Cover Crop Impact on Soil Quality and Crop Yield

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Objectives

- To evaluate the impact of cover crop on soil quality
  - Biological indicators
  - Chemical indicators
  - Physical indicators
- To evaluate cover crop impact on grain crop yields
- To evaluate the relationship between inductive and deductive soil quality (soil properties vs. crop yield)


Materials and Methods

Cover crops and tillage experiment
at Piketon (2004 – 2009)

Conventional-till   (CT-CS)

Conventional-till      (CT-CSW)

No-till   (NT-CS)

No-till      (NT-CSW)

Cowpea **Corn** Rye **Soy** Wheat

Cowpea planted after wheat harvest in July

Cowpea dies in winter

Cereal rye planted after corn in late October

Composite soil samples at 0 - 15 and 15 - 30 cm depth in 2004 (**INITIAL**) and 2009 were collected from exact same locations.

Soil samples were analyzed for:

- Soil quality biological indicators
- Soil quality chemical indicators
- Soil quality physical indicators

Biological indicators including:

Total microbial biomass

Basal respiration

Specific maintenance respiration

Metabolic quotient

Potentially mineralizable C and N

Urease/Dehydrogenase enzyme activity

Chemical indicators including:

Total carbon and nitrogen

Active and passive carbon

Particulate carbon and nitrogen

Cation exchange capacity

Base saturation

Electrical conductivity

pH

Physical indicators including:

