Regenerative Agricultural

"Healthy Soil = Healthy Food = Healthy People"

By Jeff Moyer

Farm Director

Inspirational Wisdom

- " A nation that destroys its soil destroys itself."

  Franklin Delano Roosevelt

- "Despite all our pretensions, we still are totally dependent on 6 inches of top soil and the fact that it rains."

  Confucius

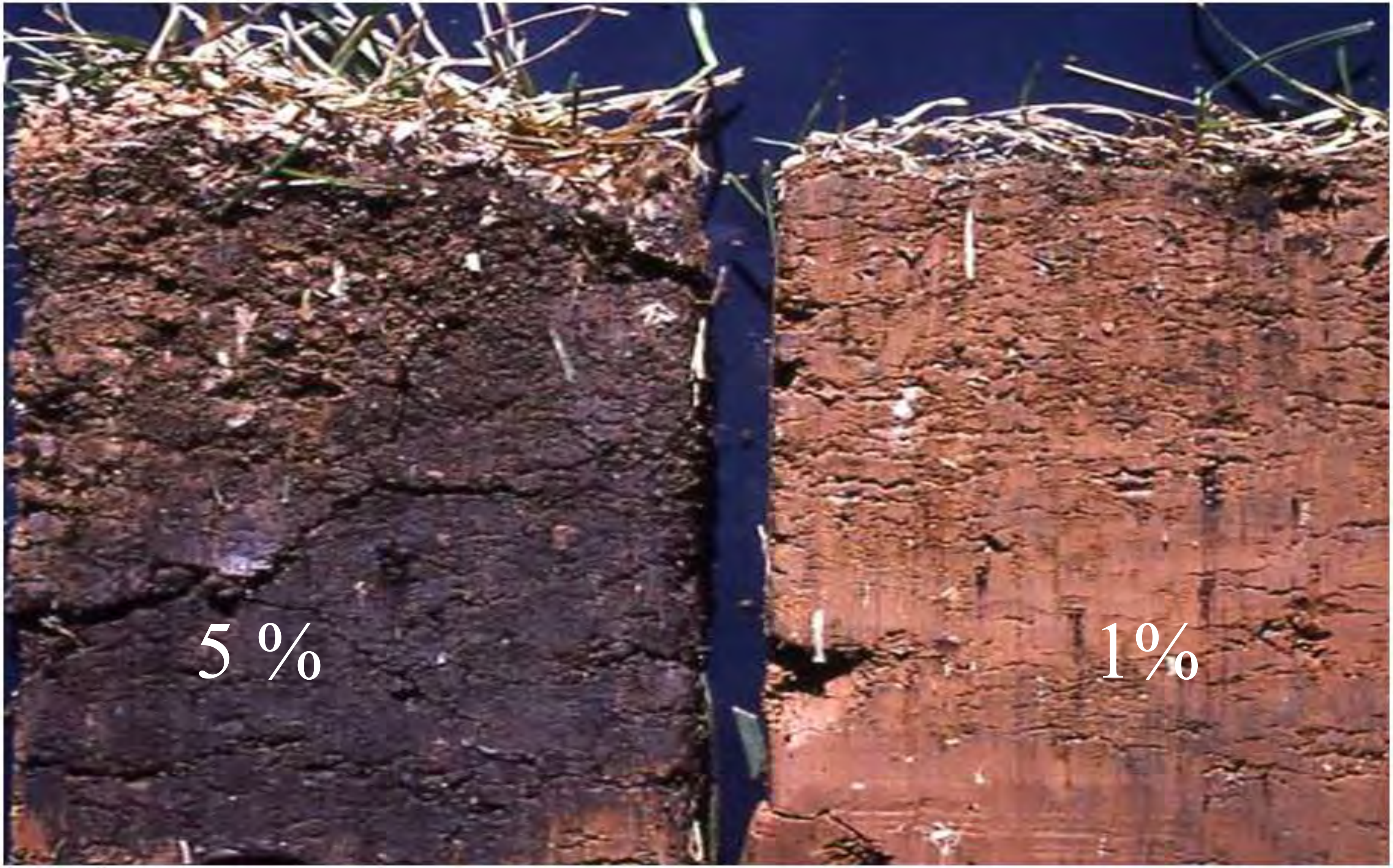
- "Nature is the greatest gift of all!"

  "Soil has the ability to regenerate itself"

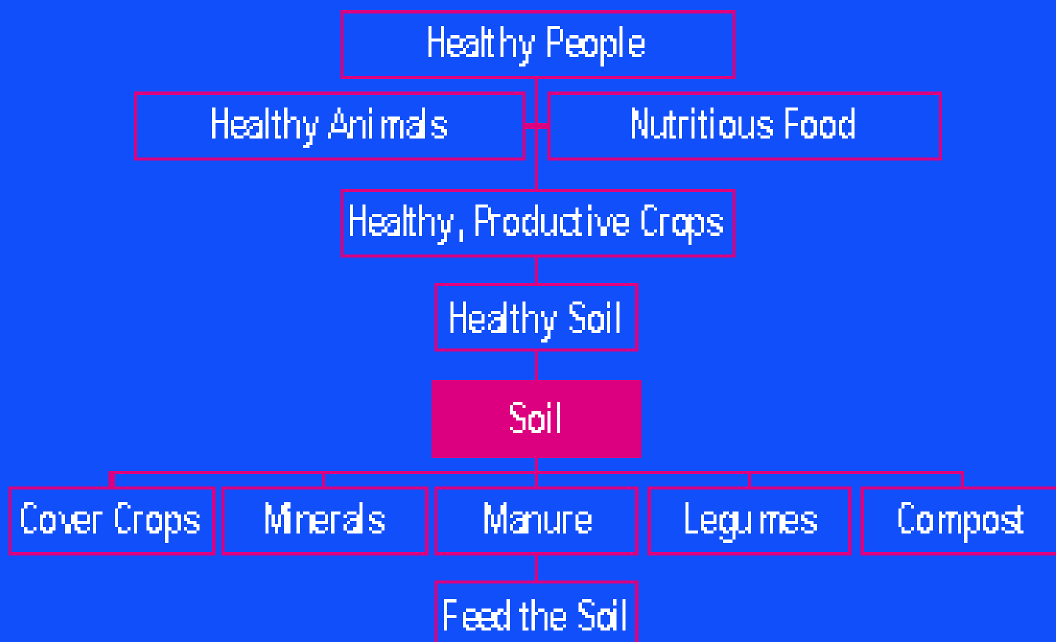
  Robert Rodale

Rodale Institute Paradise Lost

Soil Organic Matters



Building Healthy Soils



Ohio State University

Soil Microorganisms

Group	Average Number per Gram Of Soil	Live Weight per Acre Plow Depth (pounds)
Bacteria Actinomycetes	1 billion 10 million	500 750
Fungi	1 million	1,000
Algae	100 thousand	150
TOTAL		2,400

