Economics of Cover Crops

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EMPOWERMENT THROUGH EDUCATION

THE OHIO STATE UNIVERSITY EXTENSION

Cost of Tillage Operations/Acre

- Chisel Plow $14/A
- Disk Tandem $13/A
- Field Cultivate $11/A
- Plow $17/A
- Soil Finishing Tools $11/A

- Subsoil $18/A

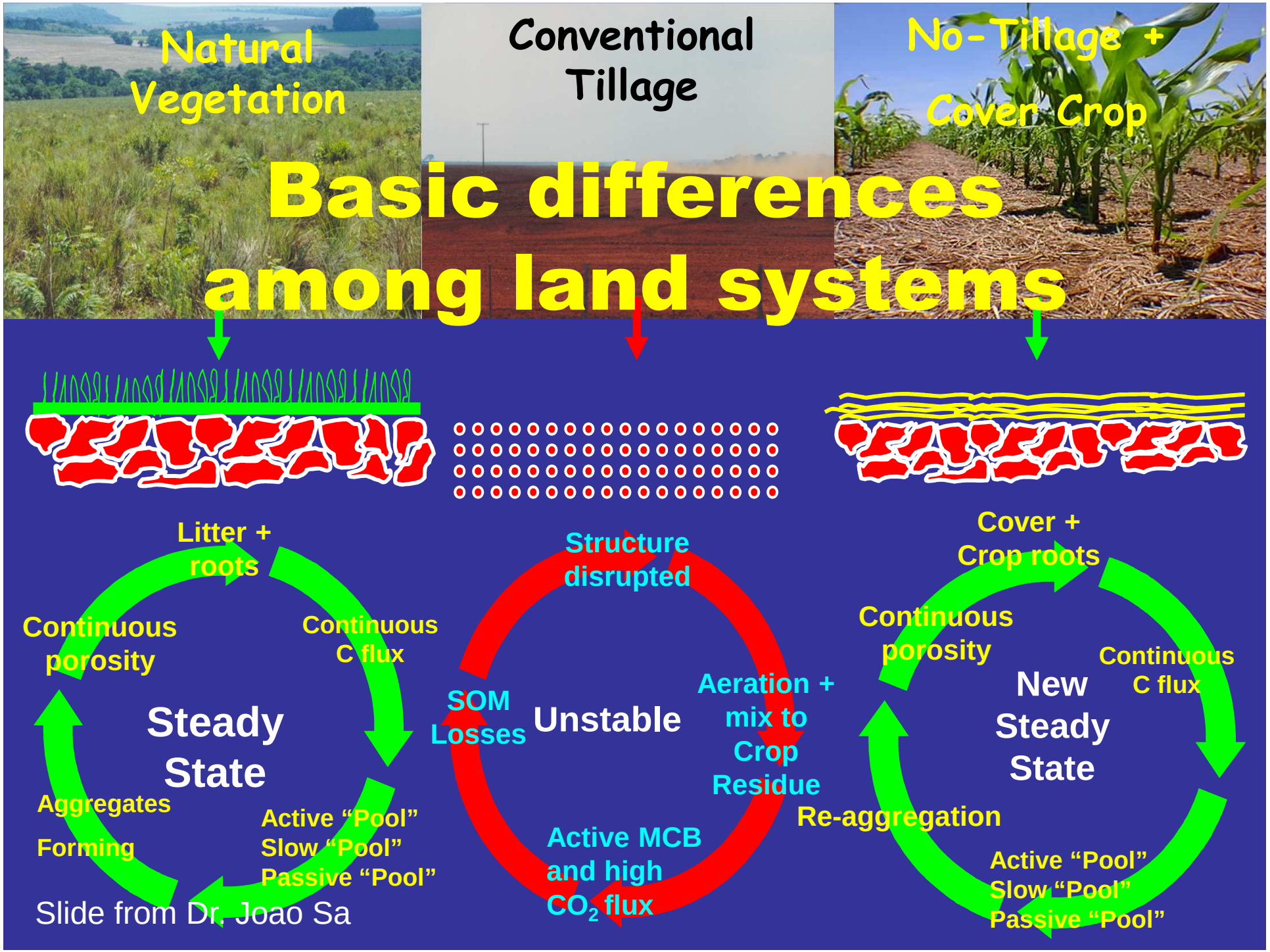
Ohio Farm Custom Rates 2010
Barry Ward, OSU Economist

Legume Cover Crop Seed Cost

Cover Crop	Seed Price/lb	Pound	Planting	Kill	Total Cost/A.
Cowpeas	$.80	40-50	$14	$0	$46-54
Winter peas	$1.00	30-40	$14	$0-15	$34-$69
Red Clover	$2.00	10-12	$6	$15	$41-$45
Chickling vetch	$1.00	30-70	$14	$15	$59-$99
Sweet Clover	$1.50	10-20	$6	$10	$31-$46
Hairy Vetch	$1.25	15-20	$14	$15	$49-$54