Bulk density and total porosity

Aggregate size distribution

Aggregate stability

Mean weight diameter

Geometric mean diameter

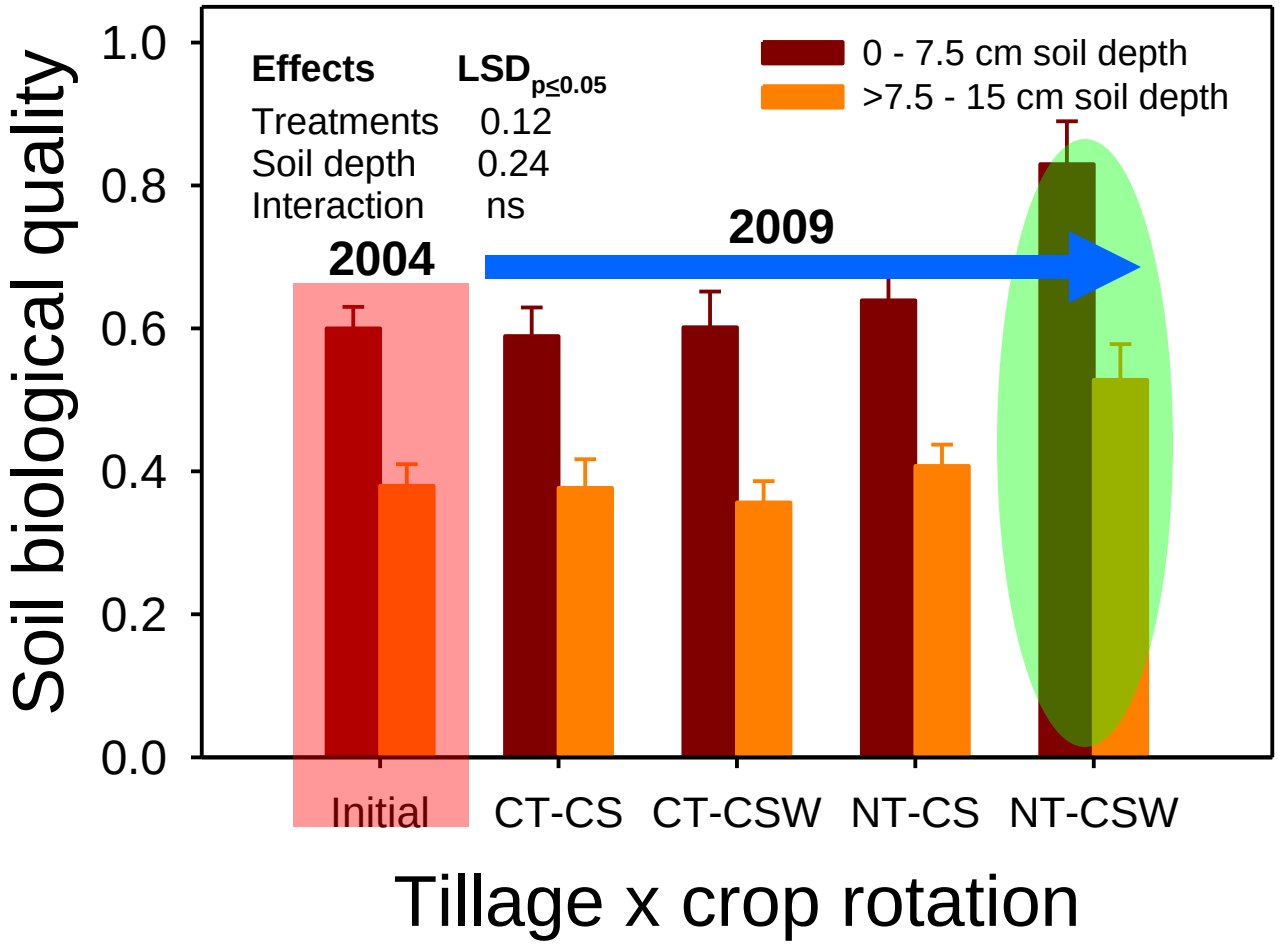
