ONE-TIME TILLAGE OF NO-TILL CROP LAND: FIVE YEARS POST-TILLAGE

Charles Wortmann
cwortmann2@unl.edu

University of Nebraska Lincoln

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No-till

- Well documented benefits
  - Fewer field operations
    - Less cost, time, fuel
  - Reduced erosion
  - Surface soil improvement
  - Water conservation
  - Increased yield??
  - Carbon sequestration??

No-till improvement: one-time tillage??

- Reduce nutrient and SOM stratification
  - E.g. one-time plowing reduced runoff DRP by 90% in a NE study
- Improve soil aggregation to greater depth
- Increase SOM to greater depth
- Control difficult weeds
- Lime or manure incorporation
- Yield?
- Soil organic matter?

Objective

- Effects on one-time tillage of continuous no-till at up to 5-yr post-tillage
  - Grain yield
  - Nutrient distribution
  - Soil organic matter
  - Water stable soil aggregates
  - Infiltration
  - Soil microbial communities over 5 years after one-time tillage.

Acknowledgements

- Graduate students
  - Andres Quincke, PhD
  - Juan Pablo Garcia, MS
- Dr. Rhae Drijber, microbiologist
- Partly funded by INTSORMIL

Experimental Design

- Split-plot, compost and no compost, 4 reps
- 2 locations in eastern Nebraska
  - Rogers Memorial Farm (RMF), 12 mi east of Lincoln: grain sorghum-soybean
  - ARDC, 35 mi NNE of Lincoln: corn-soybean
- Upland loess soils, deep, well or moderately well drained
- Mean precipitation ~29”
- Five tillage treatments conducted in spring (RMF) and fall of 2003

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- Continuous no-till
- All tillage in late Oct-Nov or early Mar
- Moldboard plow
  - ➢8” depth

- Disk tillage
  - ➢4” depth

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Twisted shank chisel tillage

- Rogers Memorial Farm
  - 8
  - 12” depth
- ARDC
  - 8” depth

Mini-moldboard plow tillage

- ARDC
  - 8” depth

Results

- Grain yield: tillage effects were significant for only 2 site-years

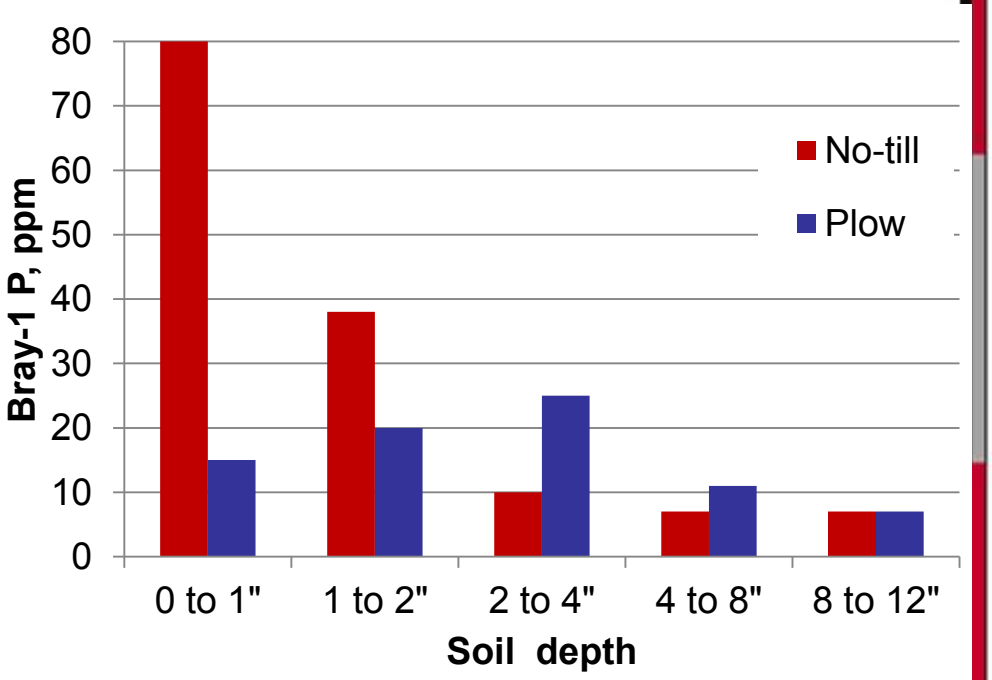
- Over all site years, yield was 4.4 and 7% more with MP and MMP, resp., compared with continuous no-till

