing after period when they compete

Long-term effects of organic management



Increased tolerance to weed competition

The USDA ARS Farming Systems Project (FSP)

Long-term cropping systems experiment in Maryland established in 1993

Systems	Crop rotations
No-till	Corn – rye – Soybean – Wheat / Soybean
Chisel	Corn – rye – Soybean – Wheat / Soybean
Organic 2-yr	Corn – rye – Soybean – vetch
Organic 3-yr	Corn – rye – Soybean – Wheat – vetch
Organic 6-yr	Corn – rye – Soybean – Wheat / Alfalfa

Crop performance in the FSP

	Corn				Soybean	
	Weed Cover	N Inputs	Population	Yield	Weed Cover	Yield
System	(%)	(lb/a)	(plants/a)	(bu/a)	(%)	(bu/a)
No-till	17	147	23,108	156	1	70
Chisel till	3	148	23,351	159	1	66
Org2	44	75	22,258	107	26	60
Org3	30	86	22,663	118	29	60
Org4+	22	107	22,987	130	21	60

Multiple years of legume forage crops in rotation decreased weeds and increases corn yield

Weed cover was greater and soybean yield was lower in organic compared to conventional

Cavigelli, M. A., J. R. Teasdale, and A. E. Conklin. 2008. Long-Term Agronomic Performance of Organic and Conventional Field Crops in the Mid-Atlantic Region. Agronomy Journal 100:785–794.

Thank You!

- Our funders: USDA OREI, NY Farm Viability Institute, NYS Agriculture Experiment Station
- My co-workers: Laurie Drinkwater, Chuck Mohler, Quirine Ketterings, Carri Marschner, Harold Van Es, Toni DiTommaso, Marissa Weiss, Janice Degni
- Our grain system farmer/Extension advisors: Klaas Martens, Thor Oechsner, Tony Potenza, John Myer, Erick Smith, John Saeli, Casey Kunes, Keith Waldron, Janice Degni
- Kreher Poultry Farms for donated compost
- The farm crew at Musgrave Research Farm

Which approach is right for you?

