Managing and Enhancing Carbon in Soils Through Soil Aggregation

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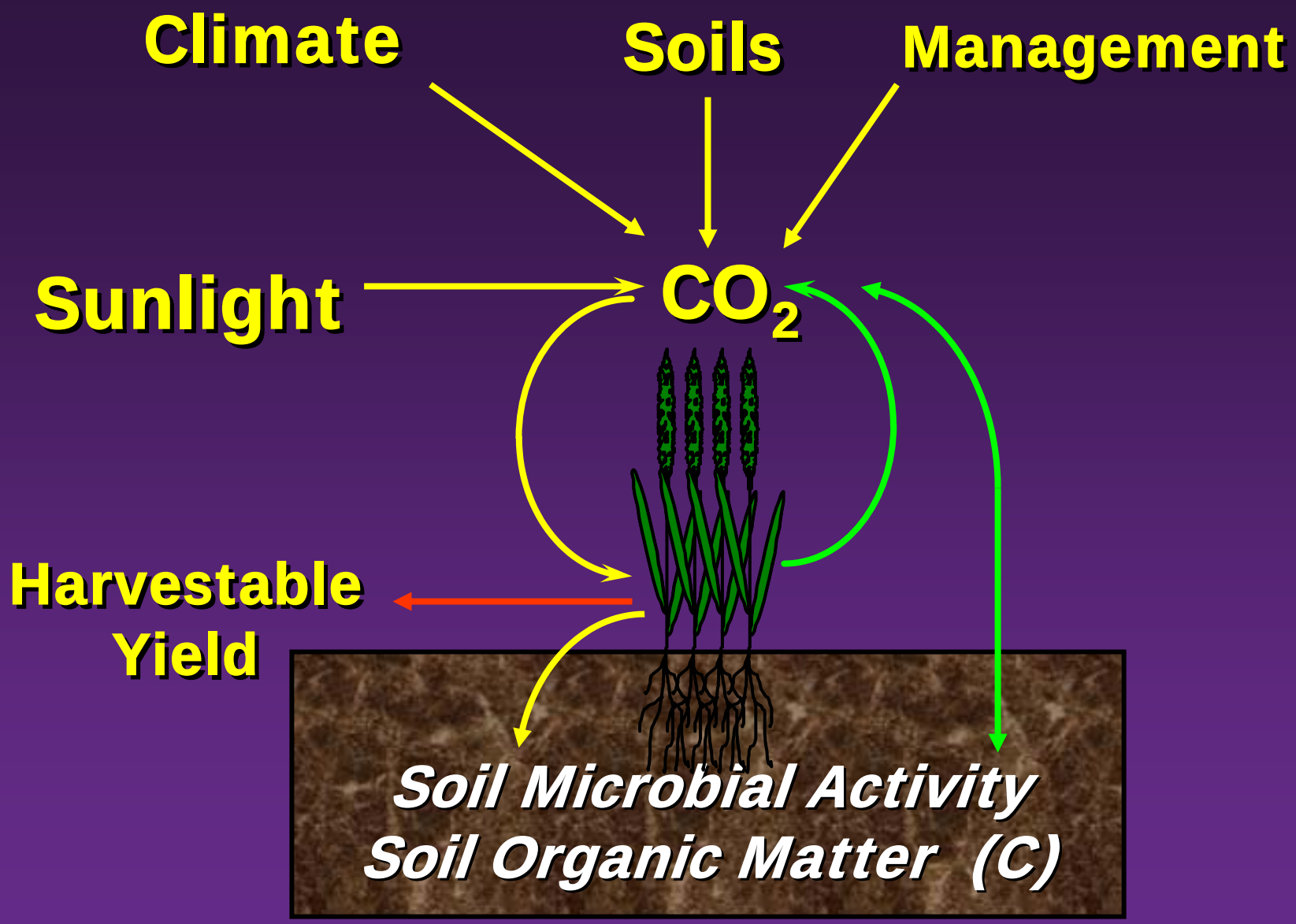
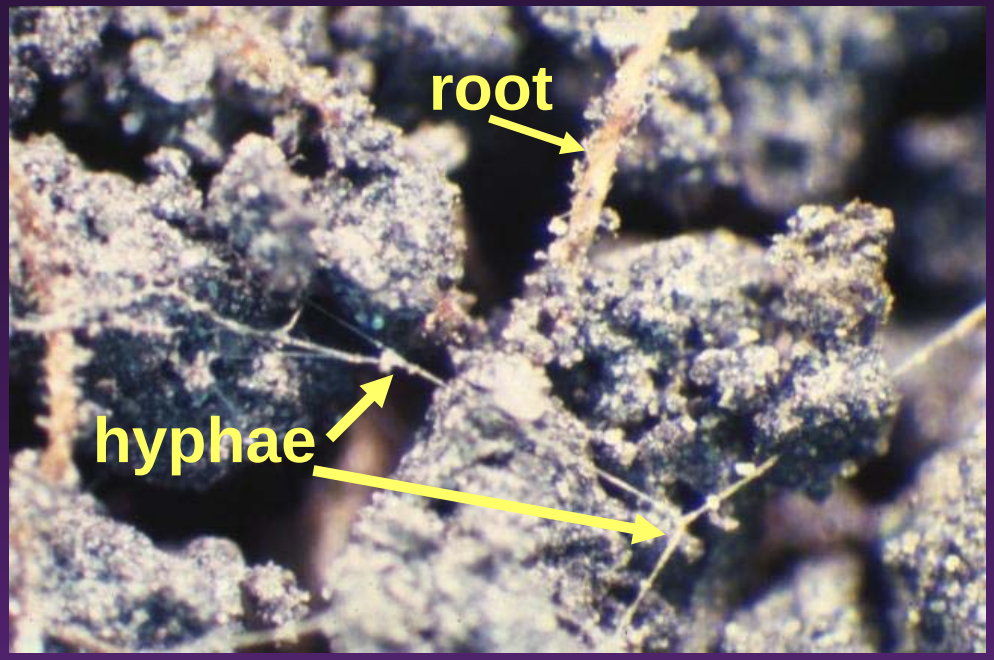
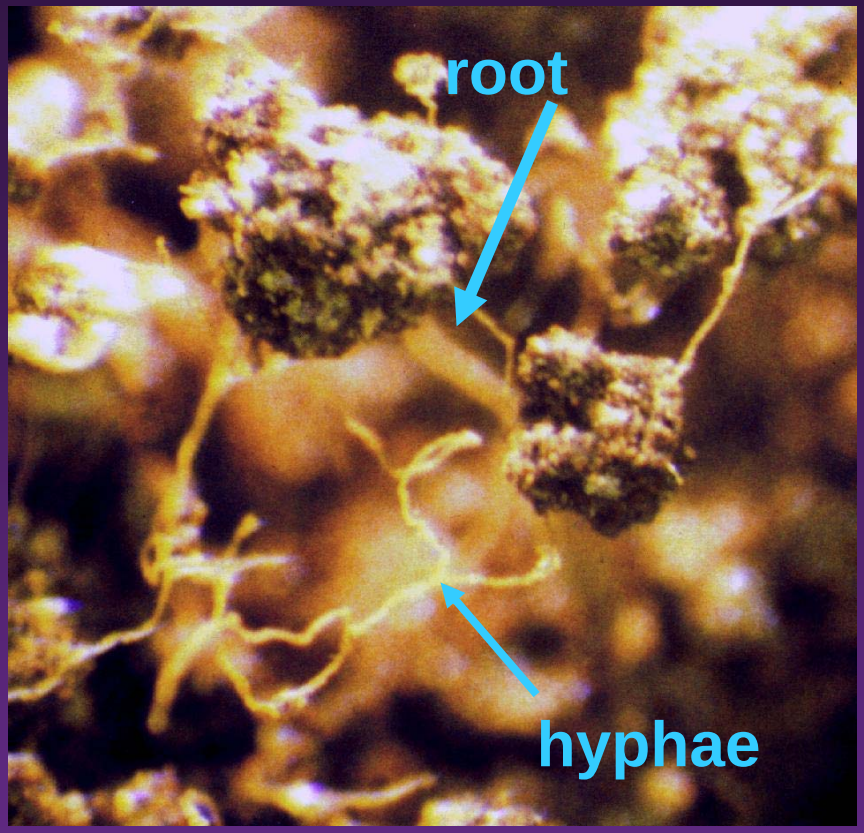
Consortium for Agricultural Soils Mitigation of Greenhouse Gases