Grass Cover Crop Seed Cost

Cover Crop	Seed Price/lb	Pound	Planting	Kill	Total Cost/A.
Cereal Rye	$.20 $12/bu	60 1 bu	$14	$15	$41
Annual rye	$.80	15-25	$14	$15	$41-$49
Wheat	$.10 $6/bu	60 1 bu	$14	$15	$35
Oats	$.15 $6/Bu	42-63 1-1.5 bu	$14	$0	$20-$23
Brassicas					
Oilseed Radish	$3.00	1-10	$14	$0	$17-$44


Natural Vegetation
Conventional Tillage
No-Tillage + Cover Crop
Basic differences among land systems
Litter + roots
Continuous porosity
Continuous C flux
Steady State
Aggregates Forming
Active "Pool"
Slow "Pool"
Passive "Pool"
Structure disrupted
SOM Losses
Unstable
Aeration + mix to Crop Residue
Active MCB and high CO_2 flux
Cover + Crop roots
Continuous porosity
Continuous C flux
New Steady State
Re-aggregation
Active "Pool"
Slow "Pool"
Passive "Pool"
Slide from Dr. Joao Sa

Value of Soil Organic Matter

Assumptions: 2,000,000 pounds soil in top 6 inches
1% organic matter = 20,000#

Nutrients:

Nitrogen:	1000# * $0.50/#N =	$500
Phosphorous:	100# * $0.48/#P =	$ 48
Potassium:	100# * $0.42/#K =	$ 42
Sulfur:	100# * $0.50/#S =	$ 50
Carbon: 10,000# or 5 ton * $2/Ton	=	$ 10

Value of 1% SOM Nutrients/Acre = $650

Jim Kinsella/Terry Taylor (2006) Jim Hoorman (2011)

Conventional agriculture is related to **soil**, air and water quality degradation

1.2 billion ton CO_2/y i.e. 570 M ton SOM loss

A 1% loss of SOM= 1000 lbs N/ac

Loss of SOM as CO_2

Soil Organic Matter Accumulation

- Takes 10 tons of Decomposed Organic Matter to equal 1% SOM
- If start with 40 tons Organic Matter and lose 75% to get 10 tons decomposed SOM
- Accumulate 4-6 tons and lose 75% equals 1-1.5 tons Decomposed SOM or

  .1-.15% SOM * $560/Acre or $56 to $84/Acre

You are Building Your Soil Fertility with SOM!

Crop Residue along Ditch from Bare Cropland, Chiseled Wheat Stubble

Crop Residue along Ditch

Value of Ton of Topsoil

- Most Biological activity occurs in top 3 inches.
- One million pounds or 500 ton of topsoil in top 3 inches.
- Average Value of Cropland = $5,000/Acre
- Soil Lost at T value = 4-5 ton/acre
- Soil Productivity Value: $5,000/500 = $10/Ton
- Lost value per acre = $10/ton soil loss * 4-5 tons

Losing $40 to $50 per acre.

Productivity of SOM

- Michigan study: Every 1% SOM =12% increase in crop yields.
- Baseline Yields: 170 bu corn, 50 bu soybeans
  Starting SOM = 3% and add 1% SOM

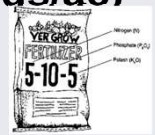
Soybeans 50 bu * 12% = 6 bu * $10 = $60/A.
.1 to.15% SOM increase/year = $6-$9/yr.

Corn 170 bu * 12% = 20.4 bu * $5 = $102/A
.1 to.15% SOM increase/year = $10.20-$15.30/yr.

Do we get more N loss from inorganic (fertilizer) N or organic N?

- Inorganic (fertilizer) N had significantly higher N losses.
- How much? 31% for fertilizer compared to 13% for crop residue (organic N).
- Crop residue has 73% more retention of N in the soil than fertilizer N (26% retention).
- Suggests slower N recycling in crop residues (or proteins) protects against N losses. (Delgado, 2010)

A Common *Myth* about inorganic fertilizers: They feed the plant directly

Fertilizer Nitrogen applied Kg/ha (pounds/ac) 	**Corn Grain Yield Mg/ha (Bu/ac)**	**Total N in corn plant Kg/ha (pounds/ac)**	**Fertilizer derived N in Corn Kg/ha (pounds/ acre)**	**Soil-derived N in corn, in Kg/ha (pounds/ acre)**	**Fertilizer-derived N in corn as percent of total N in corn %**	**Fertilizer-derived N in corn as percent of N applied %** 
50 (45)	3.9 (62)	85 (77)	**28 (25)**	60 (54)	**33**	56
100 (90)	4.6 (73)	146 (131)	**55 (50)**	91 (81)	**38**	55
200 (180)	5.5 (88)	157 (141)	**86 (78)**	71 (63)	**55**	43