Francis E. Clark, *A Perspective of the Soil Microflora*, Soil Microbiology Conf.,
Purdue University (June 1954)

Typical Numbers of Soil Organisms in Healthy Ecosystems

	Crop Land	Prairie	Forest
	Organisms per gram (teaspoon) of soil		
Bacteria	100 mil. -1 bil.	100 mil. -1 bil.	100 mil. -1 bil.
Fungi	Several yards	10s – 100's of yds	1-40 miles (in conifers)
Protozoa	1000's	1000's	100,000's
Nematodes	10-20	10's – 100's	100's
	Organisms per square foot		
Arthropods	< 100	500-2000	10,000-25,000
Earthworms	5-30	10-50	10-50 (few in conifers)

Same Resources…… Different Philosophy

The RODALE INSTITUTE

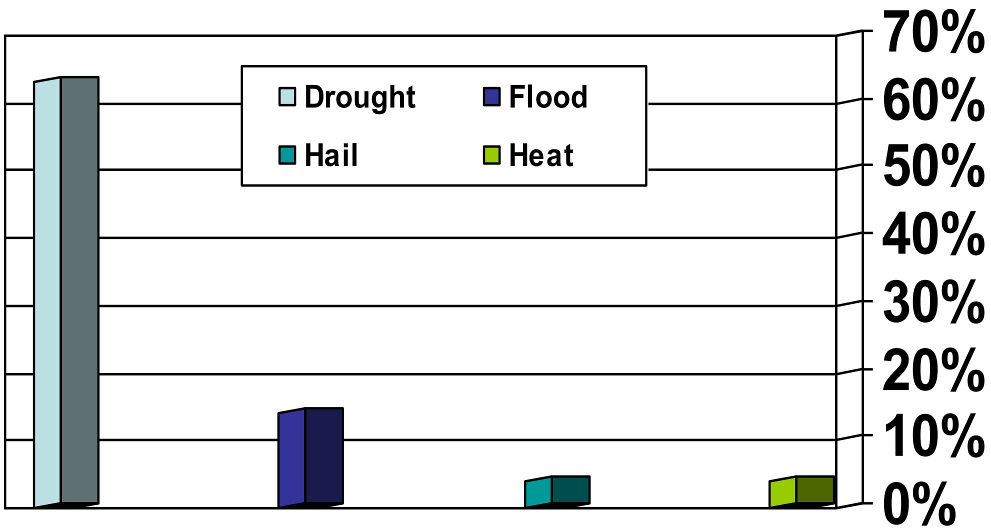
Soil in Organic Systems

- Higher corn and soybean yields in drought years
- Increased soil C and N

- Higher water infiltration
- Higher water holding cap.
- Higher microbial activity

Organic Corn - 1995 Drought

Crop Insurance Losses PA



Drought	63%			
Flood		14%		
Hail			4%	
Heat				4%

Soil Degradation

- Erosion
- Organic matter loss
- Acidification
- Reduced biological activity
- Nutrient depletion
- Compaction
- Salinization
- Water-logging
- Chemical toxicity

Soil Health/Soil Quality

- What is it?
  - » definitions, indicators
- How do you measure and evaluate it?
  - » monitoring, interpretation
- How do you improve it?
  - » management, modification

Ohio State University

One Solution is Organic Production

What Seems to be Concrete Often Isn't

Published Research

The Myth of Nitrogen Fertilization for Soil Carbon Sequestration
S.A. Khan, R.L.Mulvaney, T.R.Ellsworth, and C.W.Boast Univ. of Ill

Conclusion: A half century of N fertilization has played a crucial role in expanding worldwide grain production, but there has been a hidden cost to the soil resource: a net loss of native SOC and the residue C inputs. This cost has been exacerbated by the widespread use of yield-based systems for fertilizer N management, which are advocated for the sake of short-term economic gain rather then long term sustainability.

Published in Journal of Environmental Quality (2007)

Published Research

Synthetic Nitrogen Fertilizers Deplete Soil Nitrogen: A Global Dilemma for Sustainable Cereal Production

R.L.Mulvaney, S.A. Khan, and T.R.Ellsworth, Univ. of Ill

Conclusion: There is a prevailing view that global food and fiber production will continue to expand …. dominated by synthetic ammoniated fertilizers. ….. *Overwhelmingly*, the evidence is diametrically opposed to the buildup concept and instead corroborates a view elaborated long ago by White (1927) and Albrecht (1938) that fertilizer N depletes SOM by promoting microbial C utilization and N mineralization. An inexorable conclusion can be drawn: The scientific basis for input-intensive cereal production is *seriously* flawed

Published in Journal of Environmental Quality (2009)