Volumetric moisture content

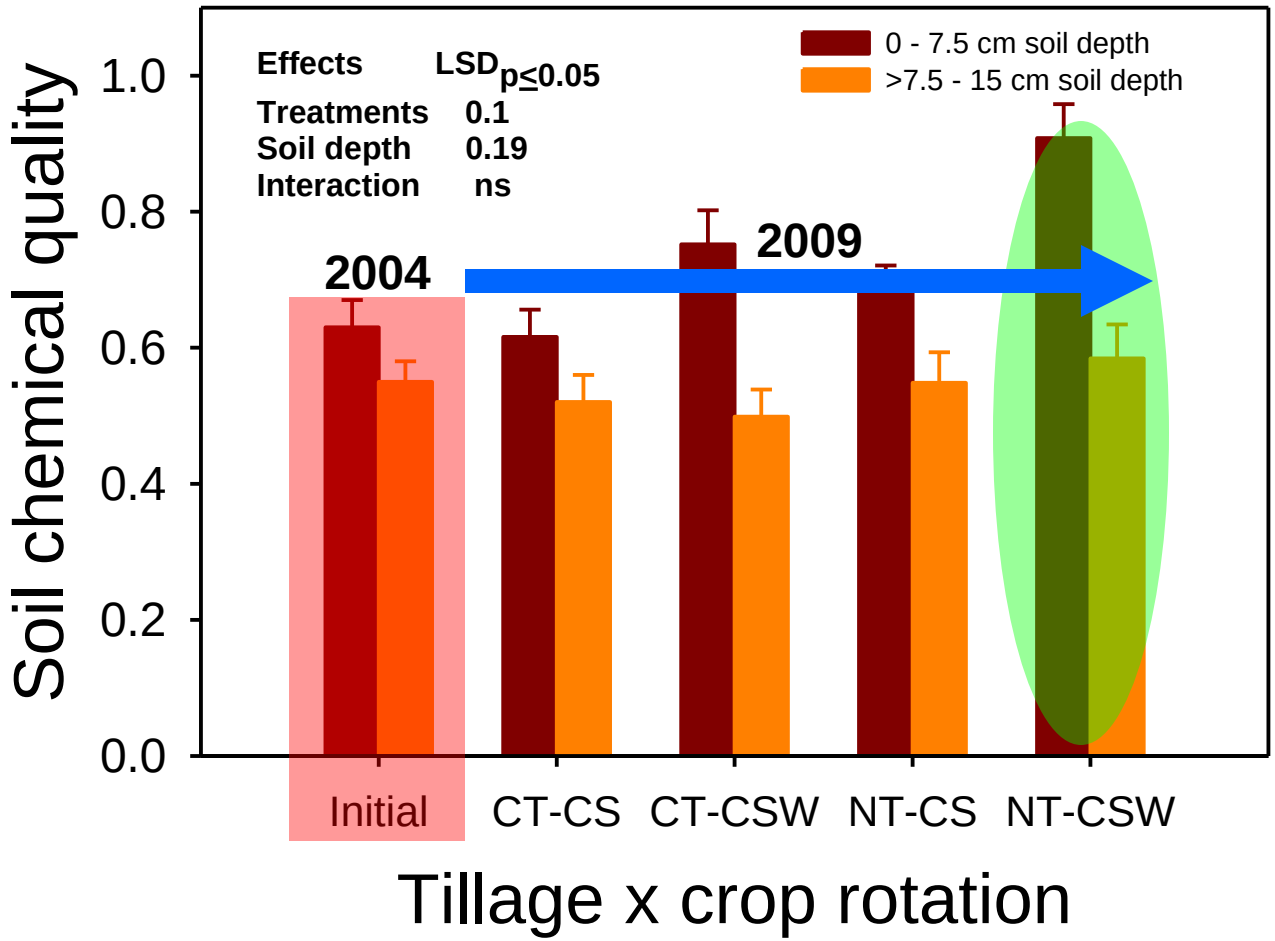
Soil quality

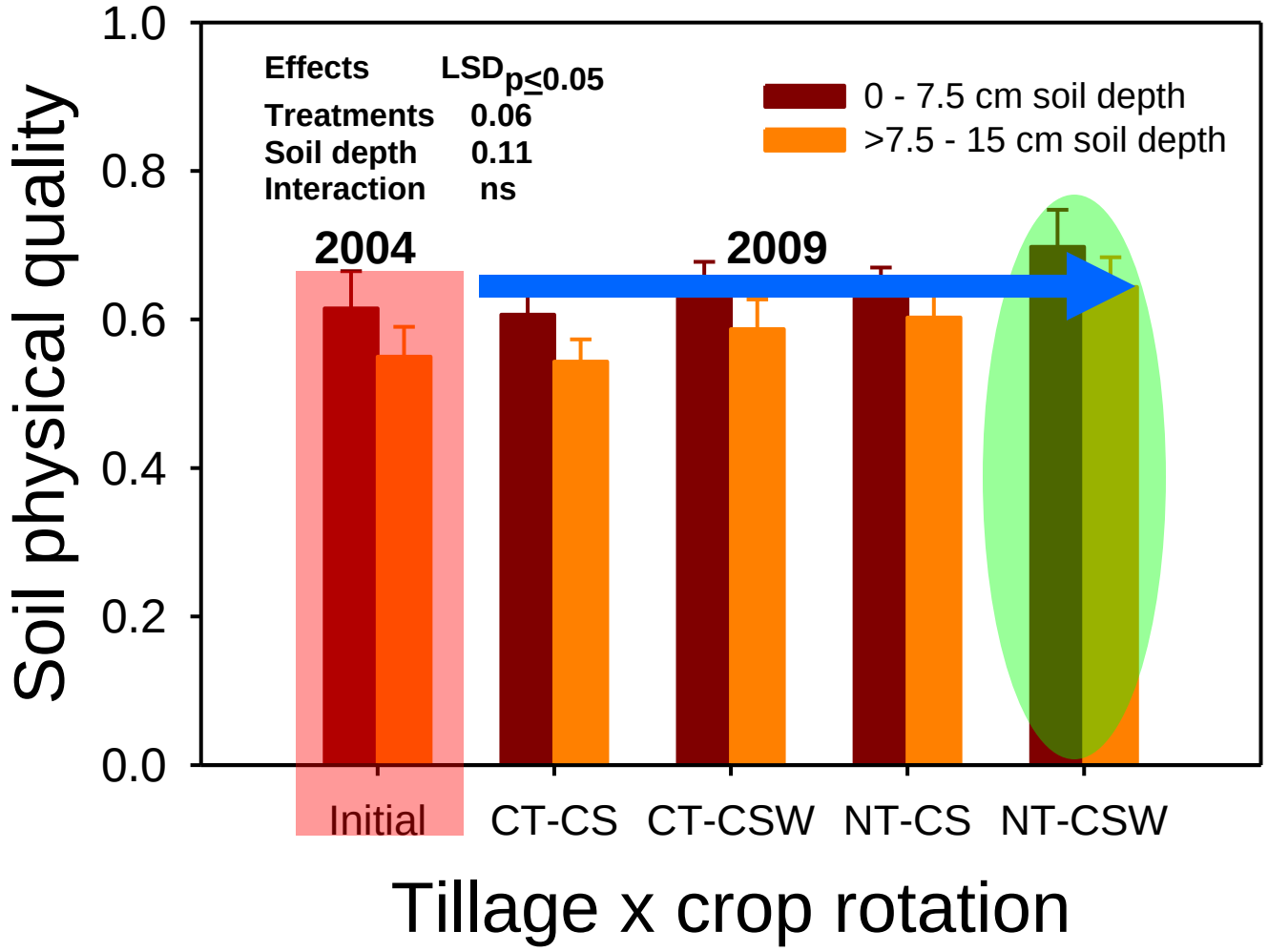
Inductive additive approach based on normalization, summation, and average of selected soil quality indicators into a single integrator was used to calculate soil quality indices:

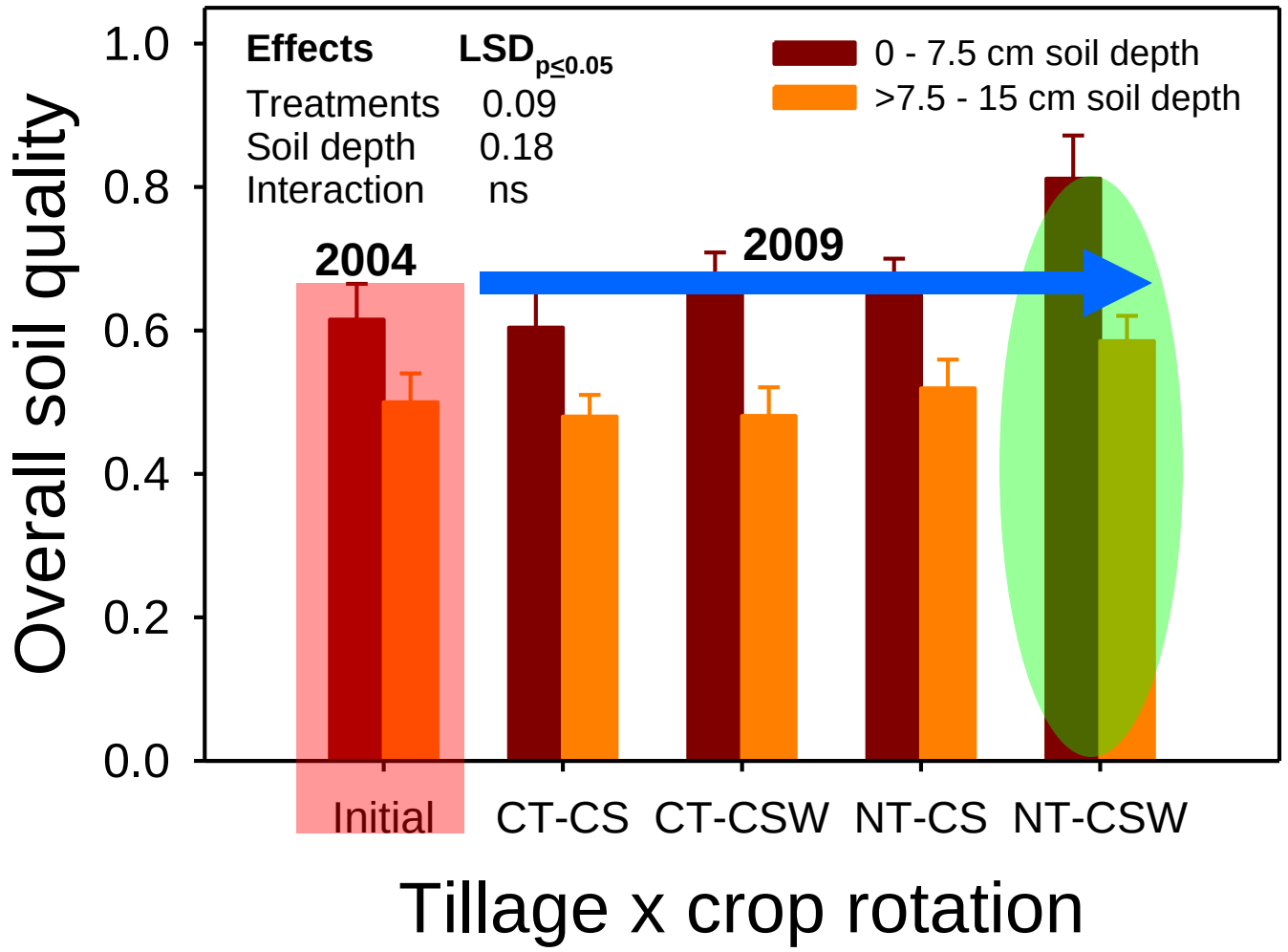
$$SQ_{index} = \Sigma(X_0 \, X_{max}^{-1}) \, n^{-1}$$