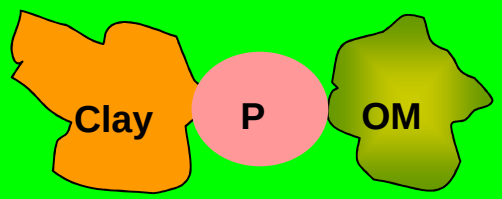
Source of Nitrogen in Corn in North Carolina on an Enon Sandy Loam Soil Fertilized with Three Rates Nitrogen as NH+4-NO-3 (tagged Isotope 15 N)

(Calculated from Reddy and Reddy 1993)
Page 725 13th Edition Nature and Properties of Soil

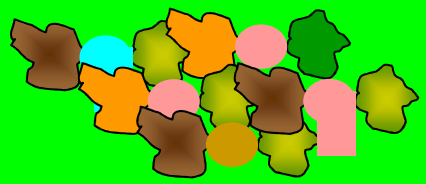
About 50-75% of the Available P in soil is organic.

P stabilizes the OM and forms a bridge to the clay.

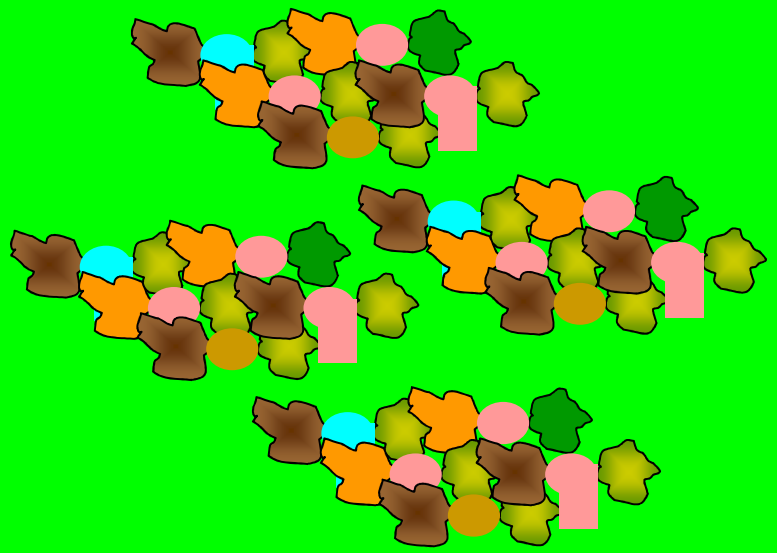
Our current P use efficiency is 50%.



Clay-P-OM



$(Clay\text{-}P\text{-}OM)_x$



$((Clay\text{-}P\text{-}OM)_x)_y$

Increased Efficiency

Nitrogen Efficiency: 30-50% conventional
Increase to 80-90% with No-till & Cover Crops.

Phosphorus Efficiency: 50% conventional
Increase to 90% with No-till & Cover Crops.

Lime Costs/acre

- 1 to 2 tons of lime per acre * $14/Ton
- Plus spreading cost $6/Acre
- Total lime cost: $34/Acre over 3-5 years
- Cost /Acre/Year: $7-11
- No-till and Cover Crops need less lime because they keep Ca^{2+} circulating

Legume Cover Crop N Economics

Cover Crop	Total Cost/A.	Pound Of N	Value of N	Total N $	Net Gain
Cowpeas	$46-54	120-150	$.40	$48-60	($2)-$14
Winter peas	$34-$69	120-150	$.40	$48-60	($9) - $26
Red Clover	$41-$45	100-120	$.40	$40-$48	($3)-$7
Chickling Vetch	$59-$99	50-125	$.40	$20-$50	($9-$49)
Sweet Clover	$31-$46	100-150	$.40	$40-$60	($6)-$29
Hairy Vetch	$49-$54	100-200	$.40	$40-60	($9)-$11

Drainage

- $800 to $1000/acre for subsurface drainage.
- Farmers say you pay for drainage every 20 years whether you pay for it or not. Poor drainage costs you in reduced yields.

Keep $1000 in Bank, Collect 2-3% interest

Spend Interest on Cover Crops: $20-30/A.

Still have principal at end of 20 years.