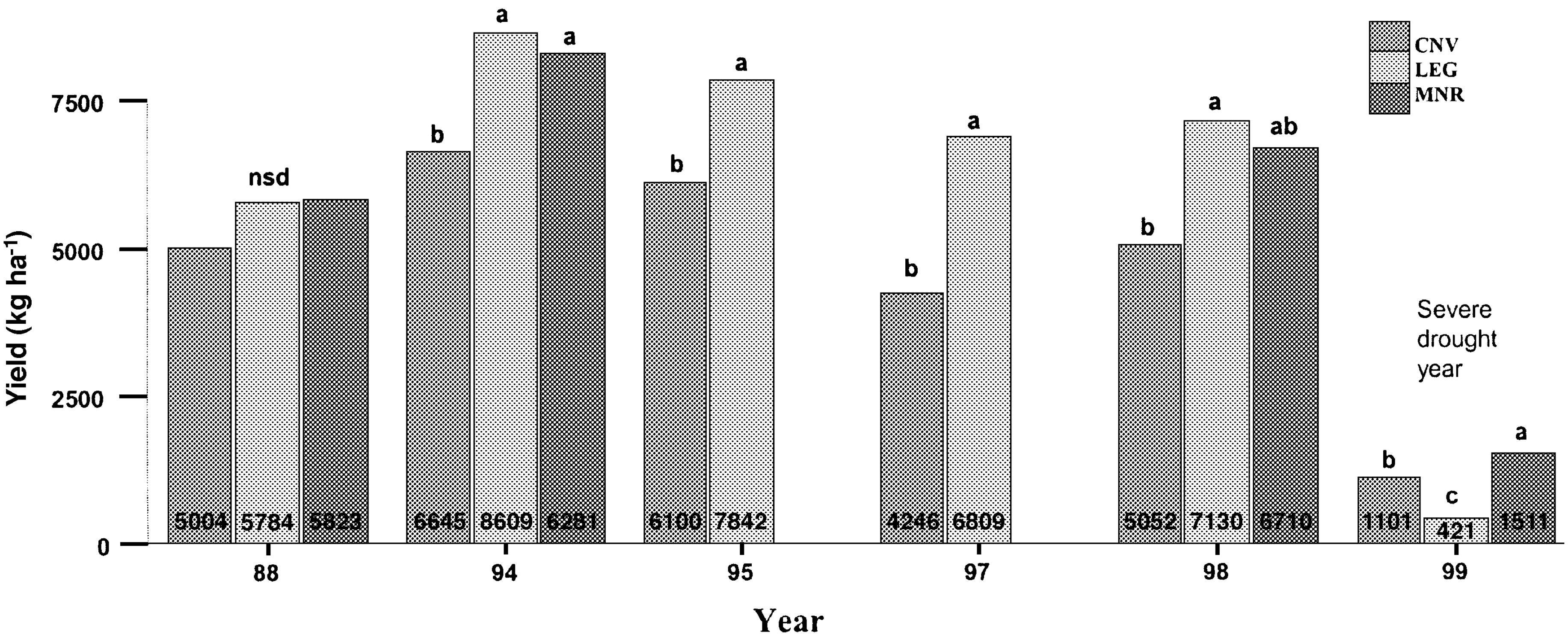
The performance of organic and conventional cropping systems in an extreme climate year

