



# RODALE INSTITUTE

## **Cover Crops And The Search For Organic No-Till**

By Jeff Moyer  
Farm Director





**“Healthy Soil = Healthy Food = Healthy People”**

*J.I.Rodale*





# SYSTEM

From Wikipedia, the free encyclopedia

- A **system** is a set of interacting or interdependent components forming an integrated whole

Livestock, Crop Rotations & Cover Crops in a Soil Management System

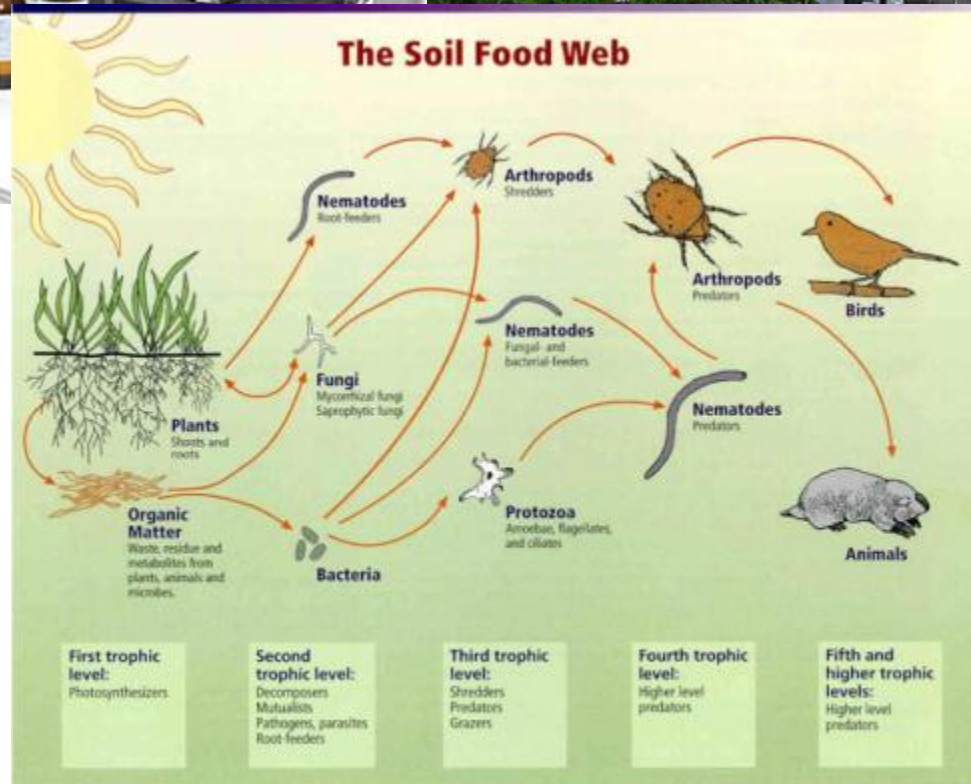


# Replace Chemistry & Bio-Technology





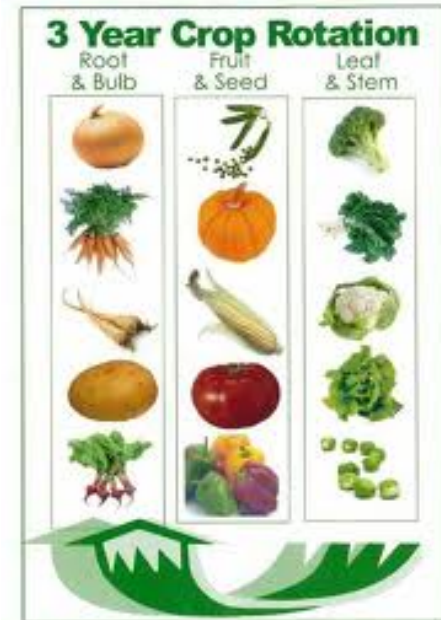
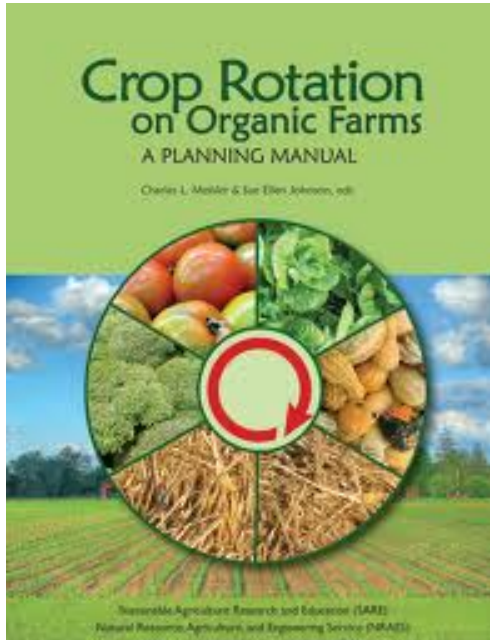
# With Biology



Relationships between soil food web, plants, organic matter, and birds and mammals



# Crop Rotation Protocols



- By Plant Type
- To Build Pest Resistance
- To Improve Soil
- To Make More Money
- To Enhance Biodiversity