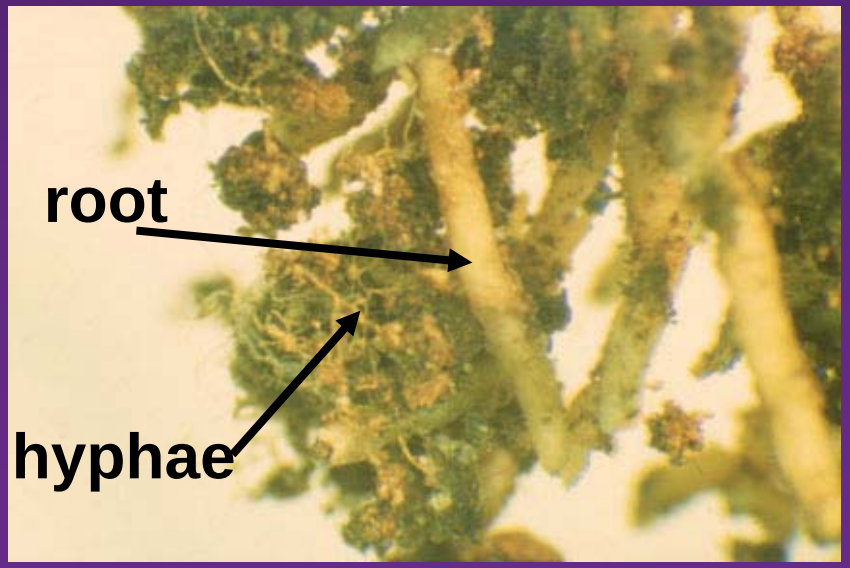
K-State Research and Extension


Climate
Soils
Management
Sunlight
CO_2
Harvestable Yield
Soil Microbial Activity
Soil Organic Matter (C)



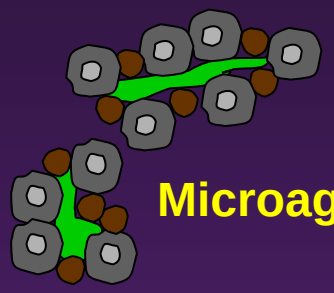


Glomalin?



Photos provided by:
Mike Miller and Julie Jastrow

Conceptual diagram of soil aggregate hierarchy



Microaggregate 20-90 and 90-250 mm

Plant and fungal debris

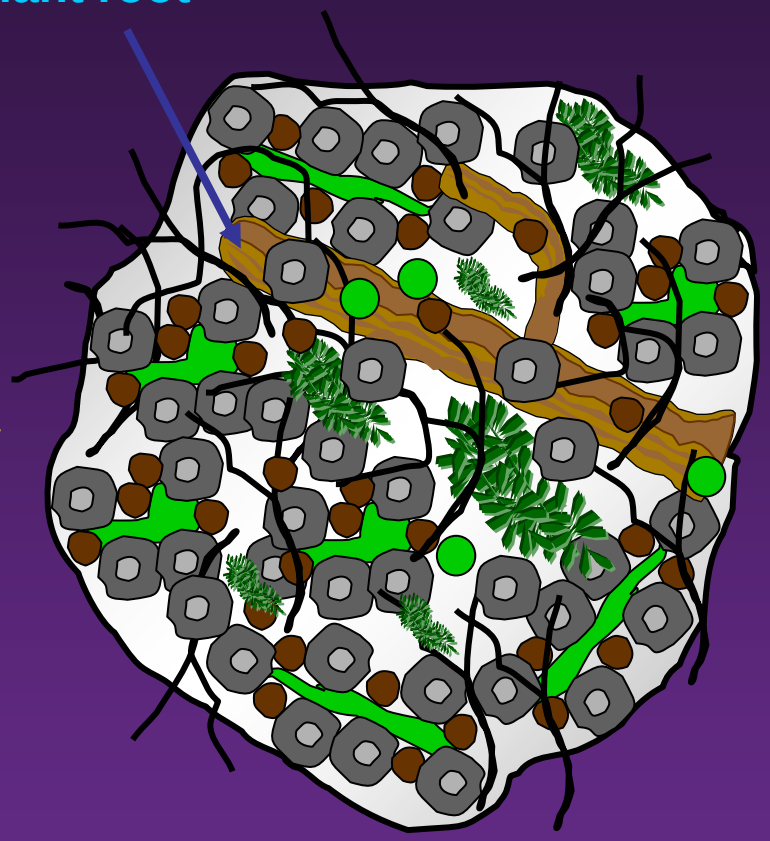
Silt-size microaggregate with microbially derived organomineral associations