Stratification of Bray-1 P

- Bray-1 P was 8x higher in 0-1” depth compared with 4-8” depth at RMF
  - More difference with compost applied
  - Lower STP at ARDC, less stratification

Greatest redistrib-tion with MP

- Reduced % of total P that was Bray-1 P
- Stratification was still less at 5 yr with MP at RMF but not at ARDC



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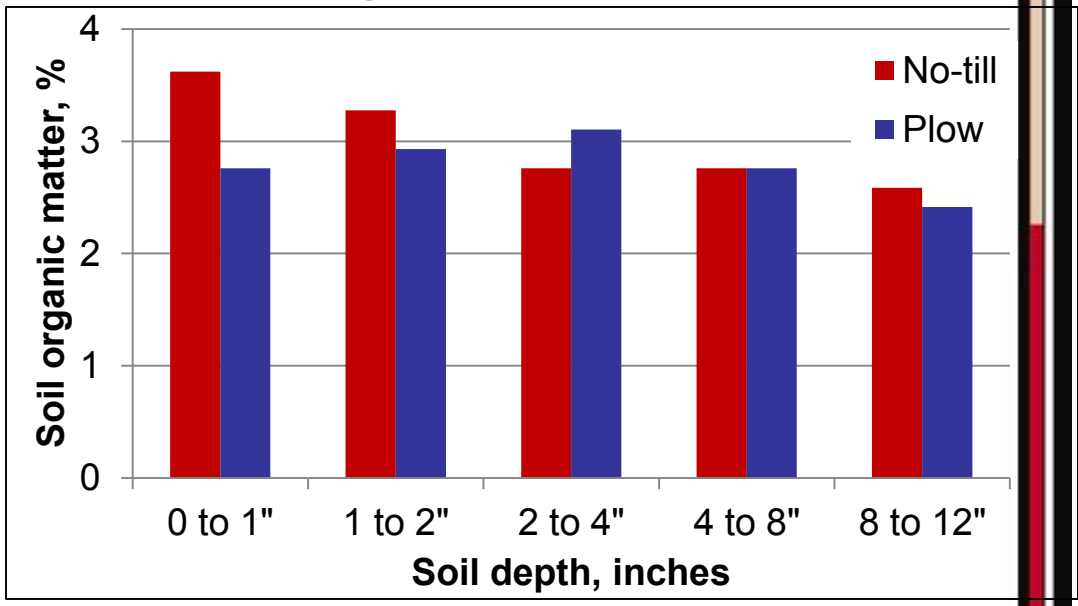
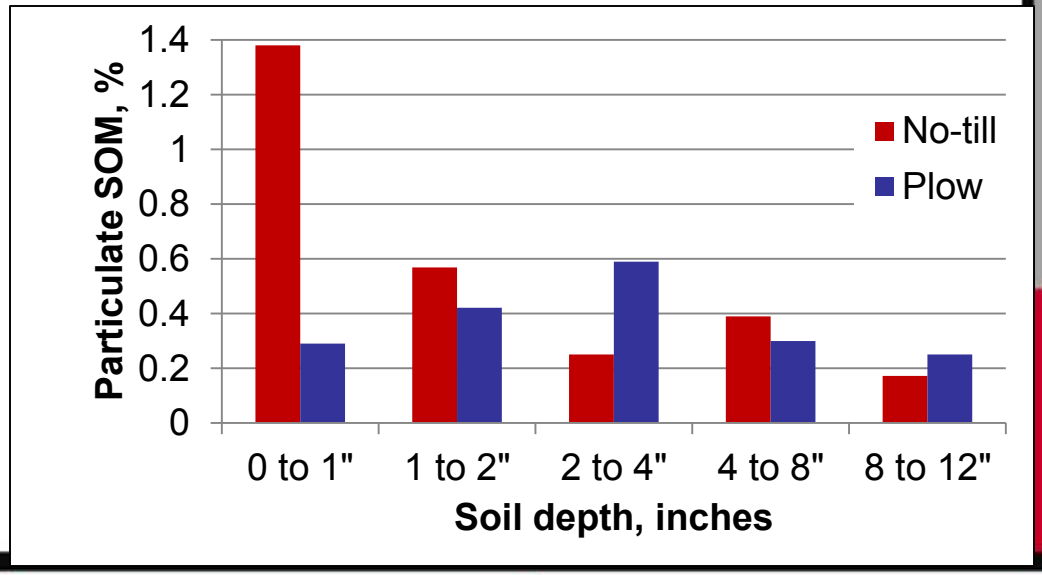
Redistribution of soil organic matter

