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Water Quality

Recent Trends in Conservation Agriculture under Mediterranean Conditions

CIHEAM

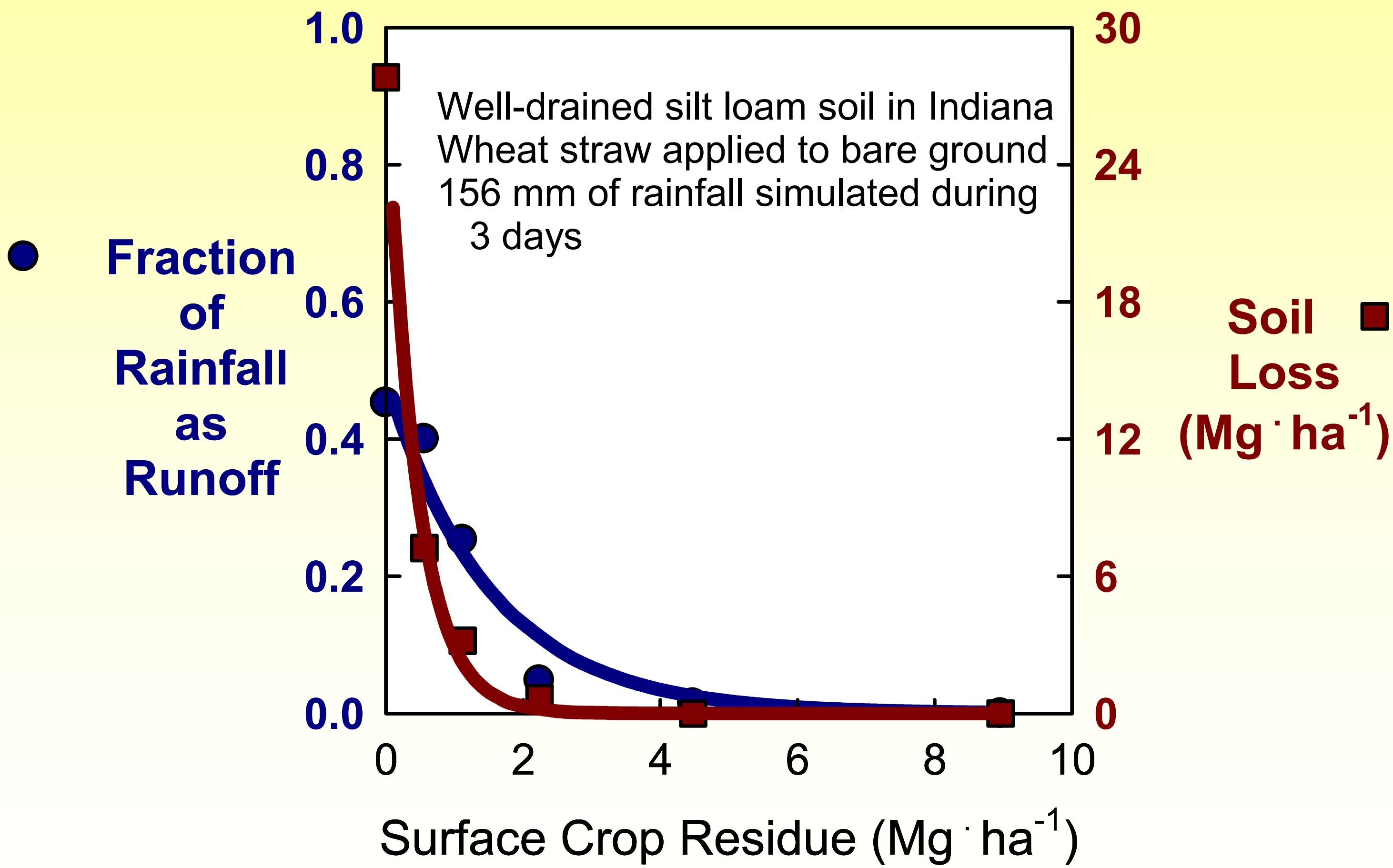
Centre International de Hautes Études Agronomiques Méditerranéennes
International Centre for Advanced Mediterranean Agronomic Studies