Clay microstructures

Particulate organic matter colonized by saprophytic fungi

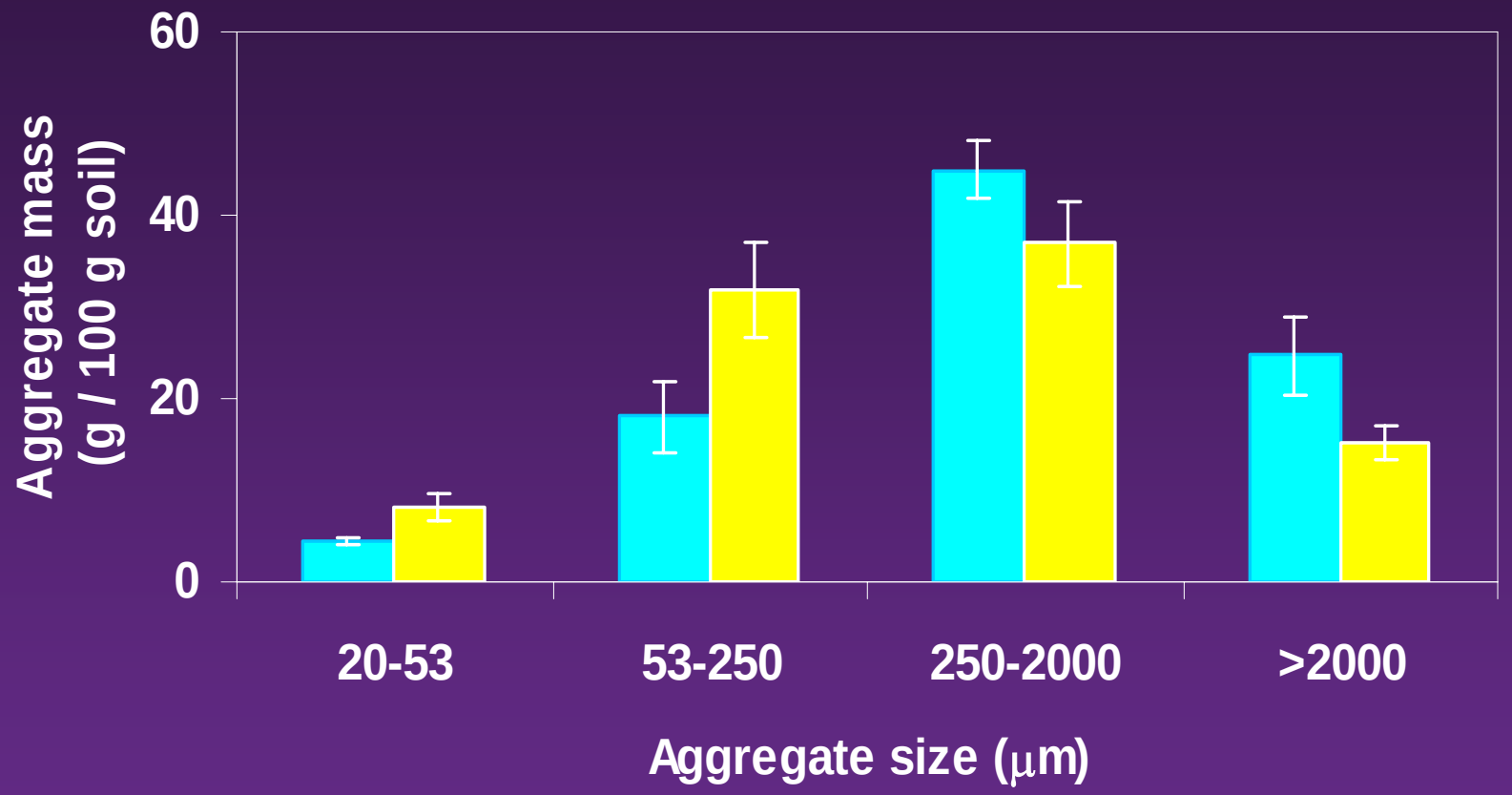
Mycorrhizal hyphe

Pore space; polysaccharides and other amorphous interaggregate binding agents



Jastrow & Miller 1997

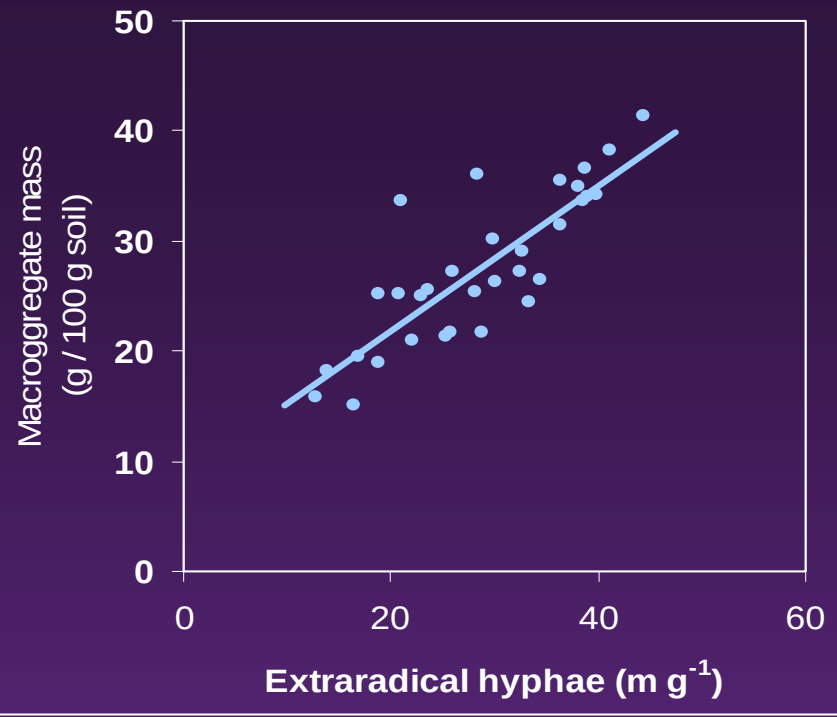
Effect of mycorrhizal suppression on aggregate distribution



Control (mycorrhizal)