Results and Discussion

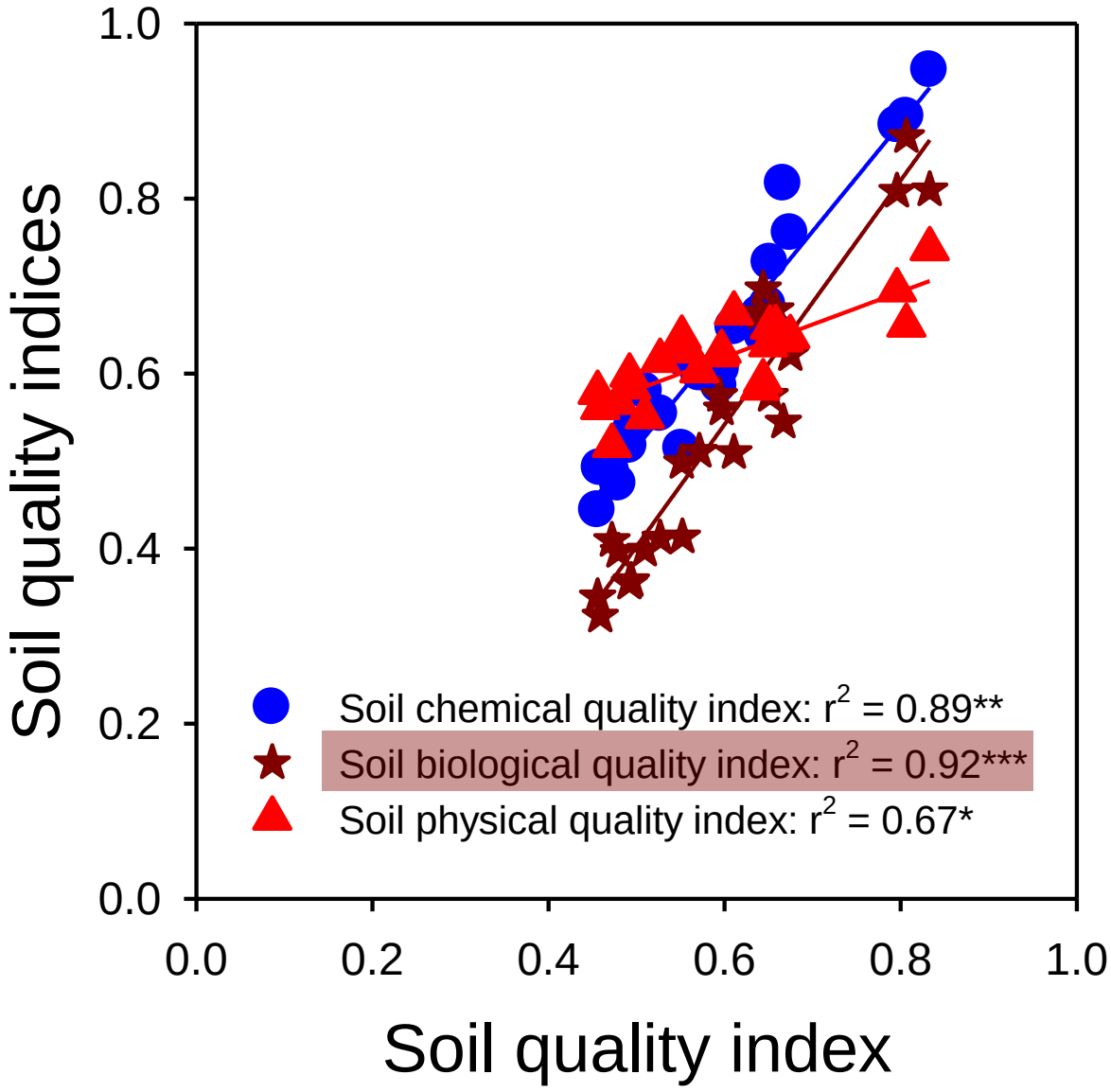

Soil biological quality
1.0
0.8
0.6
0.4
0.2
0.0
Effects
LSD p≤0.05
Treatments 0.12
Soil depth 0.24
Interaction ns
0 - 7.5 cm soil depth
>7.5 - 15 cm soil depth
2004
2009
Initial
CT-CS
CT-CSW
NT-CS
NT-CSW
Tillage x crop rotation