Water Quality

- ✓ **Lack of residue cover and exposure of soil to high-intensity rainfall can result in poor aggregation, reduced plant water availability, erosion, and off-site impacts of sedimentation and poor water quality.**

Water Quality

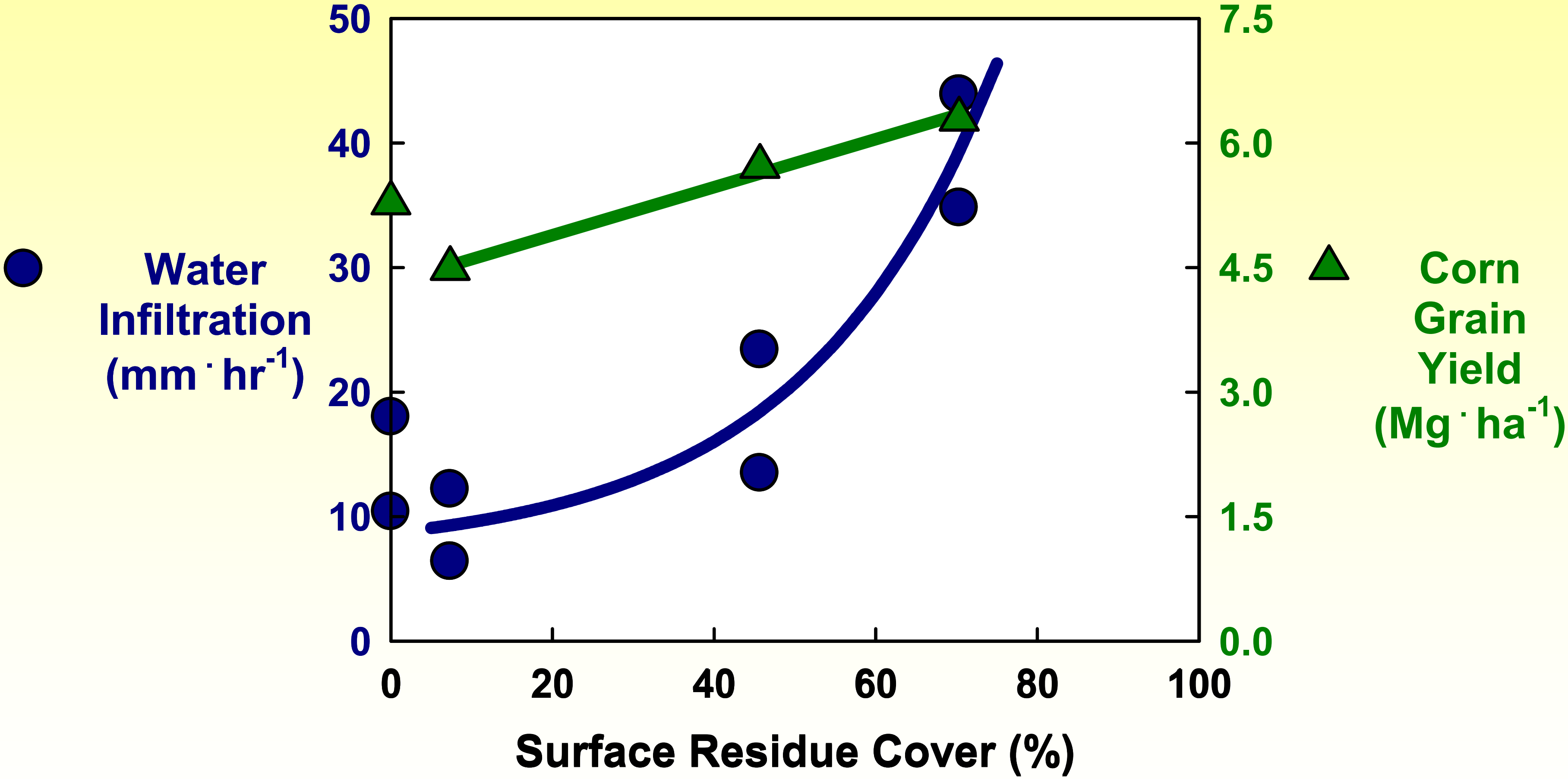