# Cover Crops

**Soil cover (reduces erosion)**

**Builds soil organic matter**

**Deliver key nutrients (Legumes - N)**

**Conserves (recycles) nutrients**

**Nutrient source for soil microbes**

**Weed suppression**

**Breaks pest cycles**

**Reduces compaction**

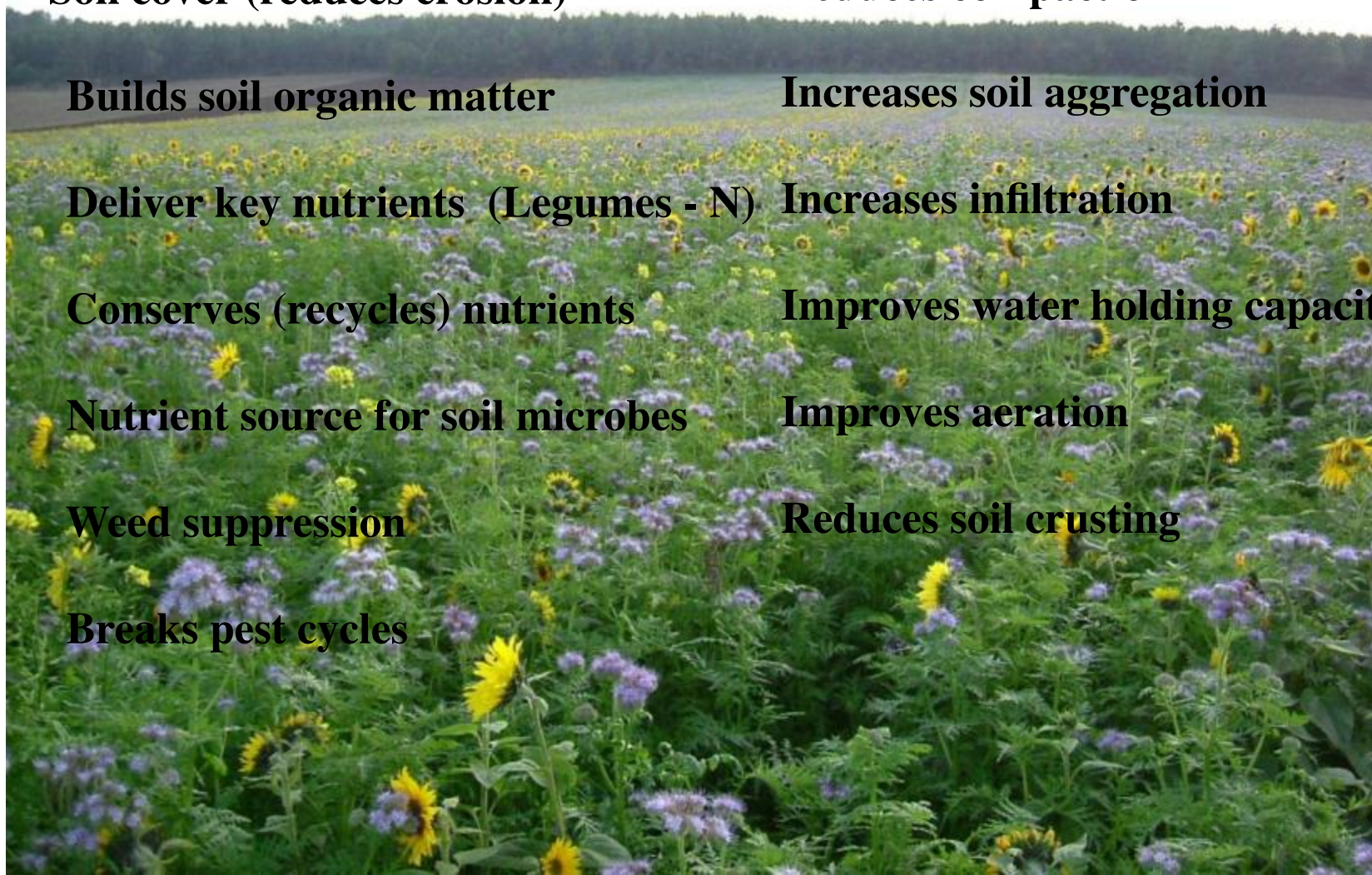
**Increases soil aggregation**

**Increases infiltration**

**Improves water holding capacity**

**Improves aeration**

**Reduces soil crusting**





# Tillage has its Drawbacks





# Tillage Opens the System Up to Damage





# Several Secondary Tillages





# A Different Way of Farming





# Past - equipment to kill cover crops

- **Culti-packer**
- **Stalk chopper**
- **Flail mower**





# Increasing the Weed Free Zone





# Tools That Make it Possible





# 16" Drum, (10) 4" Blades





# Corn

## PLOW TILL

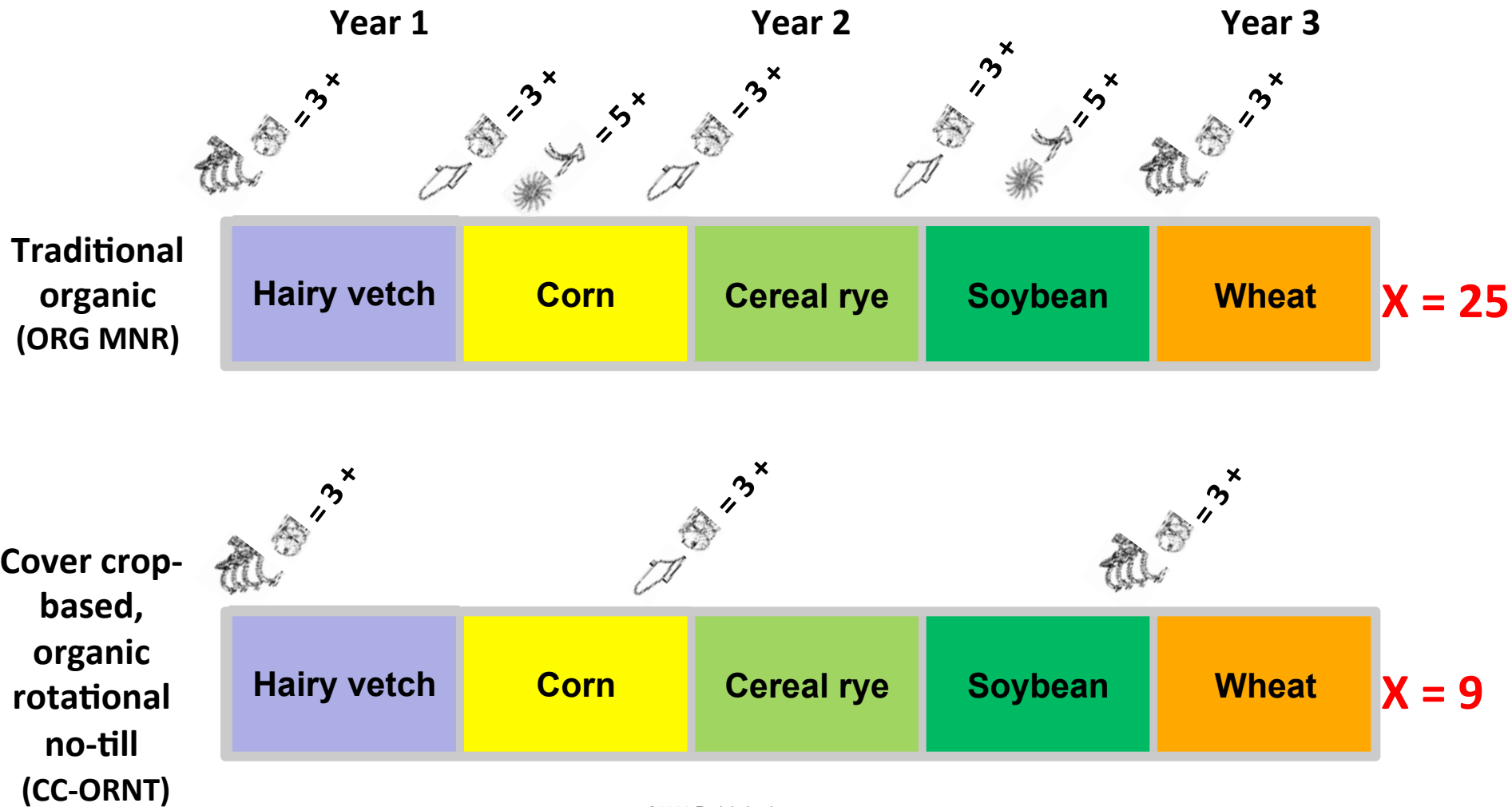
- PLOW
- DISC
- PACK
- PLANT
- ROTARY HOE
- ROTARY HOE
- CULTIVATE
- CULTIVATE
- HARVEST
- **(143 Bu/A)**

## NO-TILL

- ROLL/PLANT
- HARVEST
- **(160 Bu/A)**

A two-step organic production system Plant and Harvest!