- especially with MP
  - SOM was ~28% more at 0-1” compared to 2-8”
  - Change in SOM was -20% at 0 to 1” and +15% at 2 to 4” depth
  - Particulate OM distribution was more stratified and redistributed





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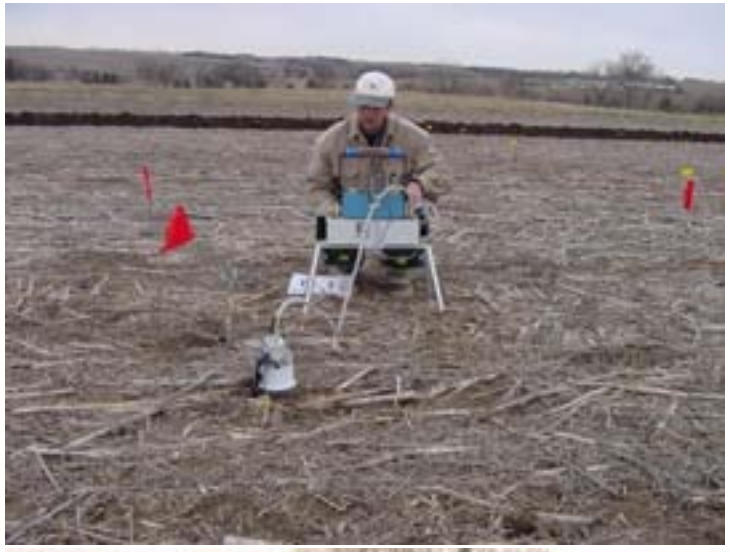
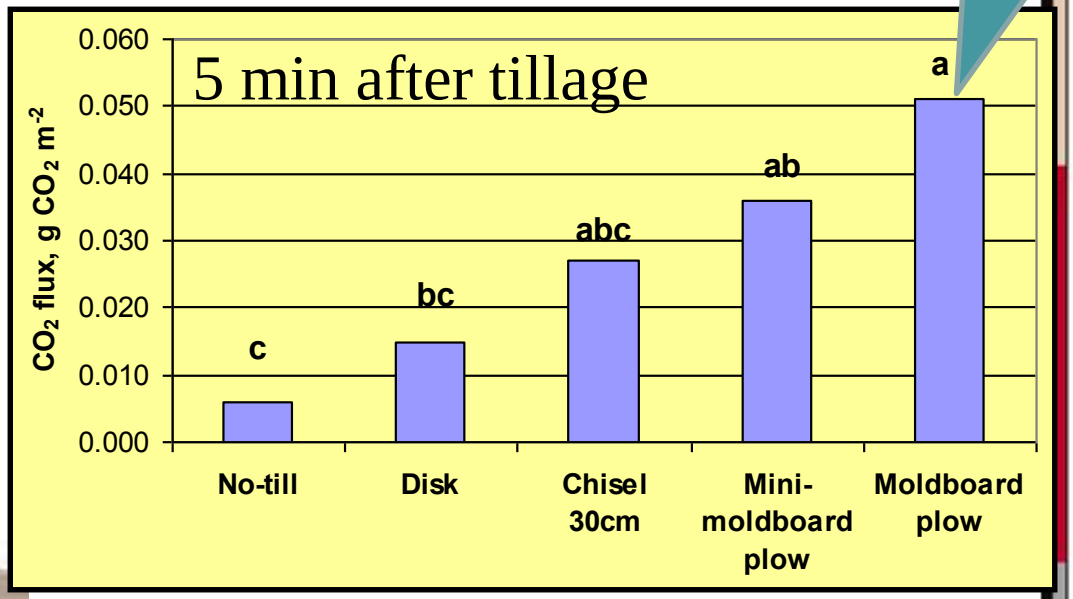
Cumulative CO_2 flux after tillage