The right tool for the job

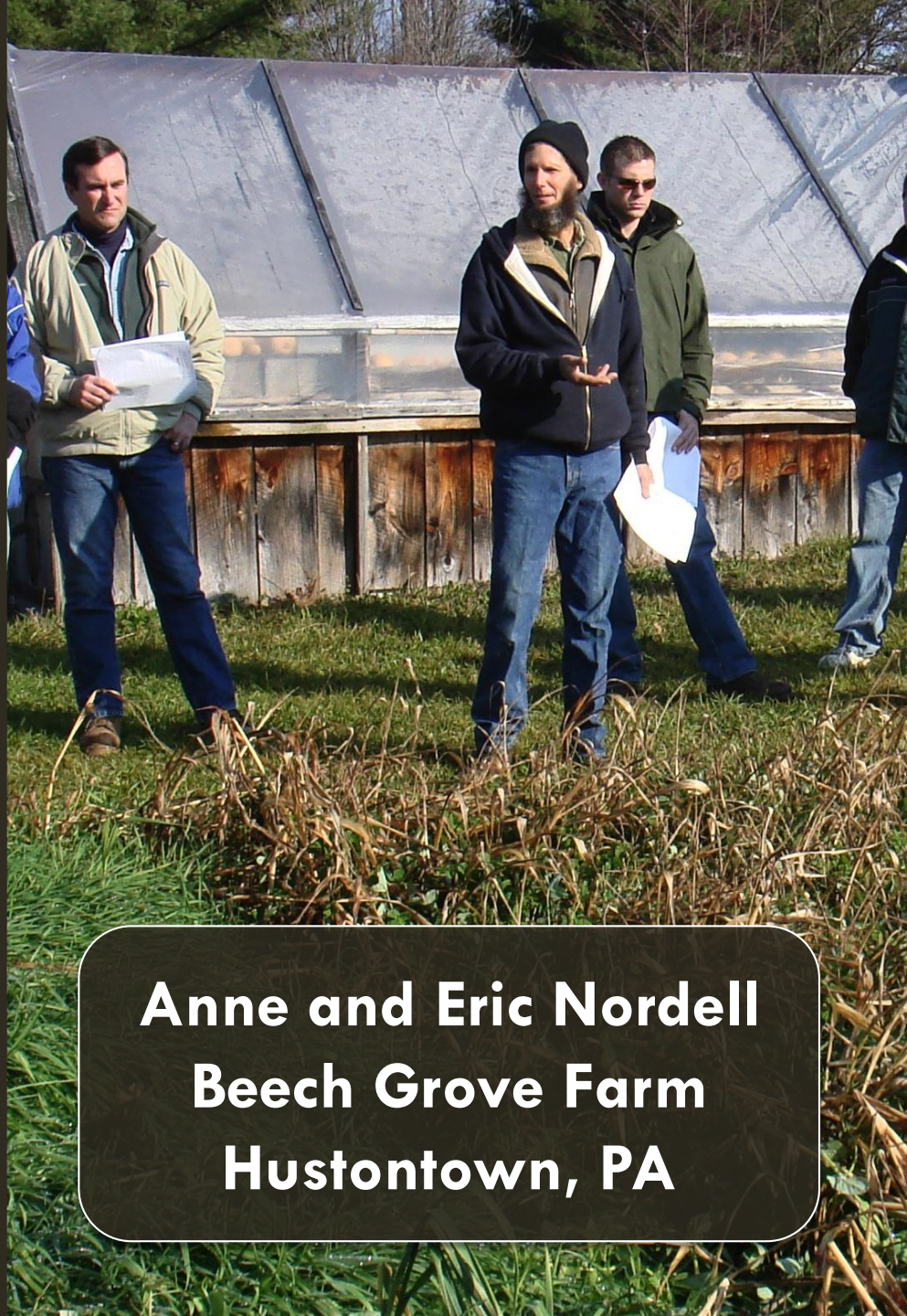
Weed the soil, not the crop

Contrasting philosophies

- Weeds are part of the system, some come in with the manure used on the farm, others from uncontrolled weeds. Weeds can be managed by using the right tools and giving crops a competitive advantage by establishing a size hierarchy.

- Use false-seed bedding and cover crops for expressive and suppressive management to weed the soil, not the crop.


Jim Crawford
New Morning Farm
Hustontown, PA



Anne and Eric Nordell
Beech Grove Farm
Hustontown, PA

“Weed the soil, not the crop”

- Zero tolerance for weed seeds
- Skim plowing
- Rotational cover cropping
  - cover crop / fallow / cover crop
  - timing of fallow alternates: spring / summer
  - fallow events include harrowing & cultipacking
- Intercropping
  - e.g., hairy vetch cover crop in onion, leek

Soil weed seed banks

Dixmont, ME Durham, ME Trout Run, PA

Eric Gallandt, University of Maine. www.gallandt.wordpress.com

Eric Gallandt, University of Maine. www.gallandt.wordpress.com

Which approach is right for you?

The right tool for the job

- Does not require advanced planning
- Risk of failure with poor weather
- Does not require constant vigilance