D.W. Lotter, R. Seidel and W. Liebhardt

American Journal of Alternative Agriculture

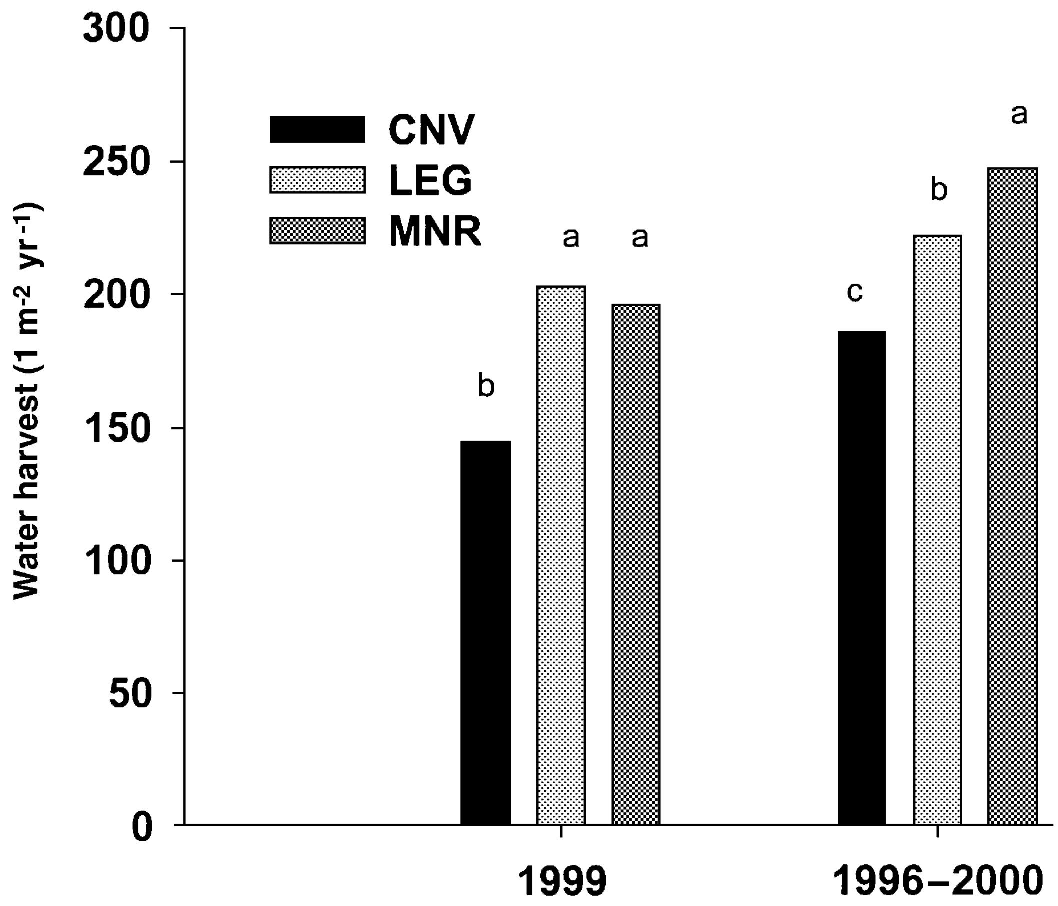
Volume 18, Number 3, 2003

Comparative Corn Yields in Drought Years



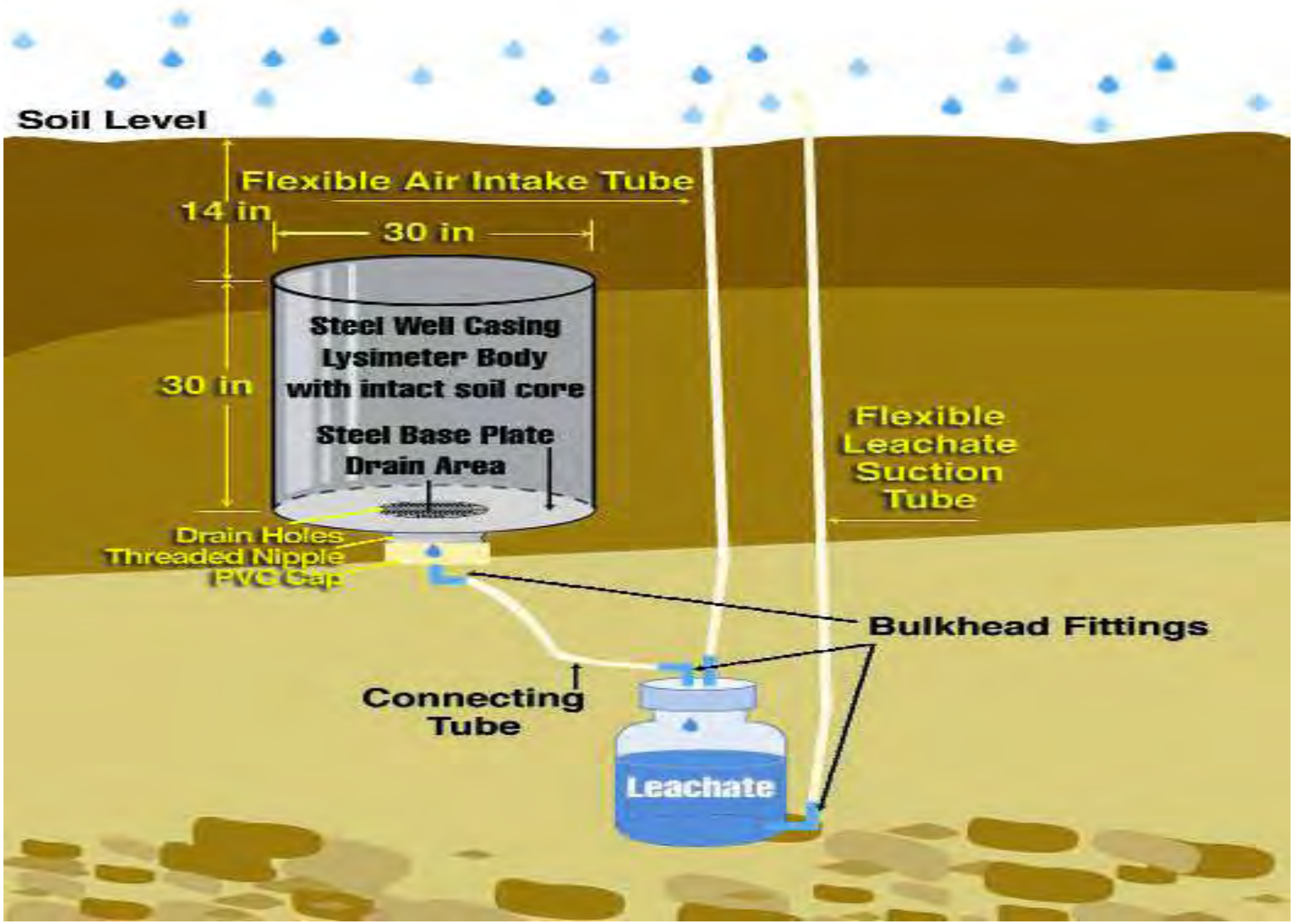
Maize yields in drought years (total April to August rainfall less than 350 mm). Different letters above bars in the same cluster denote statistical signi®cance at the 0.05 level. Letters denoting signi®cance are for one year only. CNV, conventional management; LEG, legume-based organic; MNR, manure-based organic.

Water Percolation in Soils under Different Management



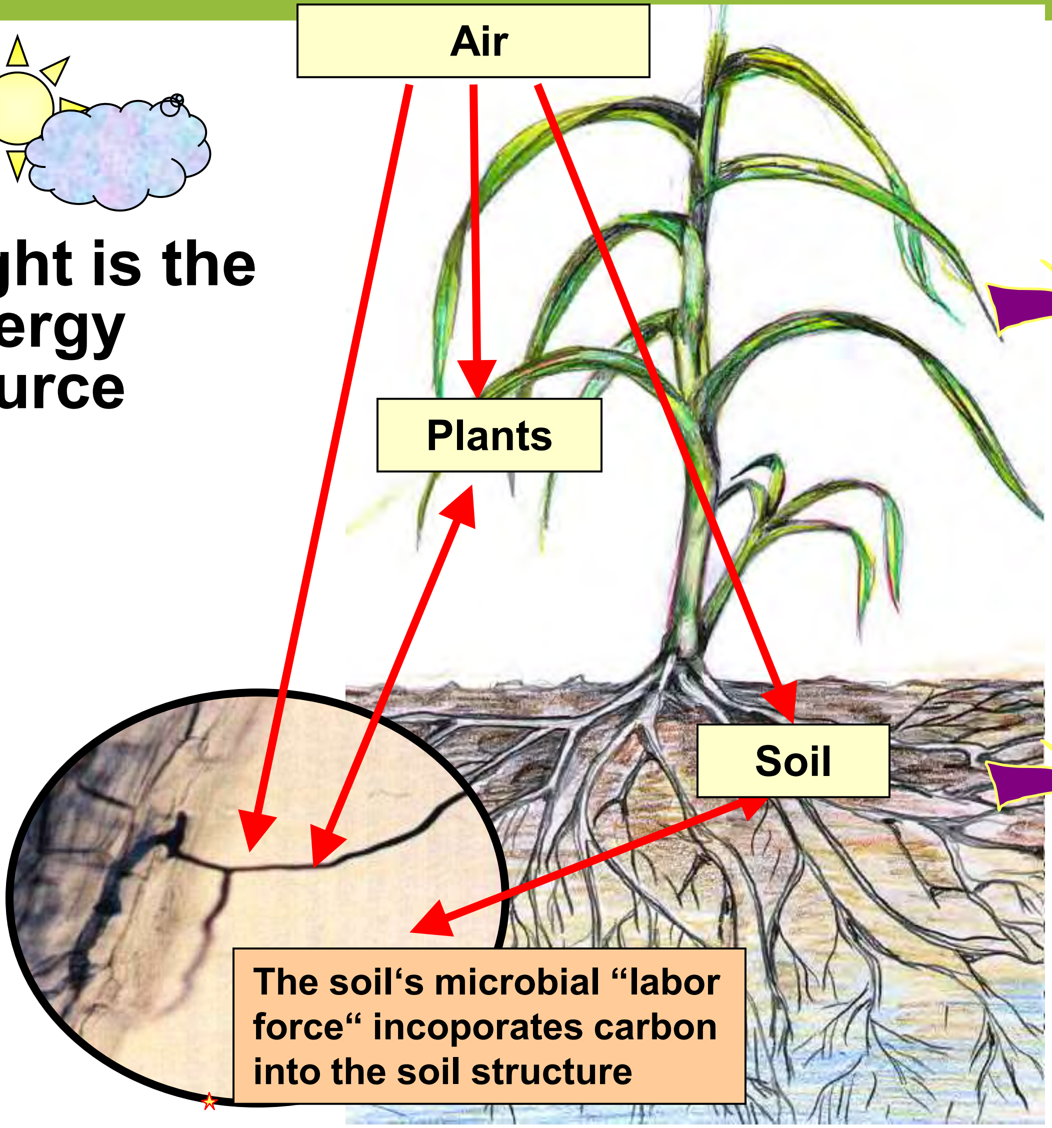
Percolated water harvested in 1999 and the average of 1996±2000 from the three crop systems in the Rodale Farming Systems Trial. Letters denoting signi®cance are for one set of bars only. CNV, conventional management; LEG, legume-based organic; MNR, manure-based organic.