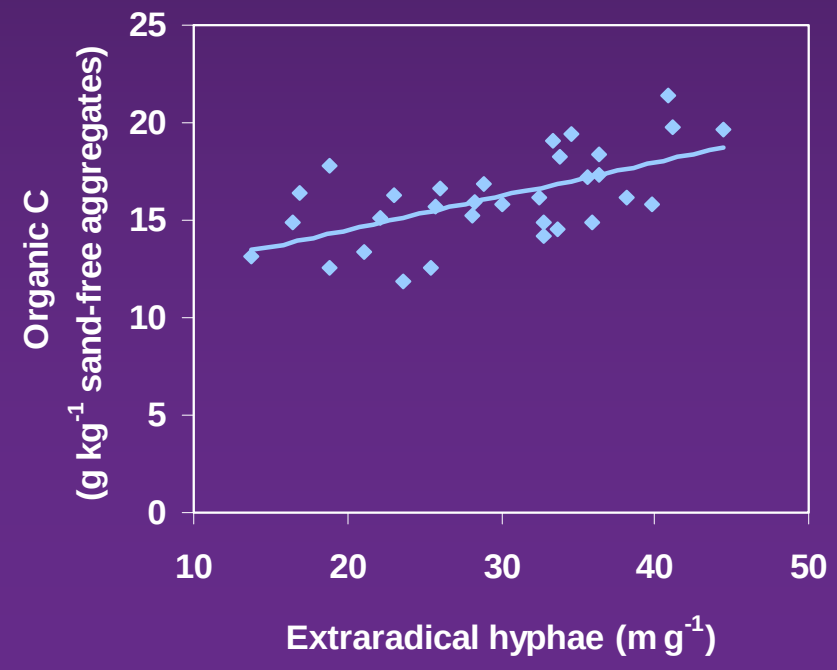
Mycorrhizal - suppressed

Wilson, 2004



Macroaggregates

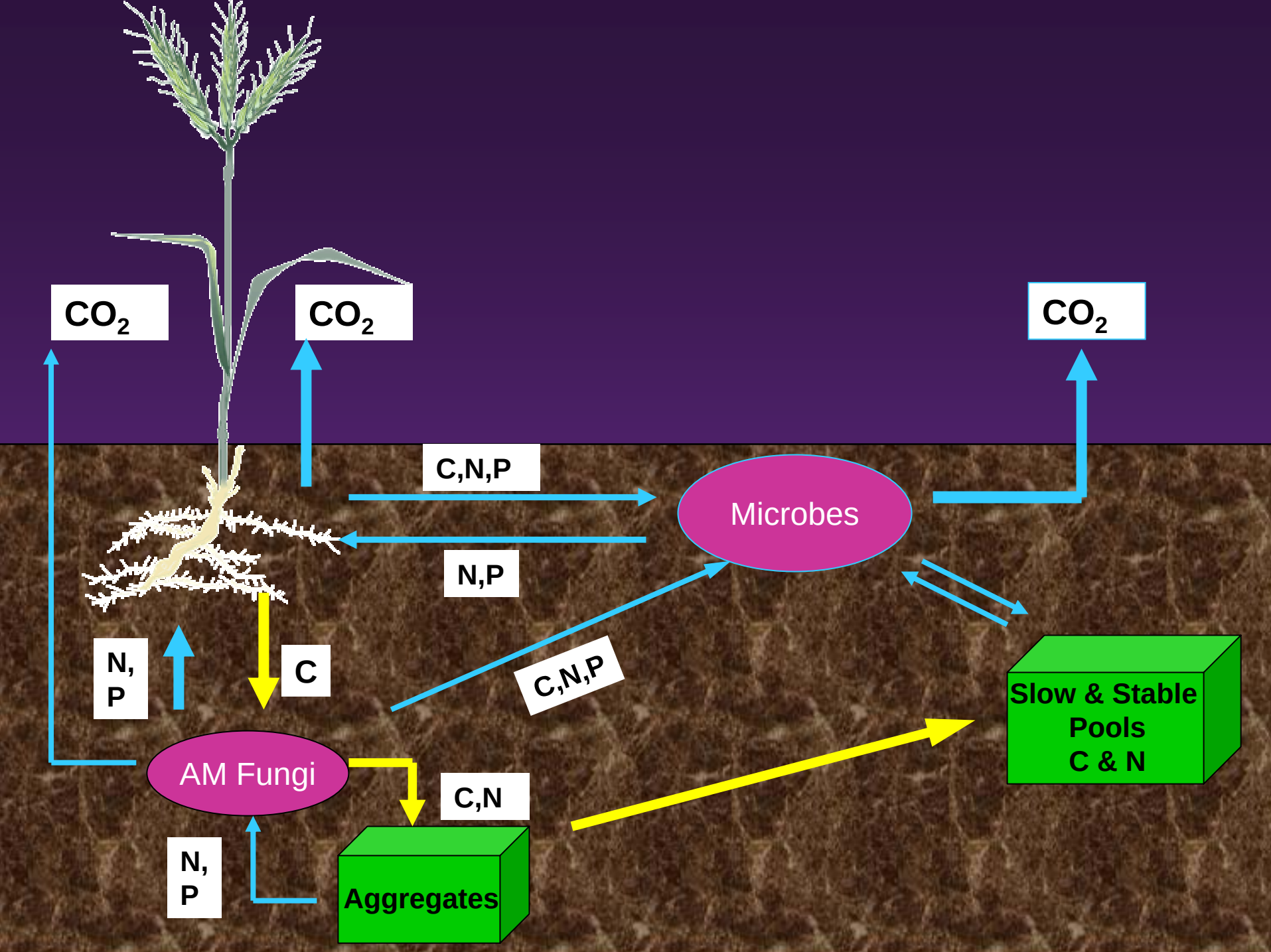
$P < 0.0001$
$r^2 = 0.834$



Organic carbon

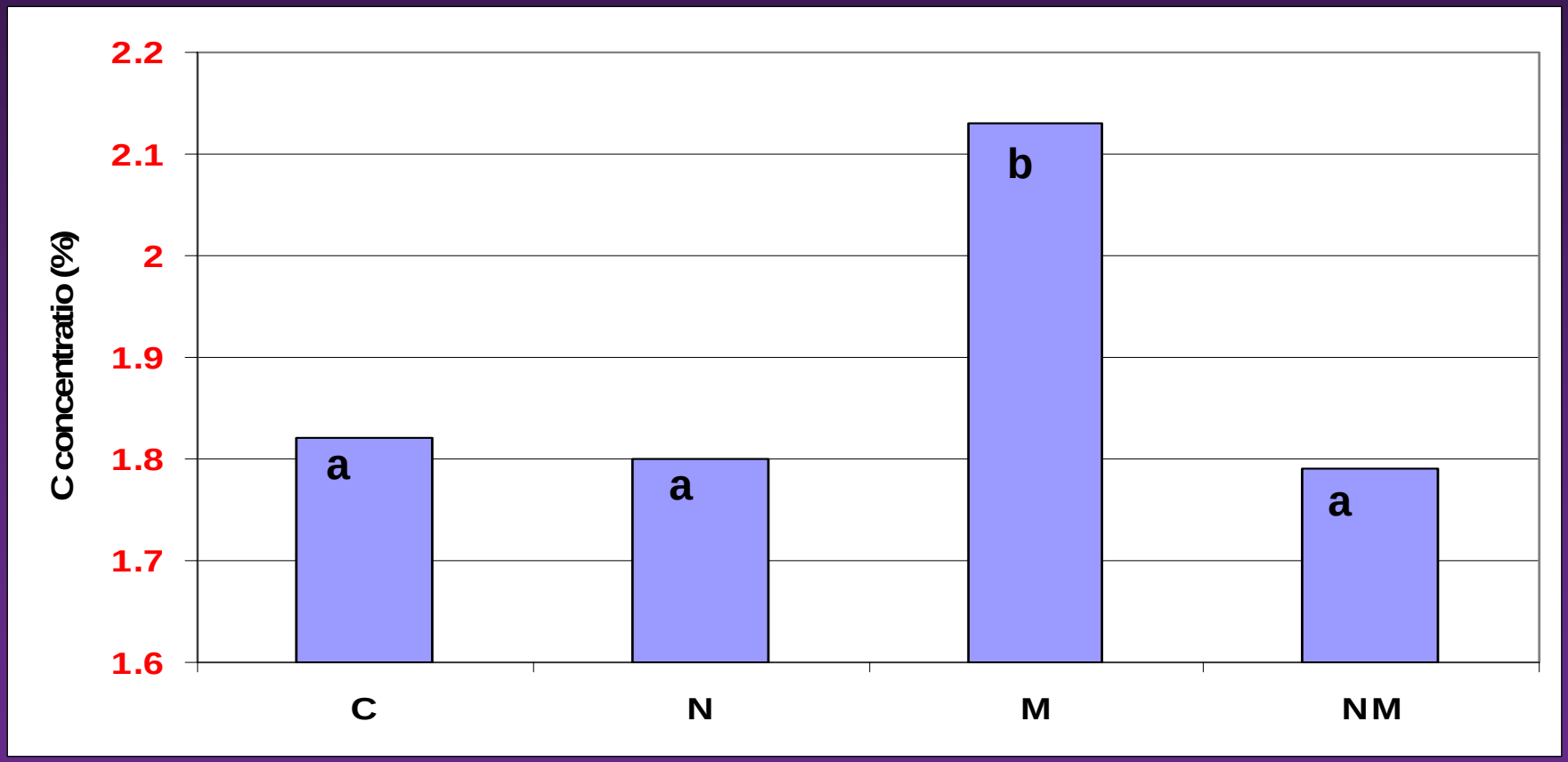
$P < 0.0001$
$r^2 = 0.605$

Wilson and Rice, In prep.