# Tillage regimes based on management (3 yr rotation)





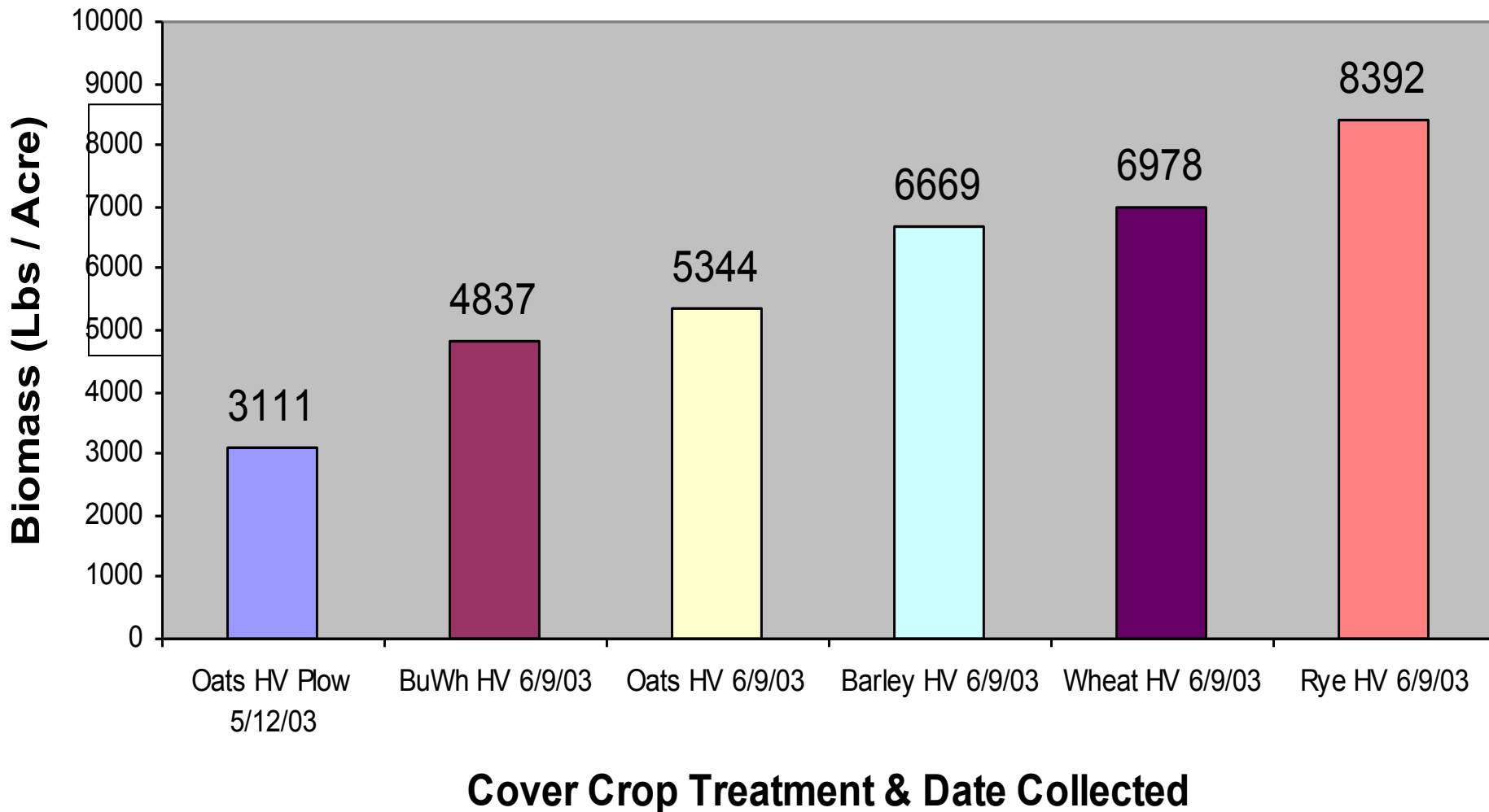
# Dense Cover Crops

## Prevent Weed Expression





# Average Biomass (lbs/A) of Cover Crop Mixtures: 2003 Corn Cover Crop Trial





# COVER CROPS – LIST FOR ROLLING

**Hairy Vetch**

**Rye**

**Buckwheat**

**Oats**

**Wheat**

**Annual Clovers, Crimson**

**Field Peas**

**Austrian Winter Pea**

**Barley**

copywrite: Jeff Moyer, Rodale Institute



# Selection of cover crops suitable for rolling

Cover crop	Type	Hardiness °F	Seeding rate lbs/acre	Biomass range tons/acre	N fixed lbs/acre	Stage for rolling
<b>Legumes</b>						
Crimson clover	Winter annual	0-10	9-40	1.5-3	70-130	Flowering
Hairy vetch	Winter annual	-10	20-40	1-3	80-250	Full bloom
Fava bean	Summer annual	20	80-170	1-2.5	70-220	Flowering
Field peas	Winter annual	10-20	70-120	1-2.5	170-190	Flowering
Soybean	Summer annual	NFT	60-120	1.5-4		any time
<b>Non-legumes</b>						
Buckwheat	Summer annual	NFT	35-134	1-1.5	N/A	Flowering
Winter barley	Winter annual	0	70-120	1.5-5	N/A	Anthesis
Spring barley	Summer annual	15	50-125	1.5-4	N/A	Anthesis
Spring oats	Summer annual	15-20	50-100	1.5-4	N/A	Milk stage
Winter rye	Winter annual	-40	60-200	2-5	N/A	Anthesis
Winter wheat	Winter annual	-25	120-160	1.5-3.5	N/A	Anthesis