Weed the soil, not the crop

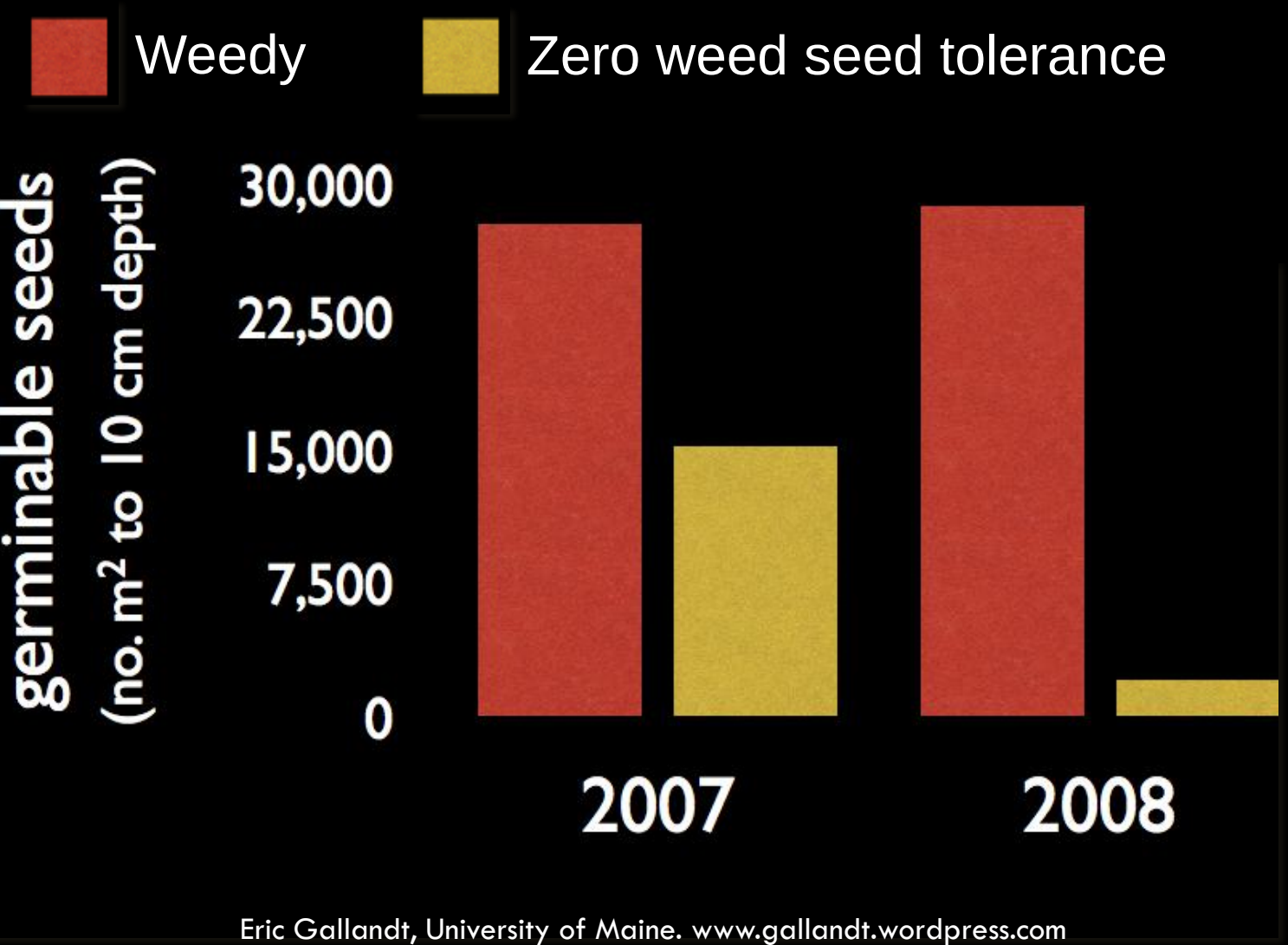
- Advanced planning essential for success
- Less dependent on weather
- Reduces labor before and after planting

Is 1 year's seeding really 7 years weeding?

Weed species	Year to 50% reduction	Years to 99% reduction
Common lambsquarters	12	78
Field pennycress	6	38
Common cocklebur	6	37
Yellow foxtail	5	30
Prostrate knotweed	4	30
Shepherd's purse	3	11
Giant foxtail	< 1	5

Davis, A., K. A. Renner, C. Sprague, L. Dyer, and D. Mutch. 2005. *Integrated Weed Management "One Year's Seeding…" Extension Bulletin E-2931. East Lansing, MI. Michigan State University.* and Fabian Menalled. **Weed Seedbank Dynamics & Integrated Management of Agricultural Weeds. MT200808AG Reprint 10/08.**