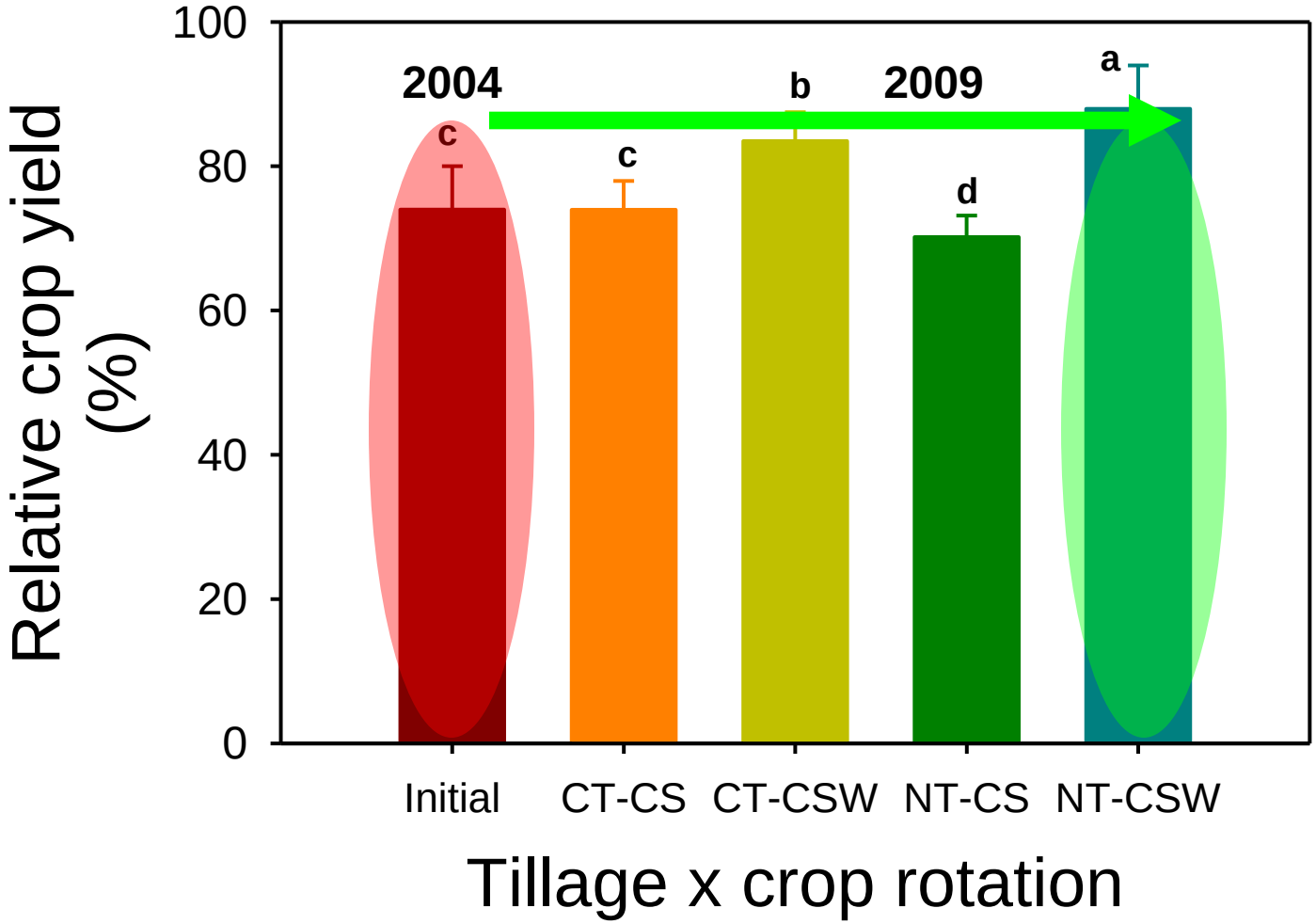

Effects LSD p≤0.05
Treatments 0.1
Soil depth 0.19
Interaction ns
0 - 7.5 cm soil depth
>7.5 - 15 cm soil depth
2004
2009
Soil chemical quality
1.0
0.8
0.6
0.4
0.2
0.0
Initial
CT-CS
CT-CSW
NT-CS
NT-CSW
Tillage x crop rotation