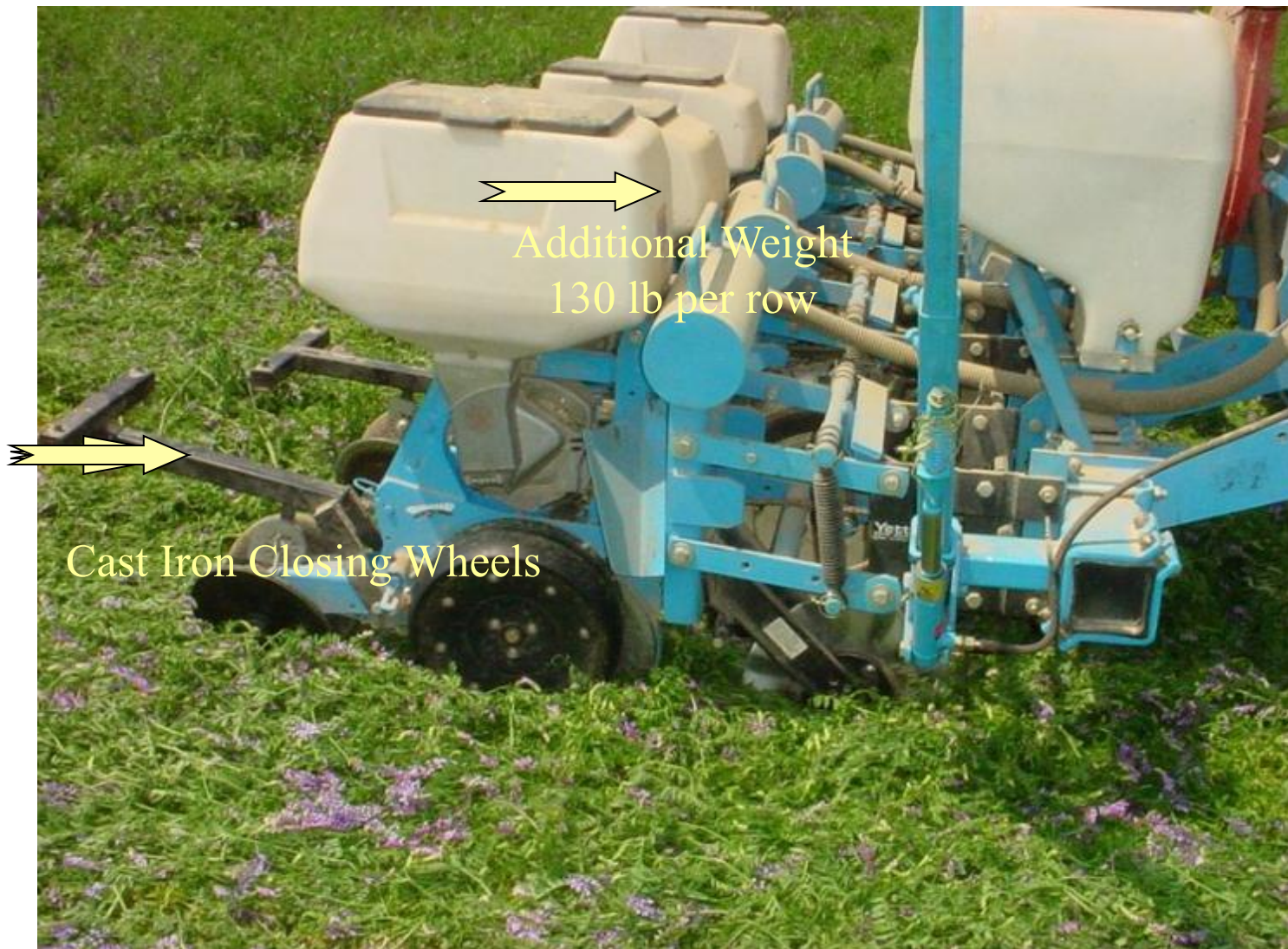
NFT= no frost tolerance

adapted from 'Managing Cover Crops Profitably', 'Northeast Cover Crop Handbook', 'Cover Crops for All Seasons'

For more details see also: Choosing the best cover crops for your organic no-till vegetable system, <http://newfarm.rodaleinstitute.org/features/0104/no-till/chart.shtml>