Annual Ryegrass Cover Crop

No-till Cropland No cover

Annual Ryegrass Cover Crop

Water Storage Value

- Every 1% SOM hold 1 acre-inch of water
- Value of an acre-inch of water = $12
- Value of 6% SOM vs 2% SOM =

  4 acre-inches of water * $12/acre-inch=$48
- .1% SOM addition per year =

  .1 acre-inch * $12/acre-inch = $1.2 per year

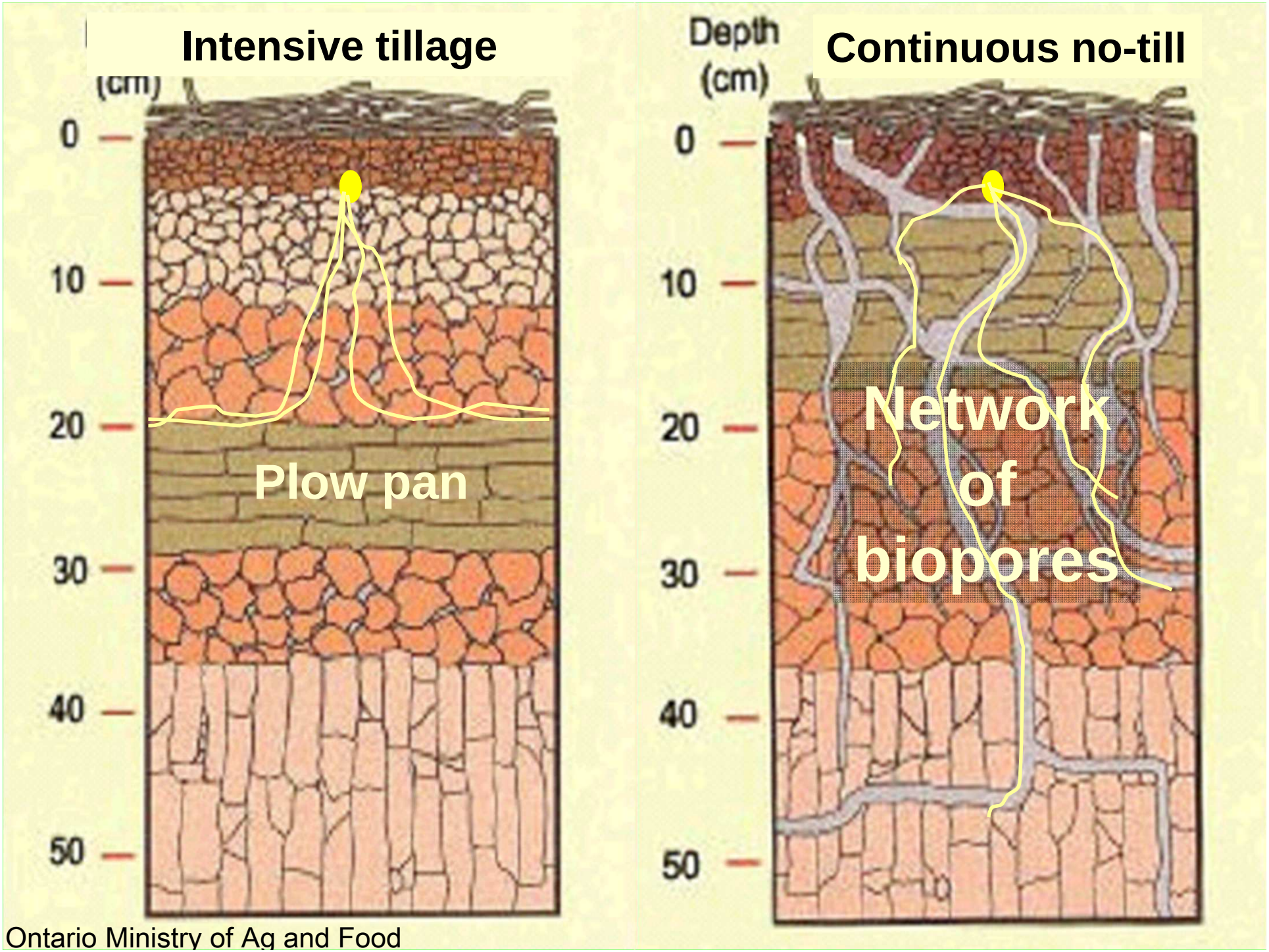
Indiana Corn Yields

Planting method	Yield bu/A	
	2002	2003
Conventional (mulch till)	55	136
Conventional (with soil compaction)	23	61
No-till/ryegrass Silt loam soil	138	140
No-till/vetch-ryegrass Claypan soil	83	78
No-till no cover crop Claypan soil	65	49

2005 Illinois demonstration results

Tillage/cover crop	Yield bu./A.
Conventional tillage	82
No cover crop no-till	124
Ryegrass 1 year no-till	137
Ryegrass 6 years –claypan	165
Ryegrass 6 years no claypan	215

Rain fall …. May- Sept. 2.3”



Ontario Ministry of Ag and Food

Cover Crop Benefits in Drought

2005 Illinois Corn Data (2.3 inches rain)

Conventional tillage 82

No-till 124-82=42 bushels * $5/Bu = $210

No-till + Annual Rye 137-82=55*$5 = $275

$275/20 years $14 per year

Negative Effects:

Cover crops may excessively dry the soil through respiration in a dry spring. Solution is to kill the cover crop early if the soil is getting too dry.