Intact Soil Core Lysimeter



Proven Carbon Sequestration

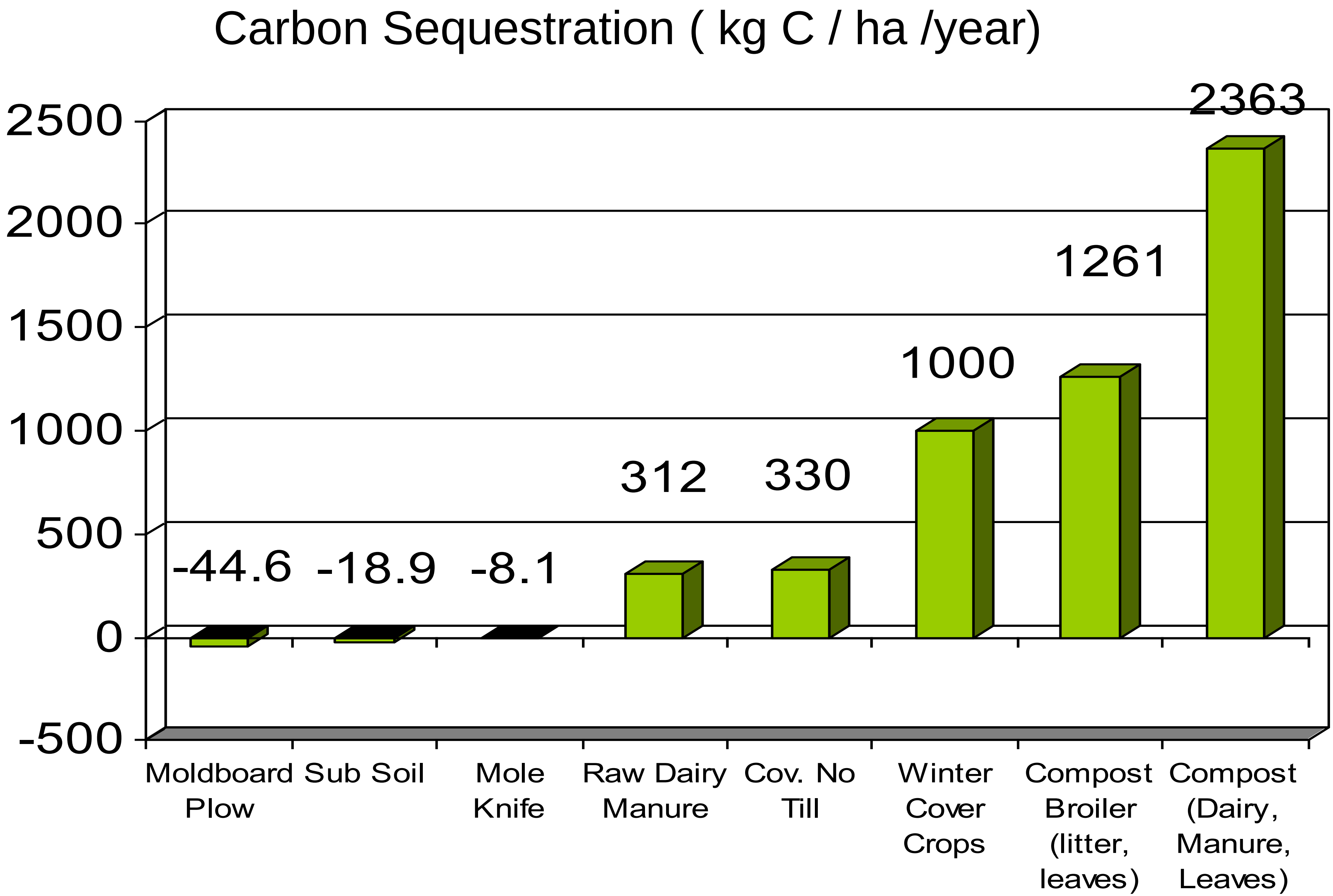
Light is the energy source



Human nutrition and health starts in the soil, from which plants draw their nutrients

The soil microbial community provides the nutritional building blocks that plants need to grow and thrive

Carbon Impact by Field Treatment



Carbon Sequestration Combines Well with Low Inputs

Table 2. Gross carbon sequestration, carbon emissions, and net carbon sequestration associated with conventional no till, cover crop tillage (organic) and biological no till.

Parameters	Conventional No Till[w]	Cover Crops Till[x]	Blogical No Till[y]
	----------------------------	(kg Carbon/ha/yr)	----------------------------
Gross Carbon Sequestration	+330	+1,000	+1,330
Carbon Emissions	-148	-78	-59
Net Carbon Sequestration	+182	+924	+1,271
Gross C-Seq Ratio	1	~3	~4
Net C-Seq Ratio	1	~5	~7

wMeta-analysis of conventional no till West and Marland 2002.
xHepperly, 2003, Pimentel et al. 2005, Teasdale et al. 2007 and Veenstra et al. 2006.