# Planter Modifications





# Yetter Residue Managers





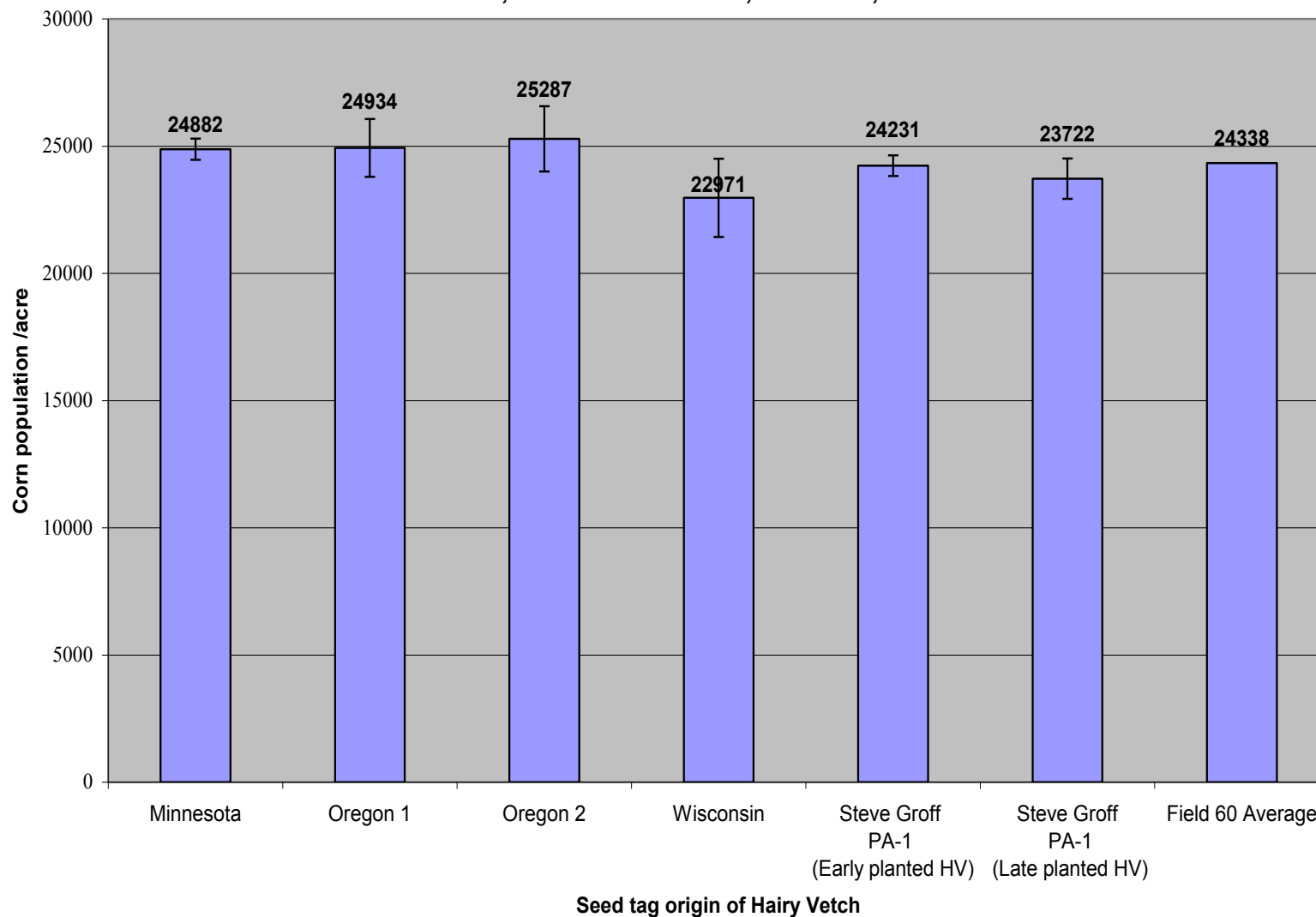
# Mis-Planted Seed





# 2006 Pre-harvest No-Till Corn Plant Population

2006 preharvest No-till Corn plant population  
Field 60, The Rodale Institute, Berks Co., PA





# Corn 3 Days After Planting





# Well “Sliced” Cover Crop Mulch





# Cover from Mechanical Kill





# Corn Planted into Hairy Vetch @ 3 Weeks After Planting





# Thick Mat of Terminated Cover Crop





# Corn Mid-Season





# No-Till Organic Corn at Harvest





# Production budgets for corn

	Organic Tilled	Organic No-till	Conv Tilled	Conv No-till
	vetch+ corn	vetch+ corn	corn	vetch+ corn
<b>Expenses</b>				
fertilizer	0.00	0.00	118.04	90.44
herbicide	0.00	0.00	108.19	144.56
seeds	139.40	139.40	88.15	148.35
custom haul	30.00	30.00	30.00	30.00
labor	39.35	18.61	15.78	16.14
fuel	47.60	23.96	23.76	20.67
repair & maintenance	17.56	10.35	8.42	8.97
interest on op.capital	6.35	4.54	11.50	13.50
fixed expenses	52.02	30.98	27.31	27.46
<b>Total Expenses (\$/acre)</b>	<b>332</b>	<b>258</b>	<b>431</b>	<b>500</b>
<b>Profit (\$/acre) *</b>				
@ 100 bu/a yield	<b>504</b>	<b>578</b>	<b>-16</b>	<b>-85</b>
@ 150 bu/a yield	<b>922</b>	<b>996</b>	<b>191</b>	<b>122</b>
@ 200 bu/a yield	<b>1,340</b>	<b>1,414</b>	<b>399</b>	<b>330</b>
<b>Break-even price (\$/bu)</b>				
@ 100 bu/acre	<b>3.32</b>	<b>2.58</b>	<b>4.31</b>	<b>5.00</b>
@ 150 bu/acre	<b>2.22</b>	<b>1.72</b>	<b>2.87</b>	<b>3.33</b>
@ 200 bu/acre	<b>1.66</b>	<b>1.29</b>	<b>2.16</b>	<b>2.50</b>

These production budgets were calculated using the free on-line Mississippi State Budget Generator (MSBG), developed by the Department of Agricultural Economics at Mississippi State University



# Energy budgets for corn

	Organic Tilled	Organic No-till	Conv Tilled	Conv No-till
Energy inputs	vetch+ corn	vetch+ corn	corn	vetch+ corn
Nitrogen fertilizer	0	0	9,875	4,942
Phosphorus fertilizer	0	0	391	391
Potassium fertilizer	102	102	118	118
Lime	203	203	243	243
Seed	2,559	2,559	1,182	2,468
Herbicide	0	0	1,055	1,509
Transportation of inputs	247	247	453	486
Equipment	639	615	619	509
Diesel fuel	5,359	3,046	2,725	2,201
Labor	1,041	511	712	563
<b>Total energy (MJ/ha*yr)</b>	<b>10,150</b>	<b>7,283</b>	<b>17,372</b>	<b>13,429</b>

This analysis was performed using the Farm Energy Analysis Tool (FEAT)<sup>3</sup>



# 2010 Soybean Research Plots





# 2012 Termination Trials - Soybeans



# Treatment #14 Planted May 23<sup>rd</sup> w/o Shark Teeth



Cover Crop Removed



Yield 17 Bu/A





# Treatment #11 Planted June 1st w/Shark Teeth



Yield 38 Bu/A



# Treatment #2 Planted May 23<sup>rd</sup> w/Shark Teeth



Yield 59 Bu/A



# Production budgets for soybeans

	Organic Tilled	Organic No-till	Conv Tilled	Conv No-till
	rye+ soybeans	rye+ soybeans	soybeans	rye+ soybeans
<b>Expenses</b>				
fertilizer	0.00	0.00	0.00	0.00
herbicide	0.00	0.00	16.32	35.79
seeds	93.02	93.02	57.34	111.34
custom haul	8.00	8.00	8.00	8.00
labor	36.87	16.13	11.36	10.93
fuel	44.03	20.38	16.00	14.10
repair & maintenance	15.62	8.41	6.25	7.04
interest on op.capital	5.06	3.43	3.45	8.08
fixed expenses	46.70	25.66	20.10	21.20
<b>Total Expenses (\$/acre)</b>	<b>249</b>	<b>175</b>	<b>139</b>	<b>216</b>
<b>Profit (\$/acre) *</b>				
@ 30 bu/a yield	<b>314</b>	<b>388</b>	<b>168</b>	<b>90</b>
@ 40 bu/a yield	<b>502</b>	<b>576</b>	<b>270</b>	<b>193</b>
@ 50 bu/a yield	<b>689</b>	<b>763</b>	<b>373</b>	<b>295</b>
<b>Break-even price (\$/bu)</b>				
@ 30 bu/acre	<b>8.31</b>	<b>5.83</b>	<b>4.63</b>	<b>7.22</b>
@ 40 bu/acre	<b>6.23</b>	<b>4.38</b>	<b>3.47</b>	<b>5.41</b>
@ 50 bu/acre	<b>4.99</b>	<b>3.50</b>	<b>2.78</b>	<b>4.33</b>

These production budgets were calculated using the free on-line Mississippi State Budget Generator (MSBG),

developed by the Department of Agricultural Economics at Mississippi State University