Weeds

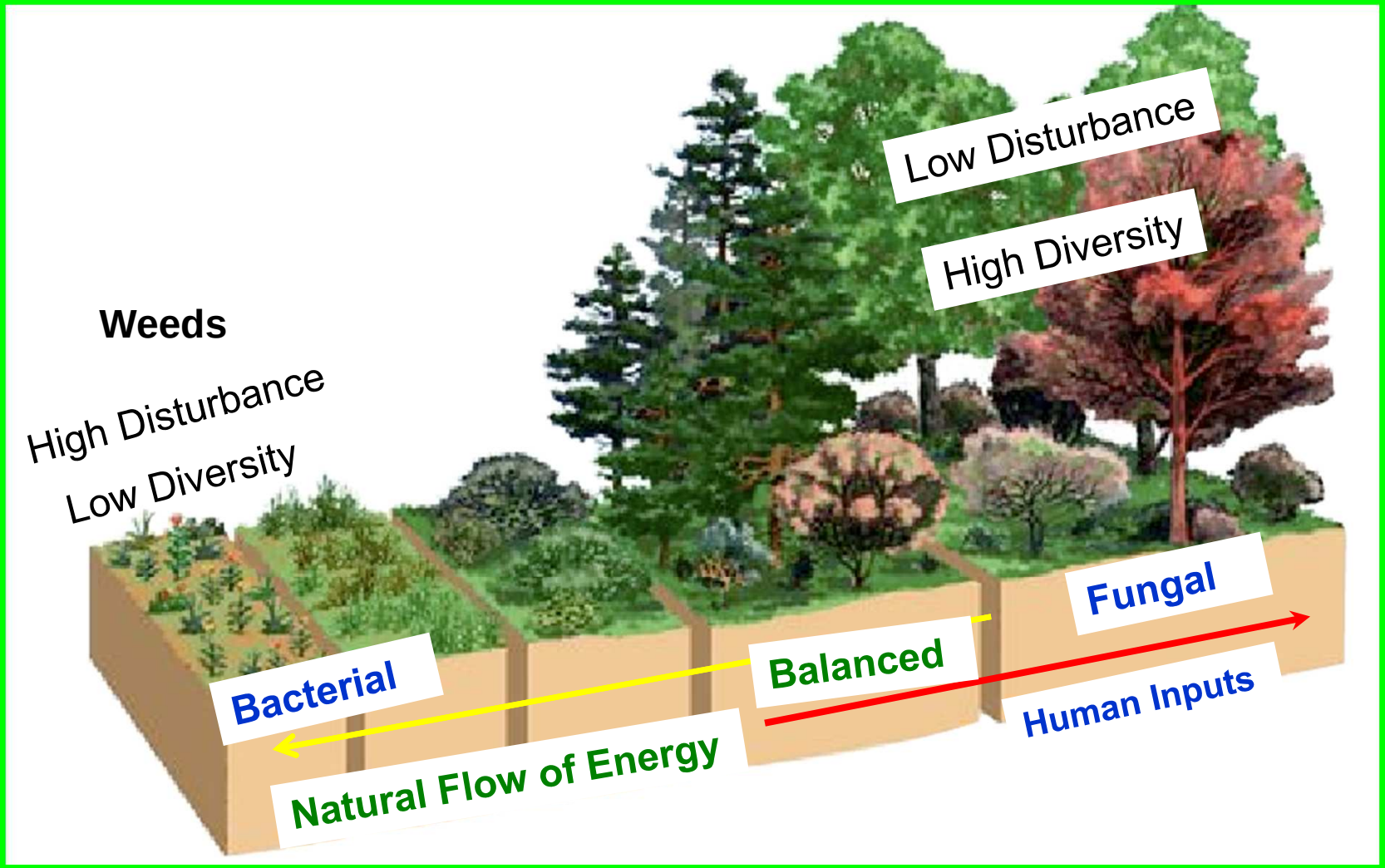
- Farmers promote weed seed by tilling the soil.
- Ways to fight weeds

  1) Hoe or pull them out

  2) Kill with herbicides

  3) Compete for sunlight and nutrients by growing cover crops and reduce weed seed production.
- Farmers with No-till and Cover Crops reduce herbicide cost by 1/3 = $7-$12/A.
- Early weeds reduce crop yields 10% * 50 bu soybeans * $10/A. = $50
- Reduced weeds: cereal rye, oilseed radish, etc.

Natural Succession of Plants & Soil



Insects

Positive: Soybean Cysts Nematodes (SCN)

1) 80-90% Reduction using cereal rye/annual rye

50 bu * 30% =15 bu * $10 =$150/A

Natural Pollinators:$5 Billion/350 million =$14/A

Negative: Slugs, Cutworm, Armyworm

1) Carabidae beetles or ground beetles are natural predators of soft body insects.

2) Cover crops may be an alternative food source for slugs and may protect corn from damage.