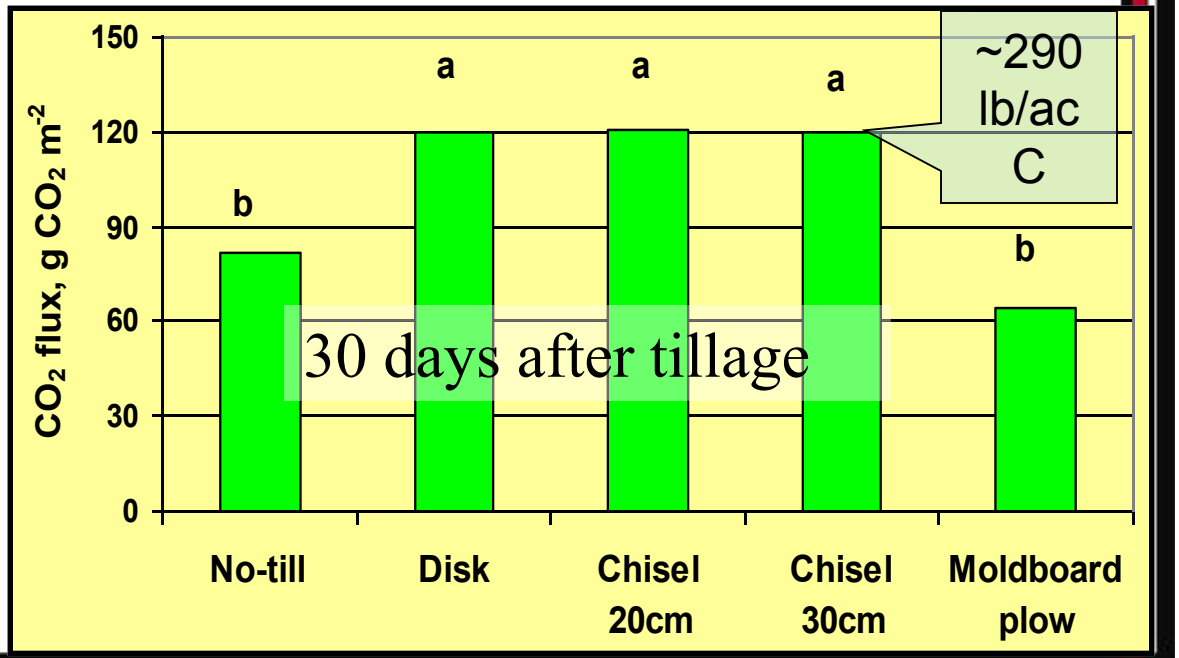
~0.2 lb/ac C





Cumulative CO_2 flux after tillage

- At 6 and 30 days after tillage
  - similar for NT and MP
  - 64% more with disk and chisel at RMF
- low flux compared with studies of one-time **summer** tillage of NT.