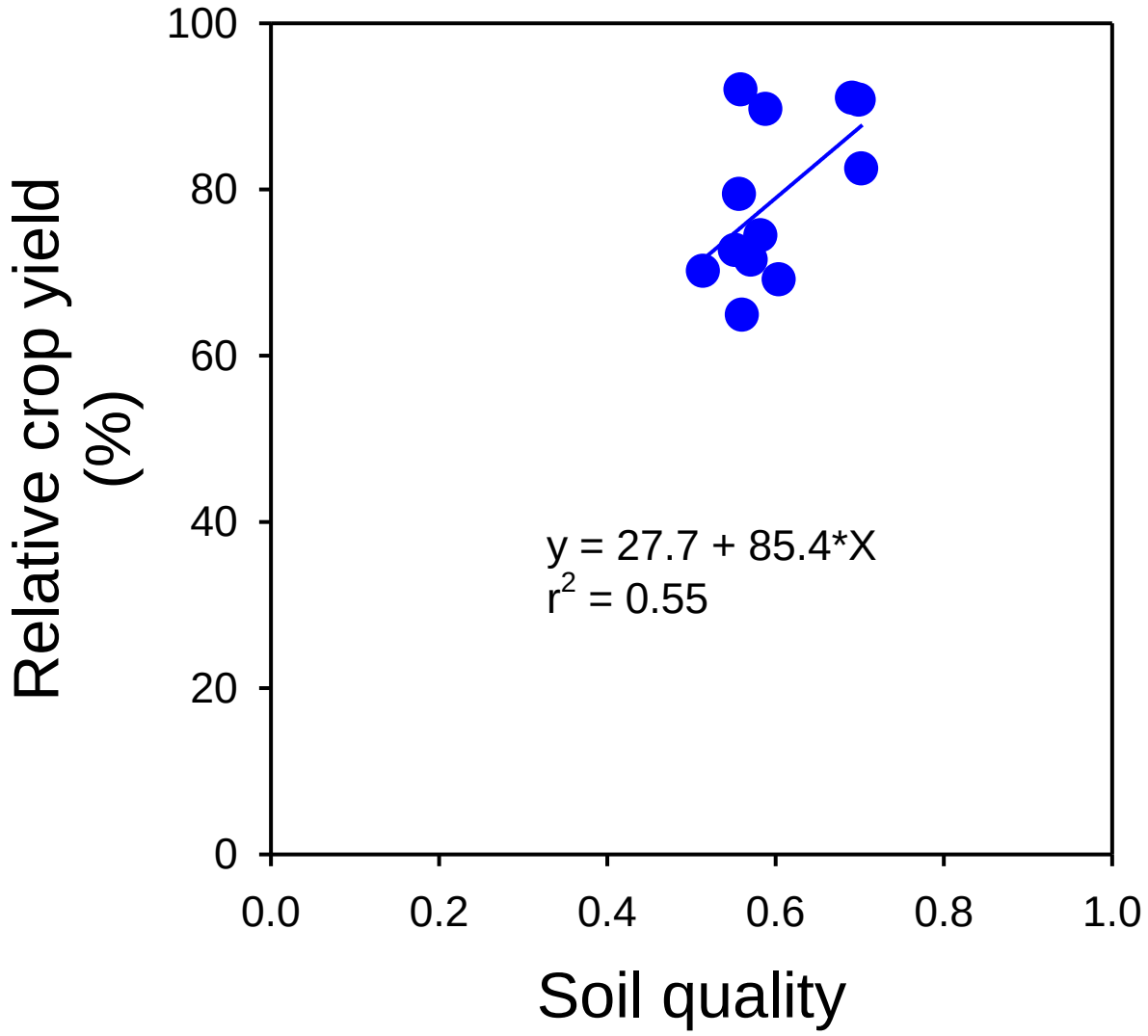

Soil physical quality
1.0
0.8
0.6
0.4
0.2
0.0
Effects LSD p≤0.05
Treatments 0.06
Soil depth 0.11
Interaction ns
0 - 7.5 cm soil depth
>7.5 - 15 cm soil depth
2004
2009
Initial
CT-CS
CT-CSW
NT-CS
NT-CSW
Tillage x crop rotation


Effects
LSD p≤0.05
Treatments 0.09
Soil depth 0.18
Interaction ns
0 - 7.5 cm soil depth
>7.5 - 15 cm soil depth
2004
2009
Overall soil quality
1.0
0.8
0.6
0.4
0.2
0.0
Initial
CT-CS
CT-CSW
NT-CS
NT-CSW
Tillage x crop rotation


NT corn-soy-wheat
with cover crops
CT corn-soy
rotation


1.0
0.8
0.6
0.4
0.2
0.0
Soil quality indices
0.0
0.2
0.4
0.6
0.8
1.0
Soil quality index
Soil chemical quality index: r2 = 0.89**
Soil biological quality index: r2 = 0.92***
Soil physical quality index: r2 = 0.67*


Relative crop yield (%)
100
80
60
40
20
0
2004
2009
c
c
b
d
a
Initial
CT-CS
CT-CSW
NT-CS
NT-CSW
Tillage x crop rotation


Relative crop yield (%)
100
80
60
40
20
0
0.0
0.2
0.4
0.6
0.8
1.0
Soil quality
y = 27.7 + 85.4*X
r2 = 0.55

Conclusions:

- **Cover crop** had significant impact on soil quality indicators. The impact was more pronounced in NT than CT.
- **Biological indicators** were more sensitive than chemical and physical indicators.
- **Switching to NT**, it is essential to adopt crop rotation with cover crops to maintain yields.
- **Improvements** in crop yields lag behind improvements in soil quality.

Questions?