# Energy budgets for soybeans

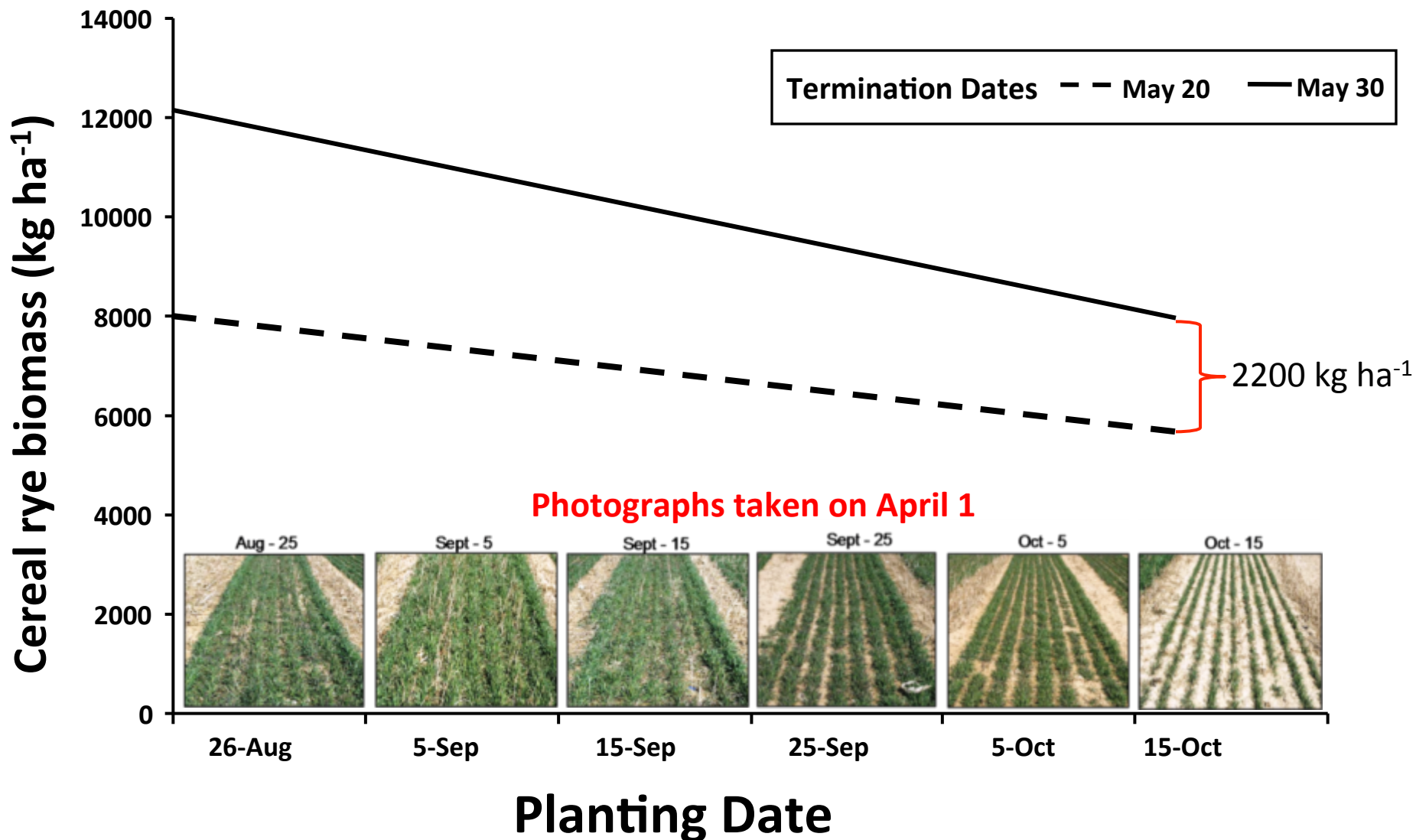
	<b>Organic Tilled</b>	<b>Organic No-till</b>	<b>Conv Tilled</b>	<b>Conv No-till</b>
<b>Energy inputs</b>	<b>rye+ soybeans</b>	<b>rye+ soybeans</b>	<b>soybeans</b>	<b>rye+ soybeans</b>
Nitrogen fertilizer	0	0	0	0
Phosphorus fertilizer	0	0	0	0
Potassium fertilizer	102	102	118	118
Lime	203	203	243	243
Seed	3,441	3,441	1,532	3,287
Herbicide	0	0	408	893
Transportation of inputs	465	465	315	497
Equipment	639	615	586	461
Diesel fuel	5,047	2,733	2,110	1,593
Labor	701	188	200	196
<b>Total energy (MJ/ha*yr)</b>	<b>10,597</b>	<b>7,747</b>	<b>5,512</b>	<b>7,288</b>

This analysis was performed using the Farm Energy Analysis Tool (FEAT)<sup>3</sup>,



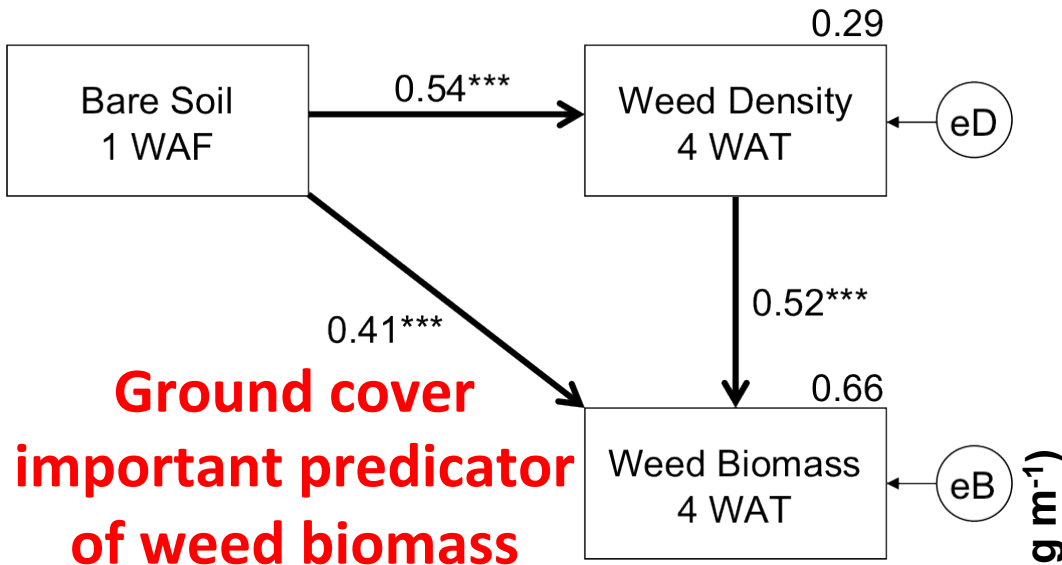
# Effects of planting and termination date on cereal rye biomass

(Penn State University, Rock Springs, PA; Aroostook cereal rye)