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Soil organic C change

- Soil samples were taken in increments to 30” depth 2 & 5 yr after tillage
- Soil bulk density was determined
- SOC mass quantified
  - ➢fixed depth
  - ➢equivalent soil mass
    - 400 kg m^{-2} for 1’ depth

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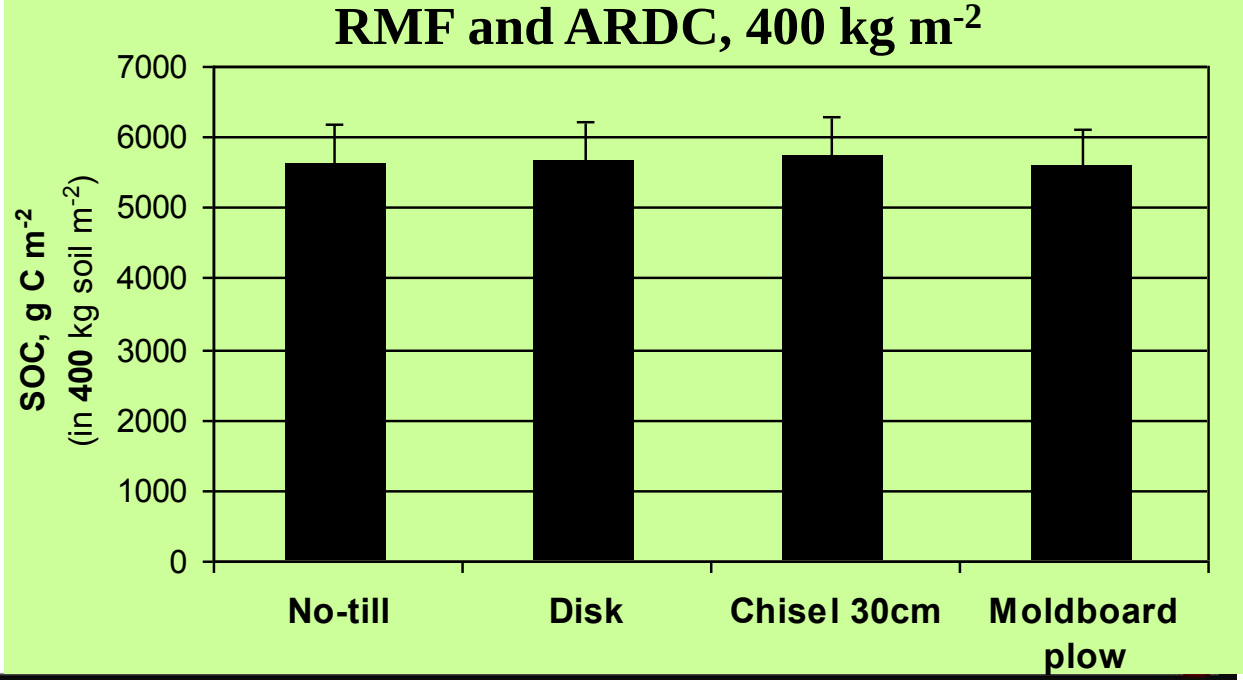
Change in soil organic C to 12”

- 2 years
  - –Equivalent soil mass: no change
  - –Fixed depth: 13% less for MP than NT
- 5 years
  - –No tillage effect



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Soil physical properties

- 83% of the soil was in water stable aggregates > 0.002”
  - diameter of human hair 0.001”
- No tillage effect on soil aggregates at 5 yr
- infiltration decreased and runoff increased at RMF with MP compared to NT
  - ➢ Opposite effect at ARDC
  - ➢ Difference due to traffic control??
    - Very controlled at RMF for years
    - Less controlled and cattle grazed corn stalks at ARDC