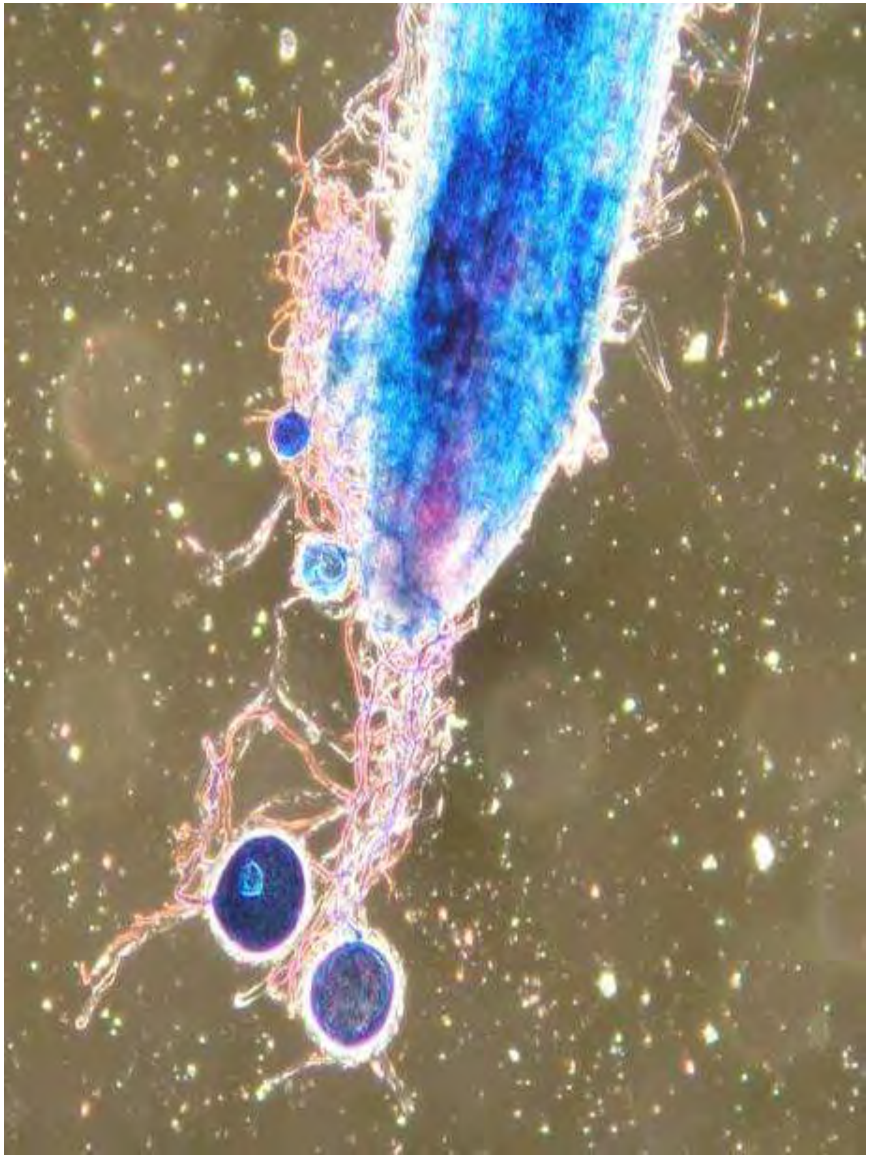
zValue projected using on additive model for carbon sequestration and input adjustments based on system requirements

Mycorrhizal Fungi

Dr. David Douds -

USDA-ARS Researcher, specializing in beneficial root fungi research for the last 25 years

Mycorrhizal Fungi



- Extends plant root systems
- Produces erosion-resistant, carbon enriched soil
- Provides mechanisms for soil biological carbon fixation Glomalin
- Slows decay of organic matter