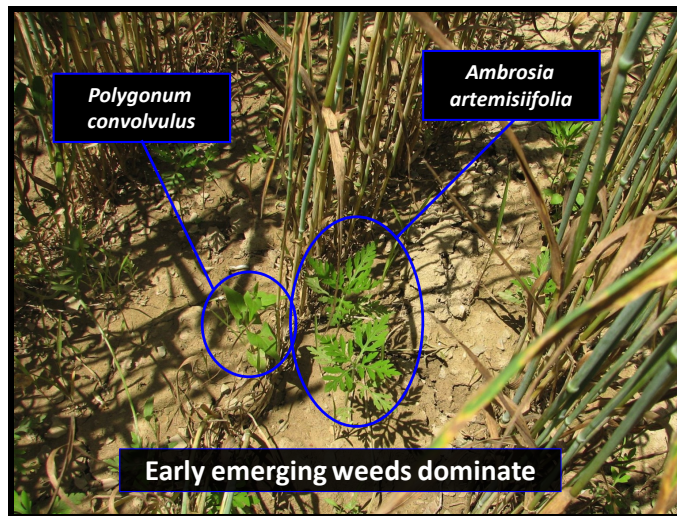
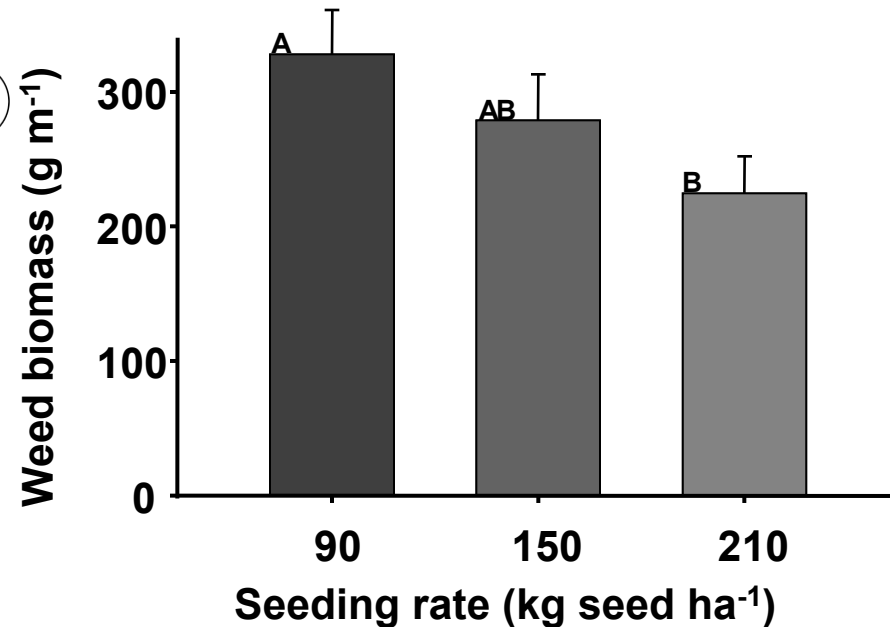


# Increasing seeding rate did not increase cereal rye biomass



**Ground cover important predictor of weed biomass**

**However, it did decrease weed biomass**





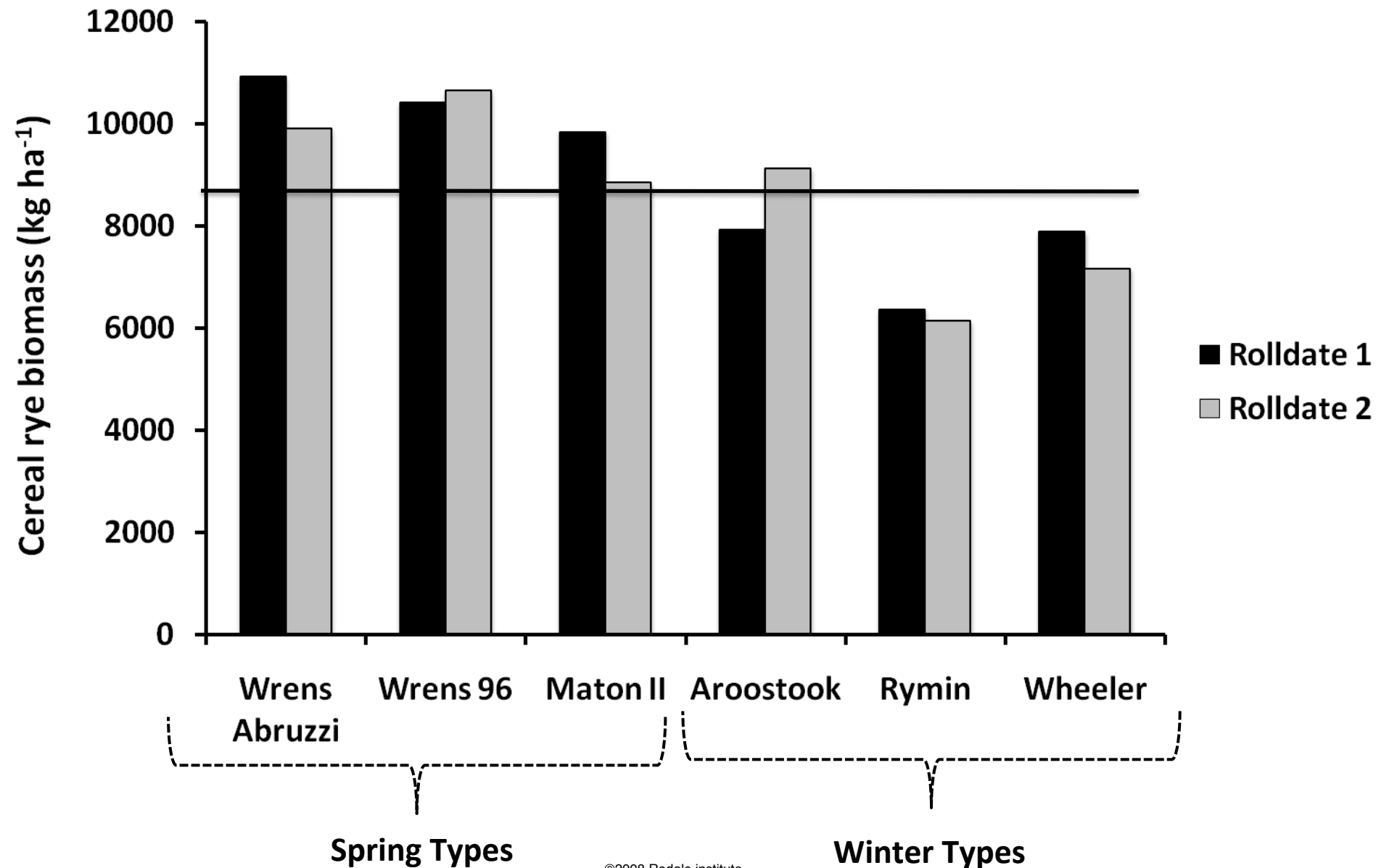
# **3 bu ac<sup>-1</sup> rye seeded on mid-September 50% broadcast 50% drilled**