Diseases

Diseases that thrive under excess water

- Phytophthora: 20% loss*50 bu=10 bu * $10= $100/A
- Phythium: 5-10% *50 bu=2.5-5 bu*$10= $25-$50/A
- Fusarium: 10% * 50 bu= 5 bu. * $10 = $50
- Rhizoctonia 2-5%*50 bu=1-2.5bu*$10= $10-$25/A

Thrive with less biological activity (tillage)

- Sclertina/White Mold (Bury seed with tillage)

2 to 4 bushel per acre * $10 = $20-40/A

Seed Production

Cereal rye:

30-60 bushels * $12 =

$360-$720/A minus $49 seed, plant, kill it plus $20 for harvesting = $290 - $650

Cowpeas: 30-35 bushels per acre or 1500 to 1750 pounds times $.80/lb = $1200 -$1400/A

minus seed, planting, harvesting costs

Forage Value of Cover Crops

- Oats, cereal rye, annual ryegrass
- 4 tons cereal rye at $80/ton =$320 Income
- Costs $49 (2 bu/Acre for seed) per acre for seed, plant, kill it.
- Harvest Costs: $33
- Net Income: $237

Manure Application & Retention

Manure Applied to a Cover Crop

Manure Value of Cover Crops

Swine Manure: 95% Water 5% solids
Manure Nutrient Analysis:18-16-14/1000 gallons
Uptake: At 5,000 gallons/A =90-80-70 $33
At 10,000 gallons/A =180-160-140 $44

Dairy Manure: 98% water 2% solids
Manure Nutrient Analysis: 20-15-15
Uptake: At 5,000 gallons/A =100-75-75 $36
At 10,000 gallons/A =200-150-150 $64

*Absorb 70% N, maximum 20# P

SOM Buffers Soil Temperatures

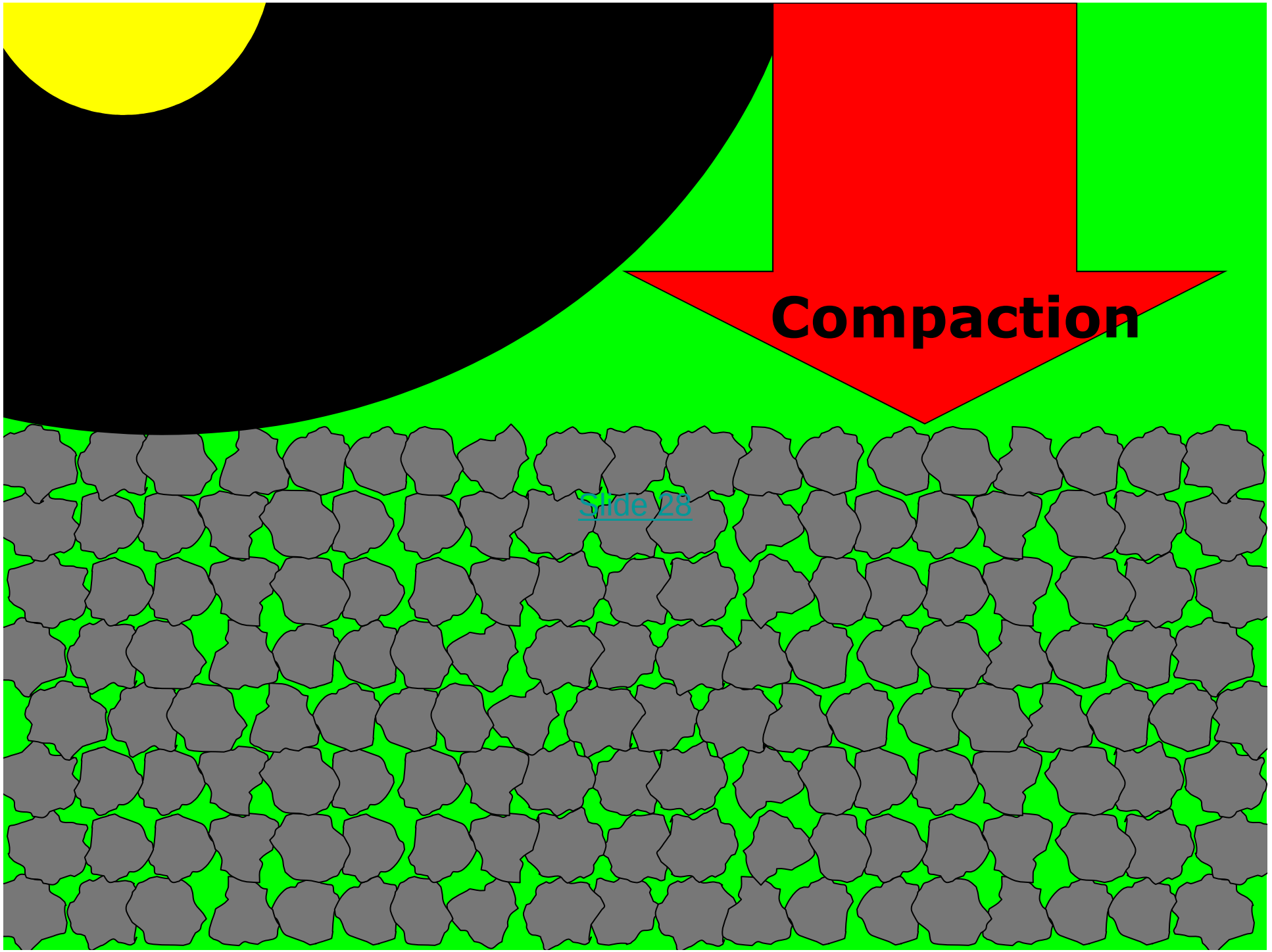
- Early frost 1/20 years
- Value to replant soybeans $100/acre
- Value of frost protection over 20 years = $5/acre