CO_2
CO_2
CO_2
C,N,P
N,P
Microbes
N, P
C
C,N,P
AM Fungi
C,N
N, P
Aggregates
Slow & Stable Pools C & N

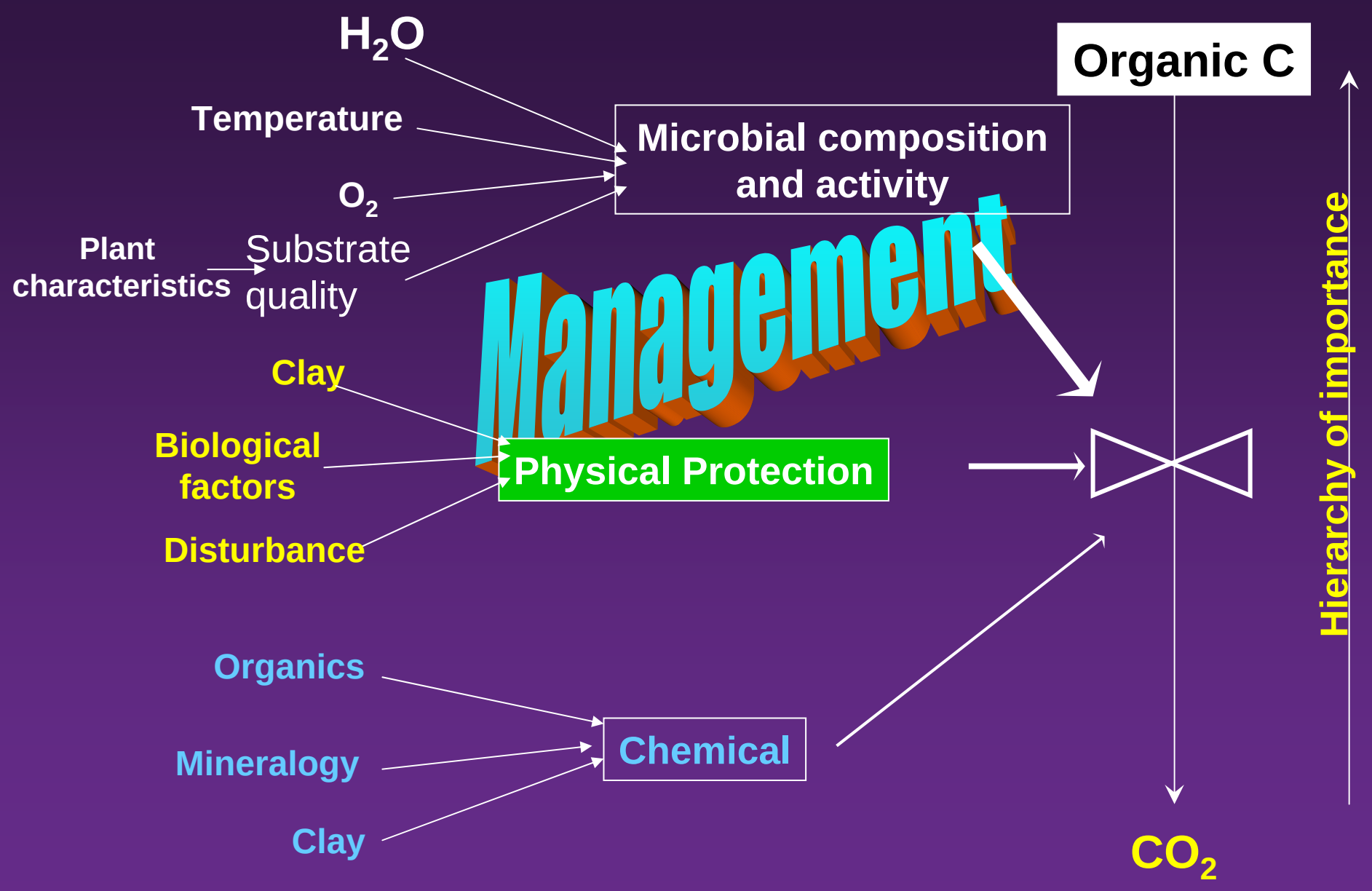
Results

[C] in large macroaggregates (>2000 μm)