NITROGEN

FERTILIZATION

NITROGEN

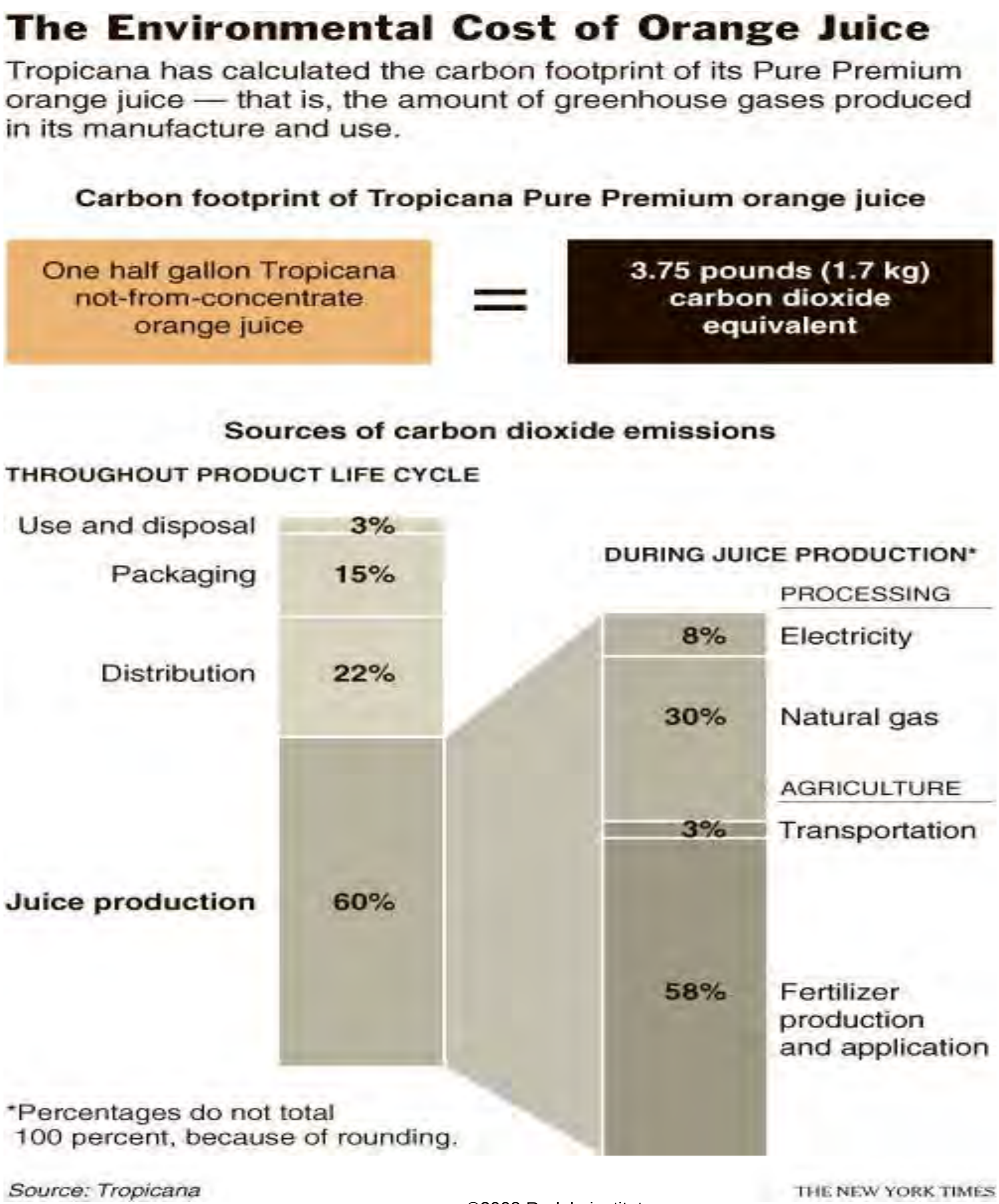
Chemical synthetic N fertilizer

- produced by the industrial Haber-Bosch process
- requires huge amounts of energy to create the 2939 PSI and 842ºF of heat
- needed to industrially extract N from the atmosphere and hydrogen from natural gas.
- The production of 1 kg (2.2lbs) of chemical N fertilizer burns the equivalent of 1 L (1.05 Qt.) of oil and 17.6 cubic feet of natural gas, releasing a great deal of carbon and other greenhouse gasses into the atmosphere

How Green Is My Orange?

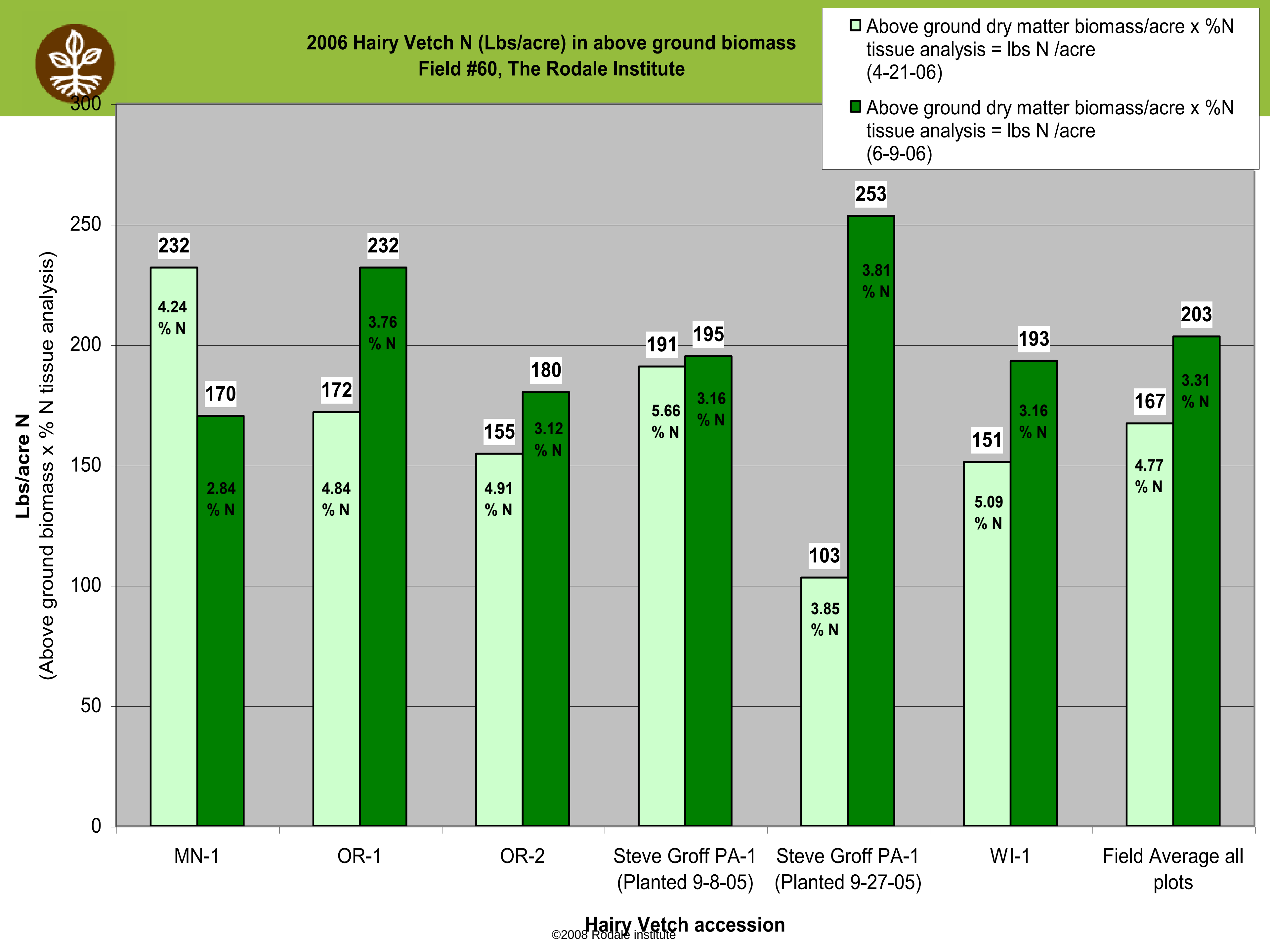
New York Times, Jan. 2009
PEPSICO/ Tropicana