Indirect Water Quality Costs

1) Water Treatment Costs: $1-2/1000 gallons * 161 gallons/day/person* $1-2/1000 * 365 days * 310 million people * 85%/350 million acres = $44/Acre

2) Army Corp Annual Dredging Costs:

$1.345 Billon/350 million acres = $4/Acre



Slide 28

Soil Compaction costs

Conventional tillage vs No-till and Cover Crops

Corn 3% yield gain

150 bushel corn * 3% = 4.5 bu * $4 = $18/A

Soybeans 8-10% yield gain

50 bushels soybeans * 10% = 5 bu * $8 =$40/A

Cover crops improve soil structure, water infiltration, and decrease runoff.

Government Payments

CSP payments: Range from $10 to $30/Acre

Carbon Credits: Depends on Price $1-4/A or more depending on how much carbon is stored in the soil.

Nutrient Credits: Miami Conservancy paying $1 per pound for N & P credits.

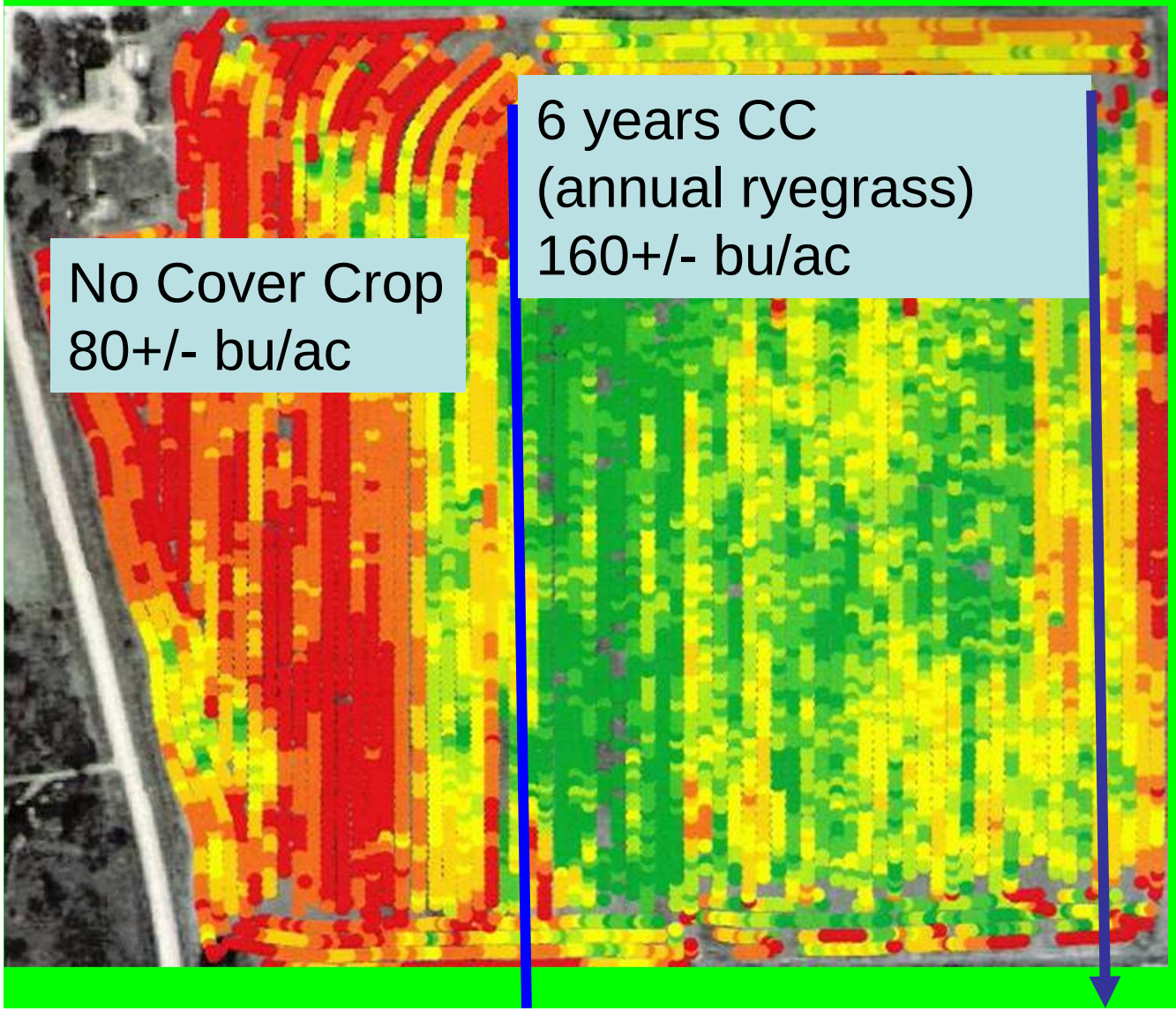
Other Local or Regional Payments

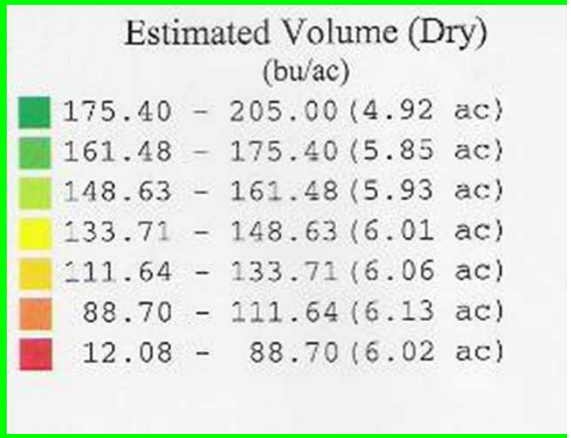
Nitrogen and Phosphorus Credits:

Miami Conservancy (Dayton) is paying $50 to $80/A if grow grass cover crop after corn silage (N, P, soil erosion) and apply manure, $20 to $40 after soybeans and wheat (P, soil erosion) if no manure applied.

Grand Lake St. Marys: $50-70/A for Cover Crops for manure management.

Cover crop effects





Mike Plumer's long-term no till with ryegrass cover crops on heavy clay soil.

Yield Benefits

Positive Results for Corn

1) Crimson clover + Radish

235.3 bu – 227.8 bu = 7.5 bu * $5 = $37.50/A

2) Oats + Radish

195.5 bu -186.5 bu = 9 bu * $5 = $45.00/A

3) ARG + Manure on Sandy Soil Leman, IN

20 bushel * $5 =$100.00/A

Corn Yield Losses

1) ARG

227.8 bu– 211.1 bu = (16.7 bu)*$5 = ($83.50/A)