Effects on next year's seed bank



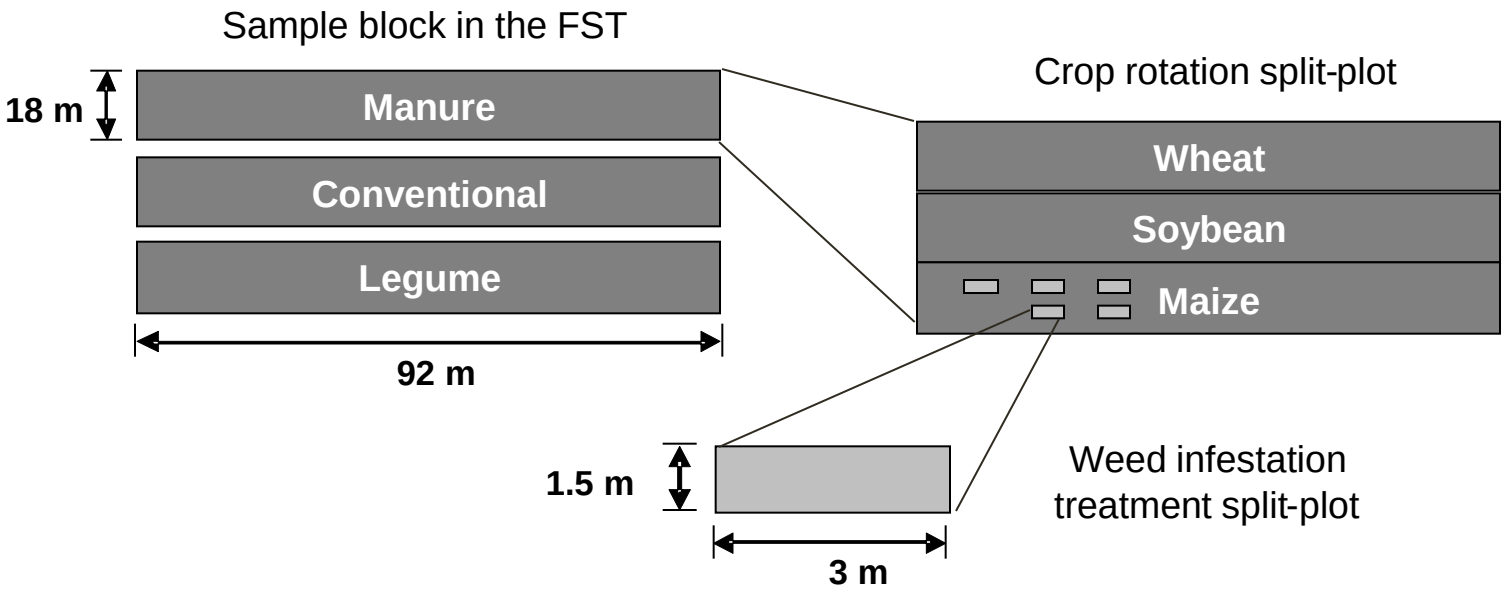
Eric Gallandt, University of Maine. www.gallandt.wordpress.com

Ideas for getting started

- Split farm into high and low seed bank fields for different crops.
- Start with the most productive fields, and focus on getting the seed bank under control there first.
- Talk to successful growers about their cultivation equipment, and be prepared to make an investment.
- Use adaptive weed management based on weed abundance.

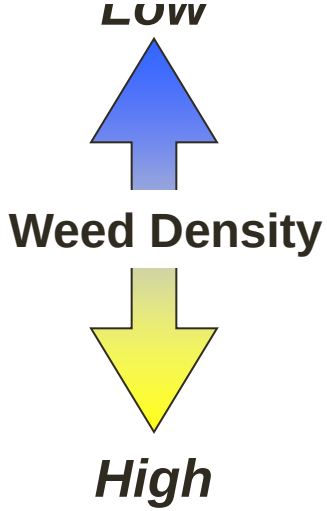
The Rodale Instiute, Photo – Jeff Mitchell

Component experiment (2005-2006)



Weed infestation treatments

- Weed free
- Standard management
- Intermediate management
- No management
- Supplemented weed seeds



Weed community structure

Standard Management

Manure	% B	B (g m^{-2})
Setaria spp.	68	371
A. theophrasti	10	57
A. artemisiifolia	9	50
A. retroflexus	6	30
C. album	2	14
Total	96	523

Legume		
Setaria spp.	84	263
A. theophrasti	9	27
A. artemisiifolia	4	12
Total	97	303

Conventional		
Setaria spp.	52	20
T. officinale	20	8
C. arvense	18	7
A. pilosus	6	2
Total	95	37

CNV weed management changed weed community more than organic management

Standard Management			No Management		
Manure	% B	B (g m^{-2})		% B	B (g m^{-2})
Setaria spp.	68	371	*Setaria* spp.	85	702
A. theophrasti	10	57	*A. artemisiifolia*	9	71
A. artemisiifolia	9	50	*C. album*	5	39
A. retroflexus	6	30	Total	98	812
C. album	2	14			
Total	96	523			
Legume					
Setaria spp.	84	263	*Setaria* spp.	82	816
A. theophrasti	9	27	*A. artemisiifolia*	8	77
A. artemisiifolia	4	12	*A. trifidia*	4	43
Total	97	303	*C. album*	4	36
			Total	98	972
Conventional					
Setaria spp.	52	20	*A. artemisiifolia*	54	369
T. officinale	20	8	*Setaria* spp.	22	151
C. arvense	18	7	*C. album*	17	116
A. pilosus	6	2	*O. stricta*	3	18
Total	95	37	Total	95	654