Carbon Footprint



Let’s Take a Look at
Some Tools to Build Soil Health
Cover Crops

Biological Nitrogen Fixation


2006 Hairy Vetch N (Lbs/acre) in above ground biomass
Field #60, The Rodale Institute
Above ground dry matter biomass/acre x %N tissue analysis = lbs N /acre (4-21-06)
Above ground dry matter biomass/acre x %N tissue analysis = lbs N /acre (6-9-06)
Lbs/acre N
(Above ground biomass x % N tissue analysis)
0
50
100
150
200
250
300
232
4.24 % N
170
2.84 % N
172
4.84 % N
232
3.76 % N
155
4.91 % N
180
3.12 % N
191
5.66 % N
195
3.16 % N
103
3.85 % N
253
3.81 % N
151
5.09 % N
193
3.16 % N
167
4.77 % N
203
3.31 % N
MN-1
OR-1
OR-2
Steve Groff PA-1 (Planted 9-8-05)
Steve Groff PA-1 (Planted 9-27-05)
WI-1
Field Average all plots
Hairy Vetch accession
©2008 Rodale institute


Let's Take a Look at
Some Tools to Build Soil Health
Compost

Compost Science and Utilization (2009), vol. 17 No. 2, 117-126

Compost, Manure and Synthetic Fertilizer Influences Crop Yields, Soil Properties, Nitrate Leaching, and Crop Nutrient Content

P.Hepperly, D.Lotter, c.ziegler-Ulsh,R.Seidel, and C.Reider

Conclusion

Both compost treatments supported both high yields and increased C and N content, while synthetic chemical fertilizer and raw manure produced only high yields but did little or nothing to improve soil C and N content. Extrapolation of these soil C and N trends suggest that, although chemical fertilization is able to stimulate high short-term yields, it will not be able to support sustainable crop productivity, crop health, or soil health, over longer time periods.

Bio-Diversity

For the First Time in History We Have the Power to Crush Our Environment


National Organic Program
USDA
ORGANIC

- **Authority:** 7 U.S.C. 6501–6522.
- **Source:** 65 FR 80637, Dec. 21, 2000, unless otherwise noted.
- **Subpart A—Definitions**
- **§ 205.1 Meaning of words.**
- **§ 205.2 Terms defined.**
- *Organic production.* A production system that is managed in accordance with the Act and regulations in this part to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity.

Tillage has it’s Drawbacks

A Different Way of Farming

Organic No-Till

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!

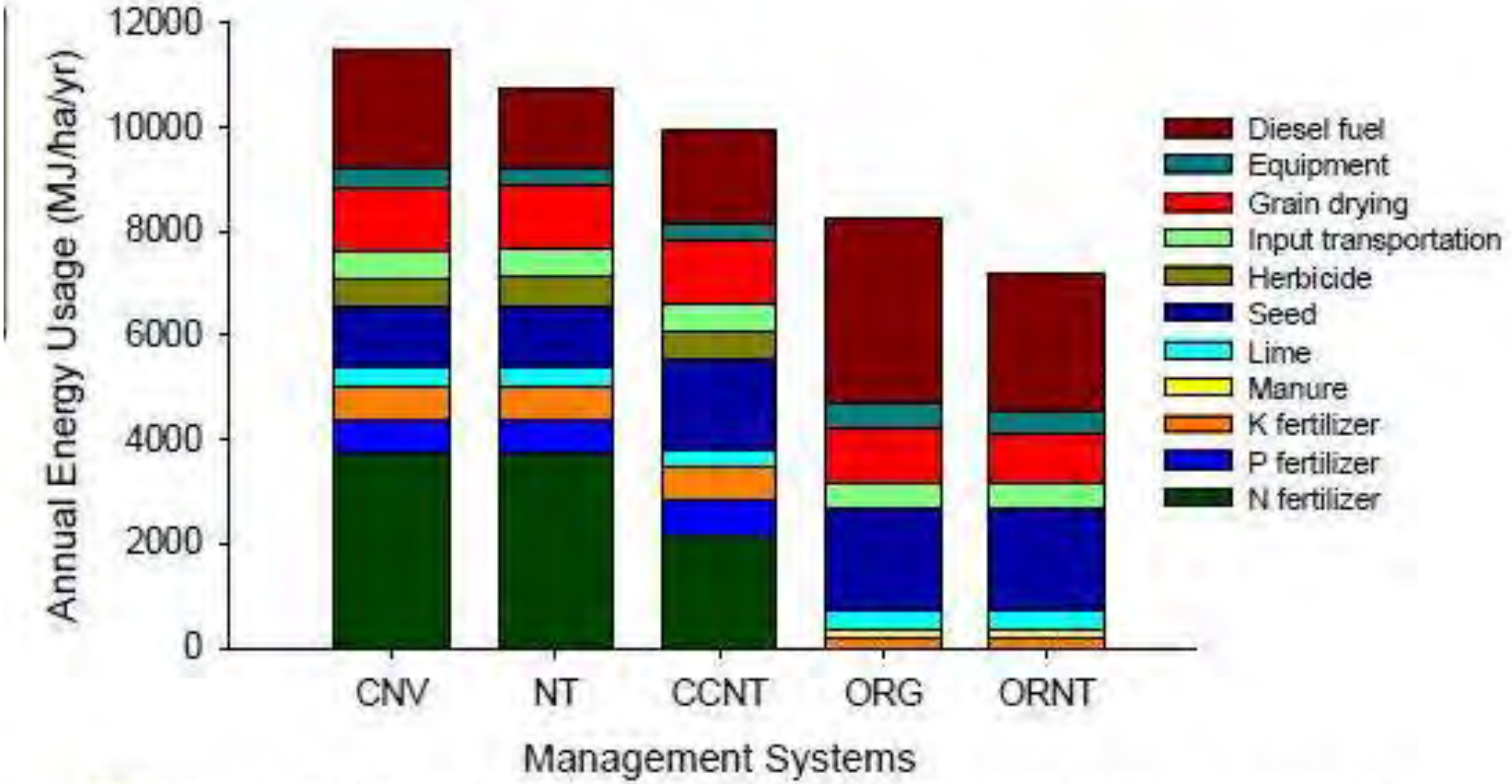


Figure 1. Annual energy usage across cropping systems. Parameter values used and references are available (see supplement).

Ryan et al - 2009

Corn 3 Days After Planting

Cover from Mechanical Kill

Corn Mid-Season

2007 Drilled Beans into Rye

2009 Tomato

6 weeks after rolling

30 Foot Roller Illinois

Works on Small Scale Ag Systems

3 Foot Crimper in Vermont

HEALTHY SOIL BEGINS WITH YOU