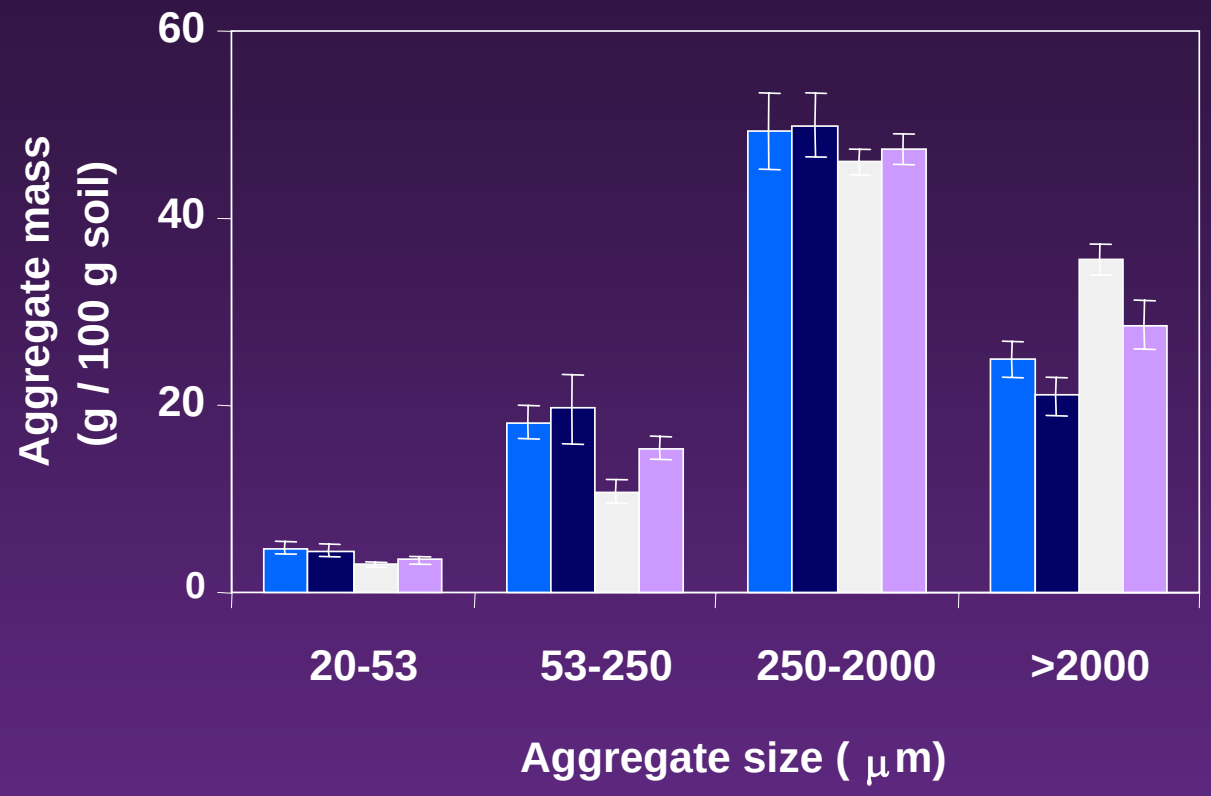


Watson et al., in prep

Conservation of Soil Carbon



Aggregate distribution



Burned / Control

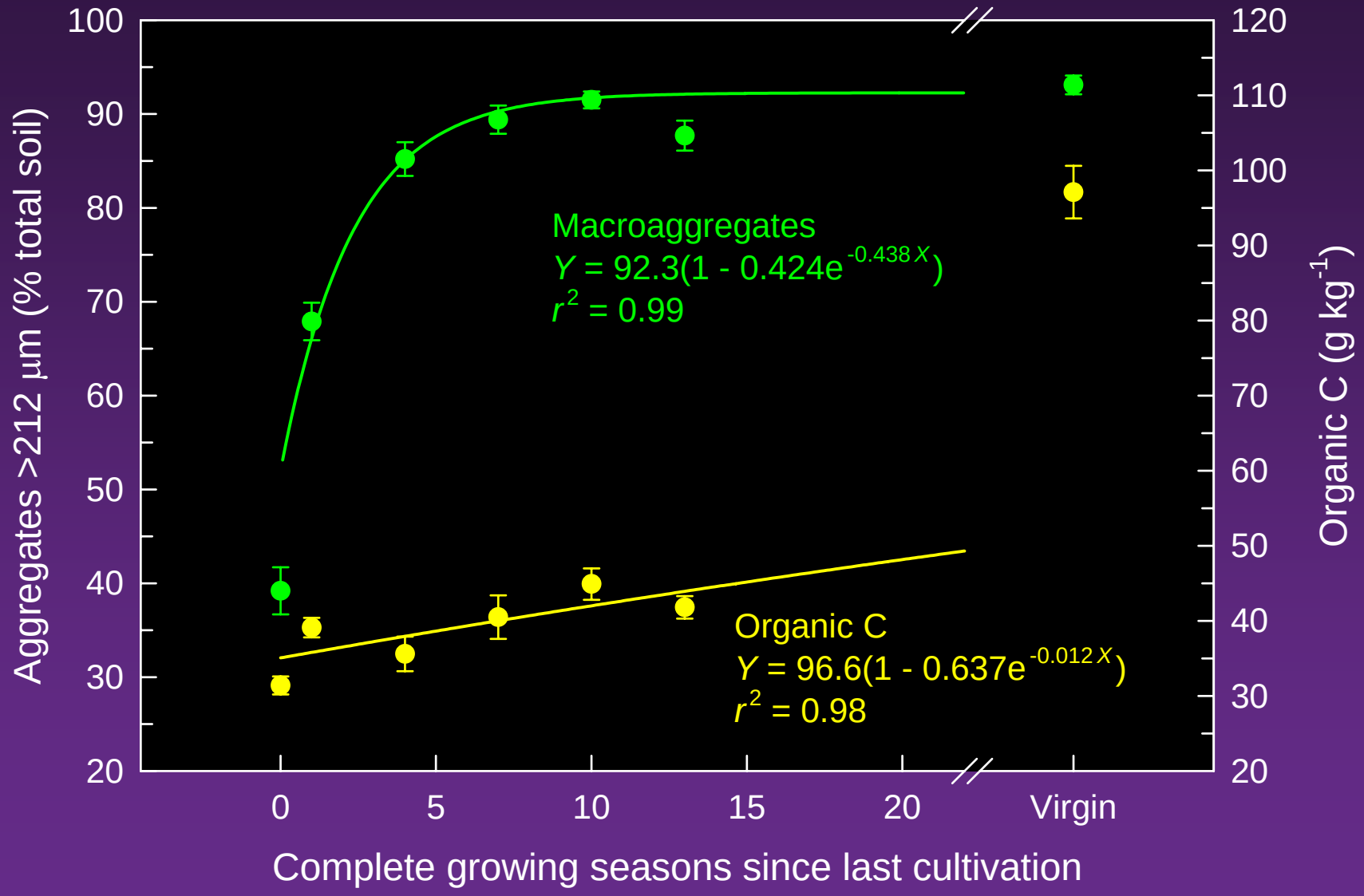
Burned / + Nitrogen

Unburned / Control