**(Picture taken in late November)**





# Cereal rye cultivar biomass assessment (Kinston, NC 2010)





# R & G MILLER & SONS, INC.

## ORGANIC FAMILY FARMS



# Who . . . What . . . When

- **Certified through MOSA**
- **Started transitioning to organic production in 1994**
- **Certified crops in 1996 and milk in 1997**
- **Currently milking 320 cows**
- **Farming 1600 certified organic acres**
  - ▶ 300 pasture
  - ▶ 300 corn
  - ▶ 200 soybeans
  - ▶ 400 alfalfa
  - ▶ 100 grass hay
  - ▶ 300 small grains (oats, spelt, rye)
- **Added 93 transitional acres this year**





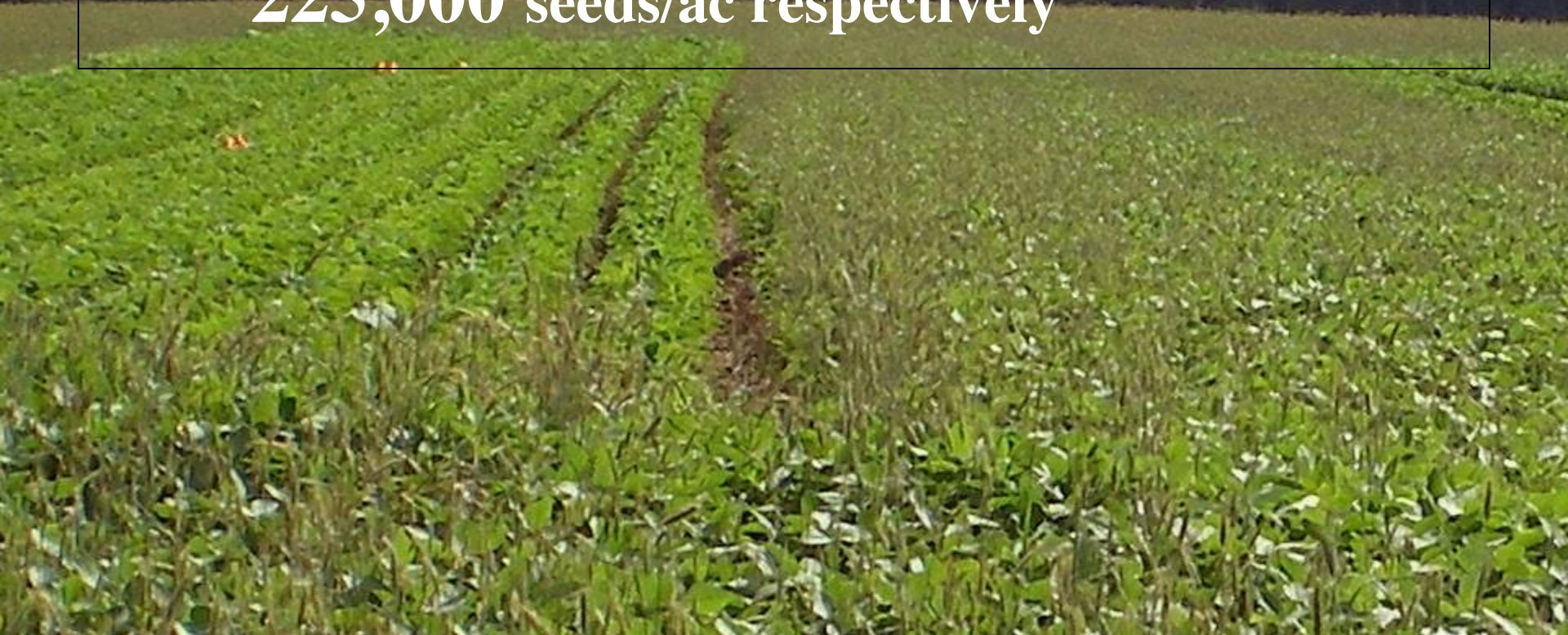
# NO-TILL SOYBEANS 2007



copyright: Jeff Moyer, Rodale Institute

# 2008

- **plant date: June 2<sup>nd</sup> (drilled beans)**  
**June 19<sup>th</sup> (row beans)**
- **plant population: 250,000 and 225,000 seeds/ac respectively**



# NO-TILL SOYBEANS

2008

- harvest date: November 4<sup>th</sup>
- yield: 32bu/ac (average)
- overall farm soybean yield: 24 bu/ac

09/11/2008

September 11, 2008



# Windy Acres Farm



Visit us at our farm store at:

5376 East Robertson Rd, Orlinda, TN 37141

615-654-FARM (3276) email us at

[debbie@windyacresfarm.com](mailto:debbie@windyacresfarm.com)

Alfred & Carney Farris



# Windy Acres Farm 2011





Here's a picture yesterday of seeding Sheyenne Organic Soybeans into rye about 5 feet high in Vermont. The fluted Yetter coulters worked great as did the I & M roller on the front of the tractor. JIM GEER



# California Transplanted Eggplant





# Sorghum Sudan Grass





# No-Till Pumpkins into Rye – Long Island, NY





# 2009 Tomato





# 6 weeks after rolling





# No-Till Grain Drill



copywrite: Jeff Moyer, Rodale Institute



# No-Till Transplanters





# Horse Drawn No-Till Transplanter



# Irrigation on Rolled/Crimped Cover Crop





# Horse Drawn & Pull Type





# 30' Roller – West Africa





# Roller/Crimper for Raised Beds





# The Concept is Scale Neutral





# Earth Tools

Walk-Behind Tractors & Compatible Implements

( 5 0 2 ) 4 8 4 - 3 9 8 8





Clove Oil:  
Application



# High Residue Cultivator





# High Residue Cultivation





# Future Research Needs



- Full cropping **system** integration
  - 1) Crop maturity
  - 2) Insect dynamics
  - 3) Whole system weed seedbank management
  - 4) Nitrogen cycle impacts



- Optimal high residue cultivation timing



- Develop better understanding of timing



- Rye biomass (decision tool)

- Enhance equipment for seed placement
- Identification of improved varietal traits in both cover crops and cash crops
- Spatial variability in cover crop performance



# Rodale Institute

**Thank You!**

Jeff Moyer

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**610-683-1420**