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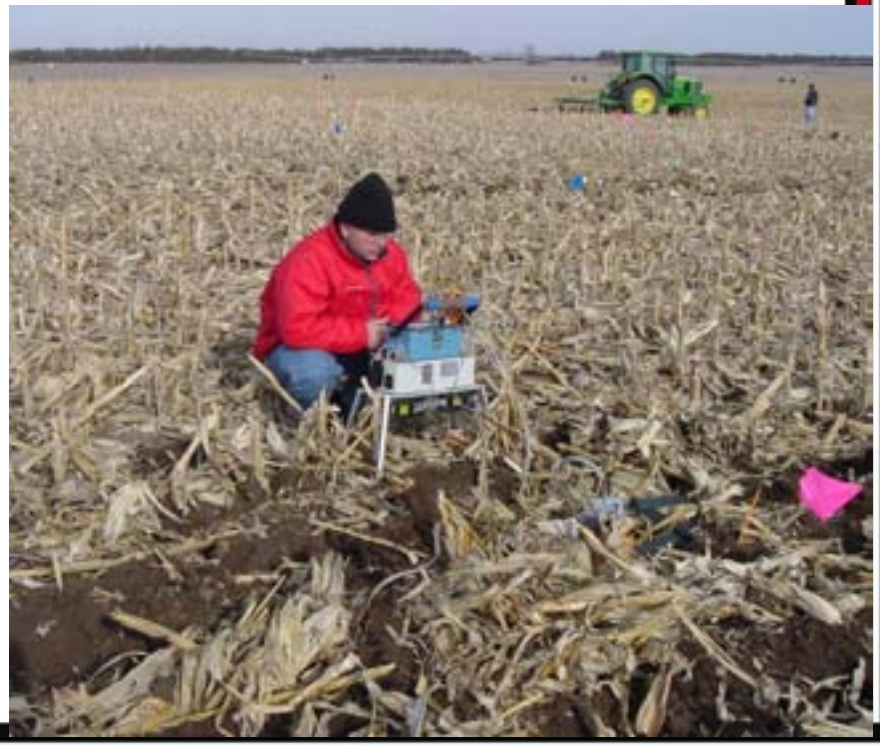
One-time tillage effect on the soil microbial community

- biomass of microbial groups
- arbuscular mycorrhyzae
  - ➢ colonization of roots
  - ➢ biomass in soil



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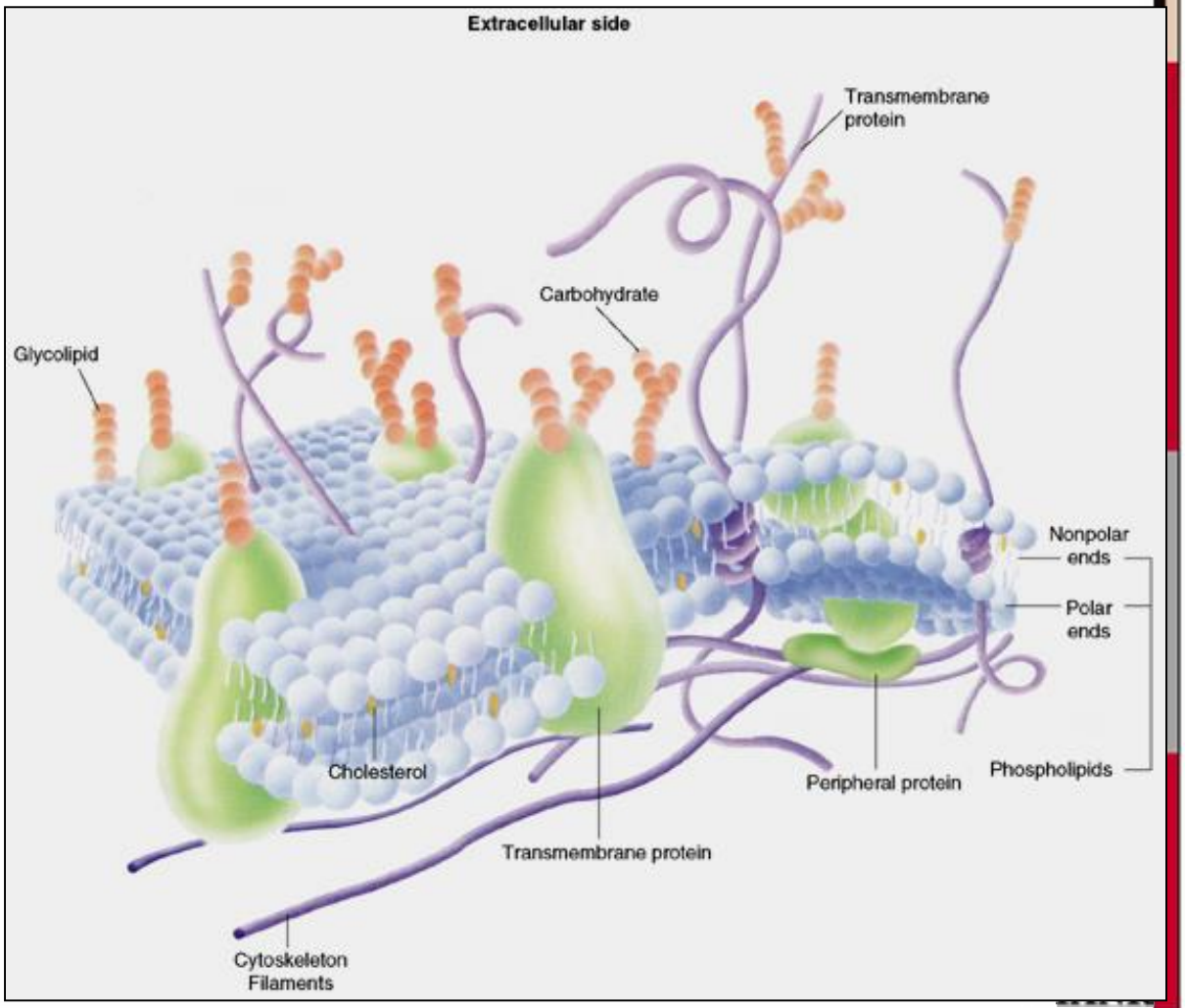
Microbial Community Fingerprints