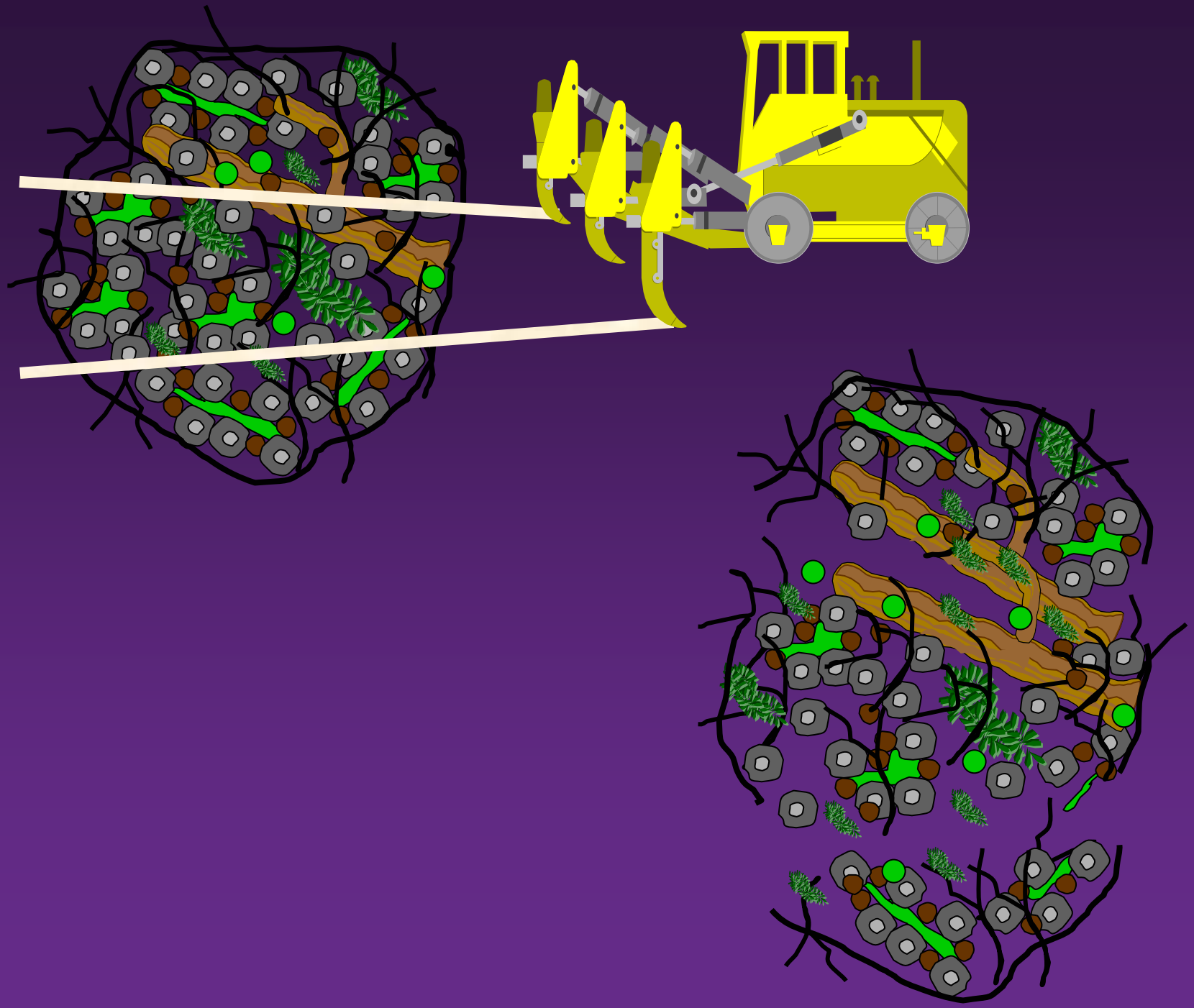
Unburned / + Nitrogen

Changes in Aggregation and Organic Carbon in a Prairie Soil

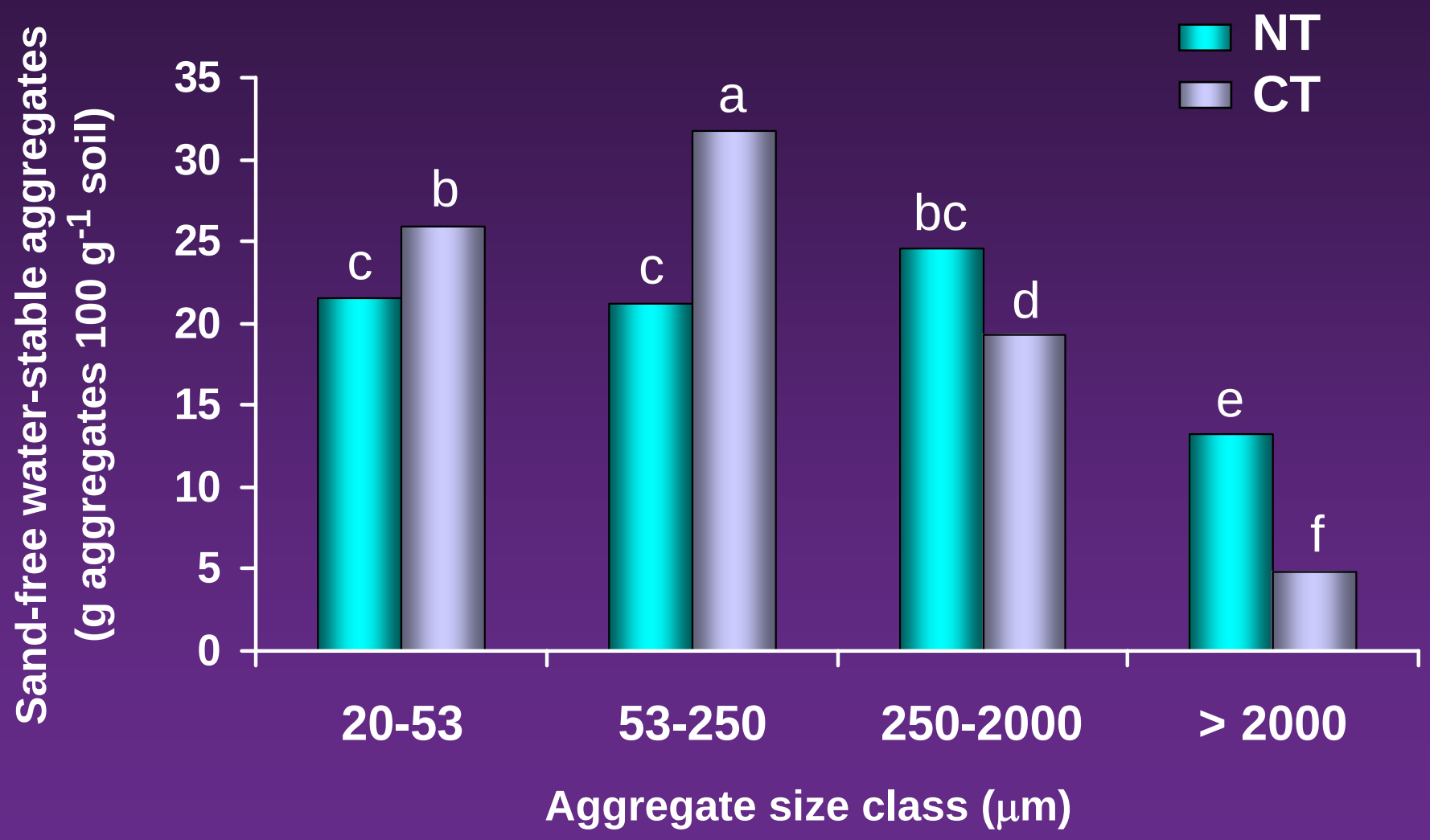
(From Jastrow, 1996, Soil Biol. Biochem. 28:665-676)