Why: Dry weather may reduce corn yields.

Solution: Kill ARG earlier to reduce water loss.

2) Winter pea + Radish

227.8 bu – 223.1 bu = (4.7 bu)* $5= ($23.50)

Golden Goose

Two Farmers with 10 Golden Geese

First Farmer: Wants10+ eggs/day. Kills one goose and gains 5 eggs. (Conventional tillage)

Second Farmer: Can sacrifice and live with 9 eggs/day. Breeds one goose and hatches 10 eggs. Takes 3-5 years before a mature bird lay eggs.
(No-till+Cover crops)

Which farmer is going to be richer
and better off after 5-10-20 years?

Cost Savings and Added Income

Practice	Conventional	NT + Cover Crop
Costs	$35-$50/A	$30-$99/A
SOM	($25-$50)/A	$56-84/A
Soil Erosion	($40-$50)/A	$0
N Efficiency		+30-60%
P Efficiency		+40%
Lime	($7-11/A)	
Drainage	($1000/A)	($20-30) + Principal

Cost Savings and Added Income

Practice	Conventional	NT + Cover Crop
Weeds		Maximum $50/A
Insects (SCN)		Maximum $150/A
Diseases	Phytophthora	Maximum $100/A
Diseases	Phythium	Maximum $25-50/A
Diseases	Rhizoctonia	Maximum $10-25/A
Diseases	Fusarium	Maximum $50/A
Diseases	Sclerotinia	Maximum $20-40/A
Seed Prod.		$290-$1400/A

Cost Savings and Added Income

Practice	Conventional	NT + Cover Crop
Forage Production		$200
Manure Value		$33-64/A
Water Treat.	($44/A)	
Dredging	($4/A)	
SOM Productivity		$6-15/A
Water Storage		$14/year
Temperature		$5/Acre
Soil Compaction	($18-$40/A)	

Added Income or Losses

Practice	Conventional	NT + Cover Crop
CSP		$10-$30/A
Carbon		$1-4/A
Local Watershed	For N and P or manure credits	$20-80/A
Yield Gain		$37.50-100/A
Yield Loss		($23.50-83.50/A)

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