Fatty Acid Methyl Esters (FAMEs): based on phospholipids, major constituents of living cells



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FAME indices

Microbial group	FAME(s) included in the summation
Bacteria	iC14:0; C15:0; iC15:0; aC15:0; iC16:0; C17:0; iC17:0; aC17:0; cyC17(9,10); C17:1(c9); cyC19(11,12)
Actinomycetes	10MeC18:0; i10MeC18:0; 10MeC19:0
VAM	C16:1(c11)
Fungi	C18:2(c9,12)
Microeukaryotes	C20:4(5,8,11,14)
Total microbial biomass	all 17 above-listed FAMEs

Tillage reduced mycorrhizal root colonization

- Effect for 2 yr
- More root P (%) with tillage
  - More P uptake with tillage
- Higher root P may have reduced AM
  - Also disruption of hyphal networks

Mycorrhyzal root colonization (nmol g□1 root).

	Soybean 2004	Corn 2005	Soybean 2004	Sorghum 2005
	ARDC		RMF	
Chisel, 12”	477	500	857	63
Disk	350	361	901	140
Plow	362	501	515	19
No-till	**1319**	**987**	**1108**	**228**
LSD (0.05)	371	207	180	116

High root P concentration with tillage.

	Soybean 2004	Corn 2005	Soybean 2004	Sorghum 2005
	ARDC		RMF	
Plow	0.053a	0.296a	0.165a	0.224a
No-till	0.039b	0.158b	0.095b	0.114b

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Soil microbial effects

- Biomass was generally less at 0-4” depth for all soil microbial types at 5 yr after one-time MP and MMP tillage compared with NT.
- Why?? Agronomic significance?? SOC significance??

Tillage effect (%Δ) on microbial biomass at 5 yr, 0-4” depth		
MP, RMF	MP, ARDC	MMP, ARDC
Bacteria		
-15	-27**	-9**
Actinomycetes		
-8	-17**	-9**
Fungi		
0	-34	-16
Bacteria		
-16	-27**	-12

Conclusions

- One time tillage of NT on silty clay loam soil can be done without detrimental agronomic effects
  - ➢Assumes erosion is controlled
- Grain production over 5 years may be increased with 1-time MP or MMP tillage
- Little or no effects detected after 5 years on soil organic C and other properties

Publications

- Garcia et al. 2007. ….. nutrients, mycorrhizae, and phosphorus uptake. Agron. J. 99:1093-1103.
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- Wortmann et al. 2010. ……five years post-tillage. Agron. J. 102:1302-1307.

Thank you!

Questions or comments??

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