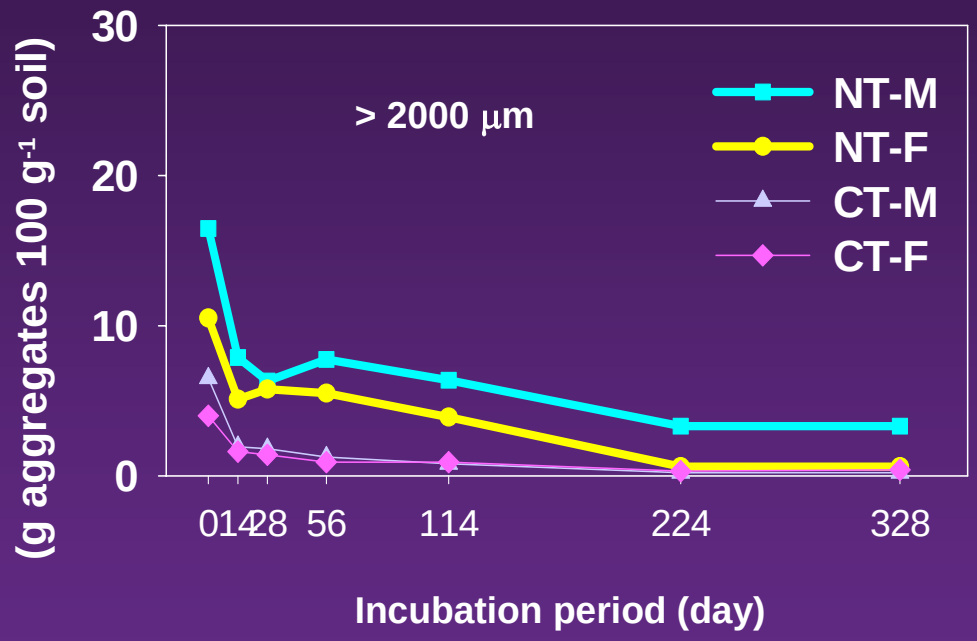
No-Tillage

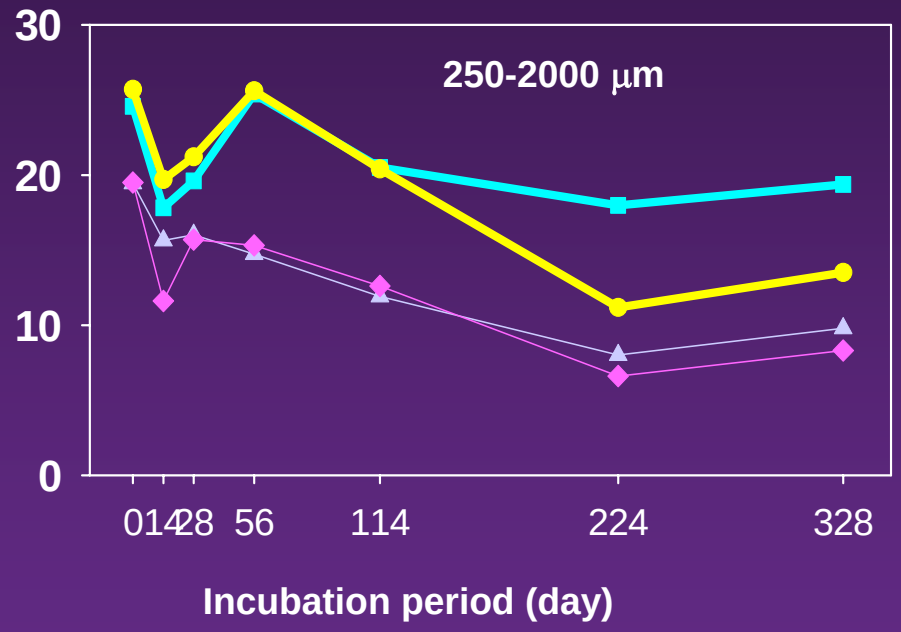


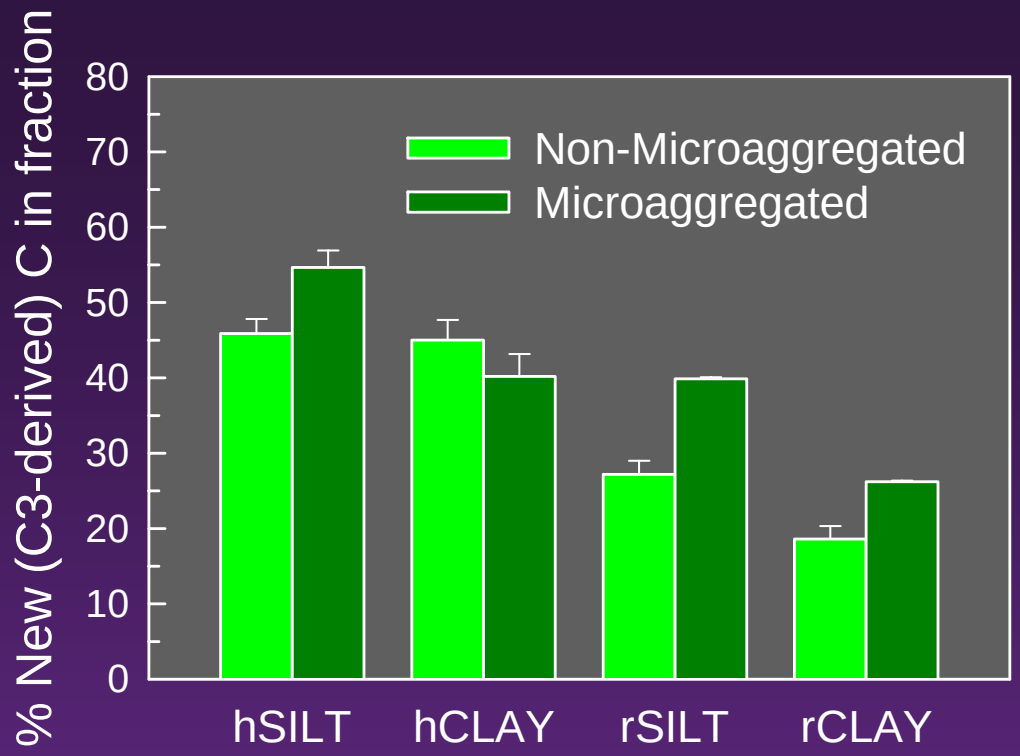
Water-Stable Aggregates



Aggregate Size Classes







h = Hydrolyzable C
r = Chemically resistant C

- ⇨ More new chemically resistant C in microaggregated silt & clay
- ⇨ Increased hydrolyzable C in microaggregated silt is probably physically protected
- ⇨ Suggests microaggregates can facilitate creation of new organomineral associations

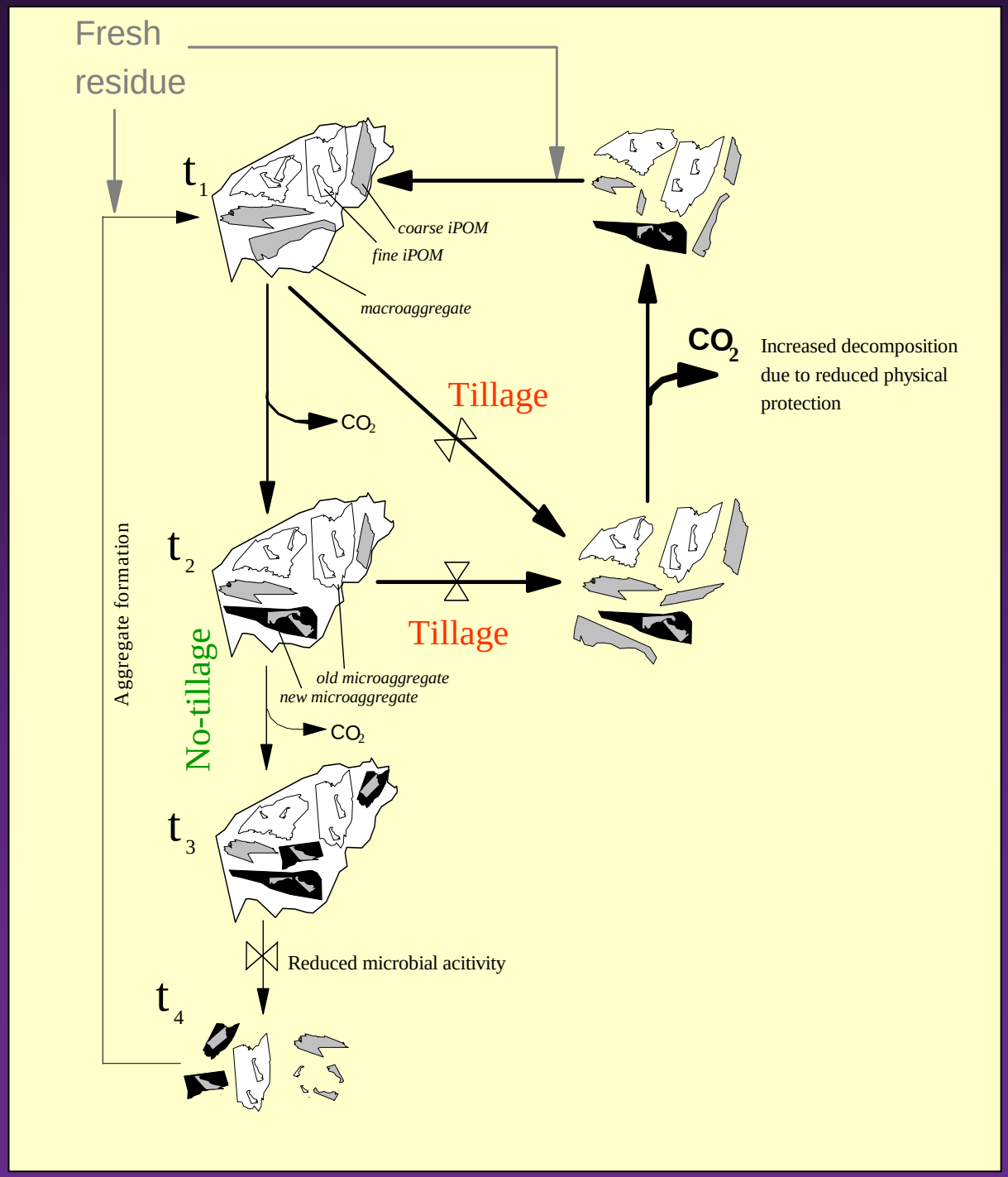
From Jastrow and Six, In preparation

Aggregate Turnover Model

Six et al., 2000, *Soil Biol. Biochem*, 32:2099-2103

	MRT (y)
Macroaggregate	
No-till	27
Conv. tillage	8
Microaggregate	
No-till	137
Conv. tillage	79

Six et al., 1999, *Soil Sci. Soc. Am. J.* 63:1350-1358



Summary

- Aggregation of soil particles provide both physical and chemical protection of soil C
- Soil microbial activity enhances aggregation
- Plant and soil management enhances
  - Aggregation
  - Soil C and its stability
- Soil C turnover can be decreased 2-3 times
  - From decades to centuries