Impact of surface crop residues



Data from Mannering and Meyer (1963) Soil Sci. Soc. Am. Proc. 27:84-86

Water Quality

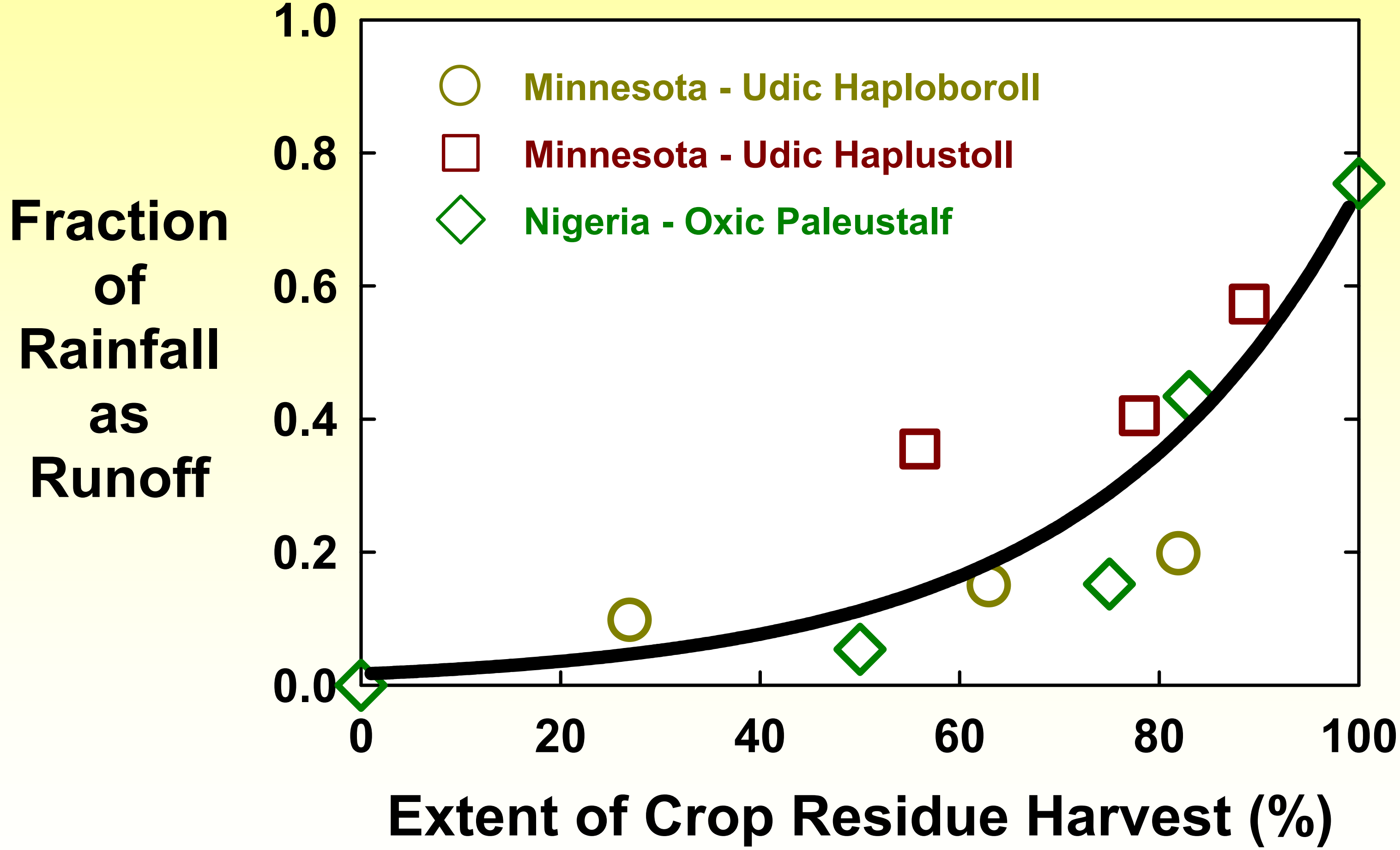
Impact of surface crop residues



Data from Triplett et al. (1968) Agron. J. 60:236-239

Water Quality

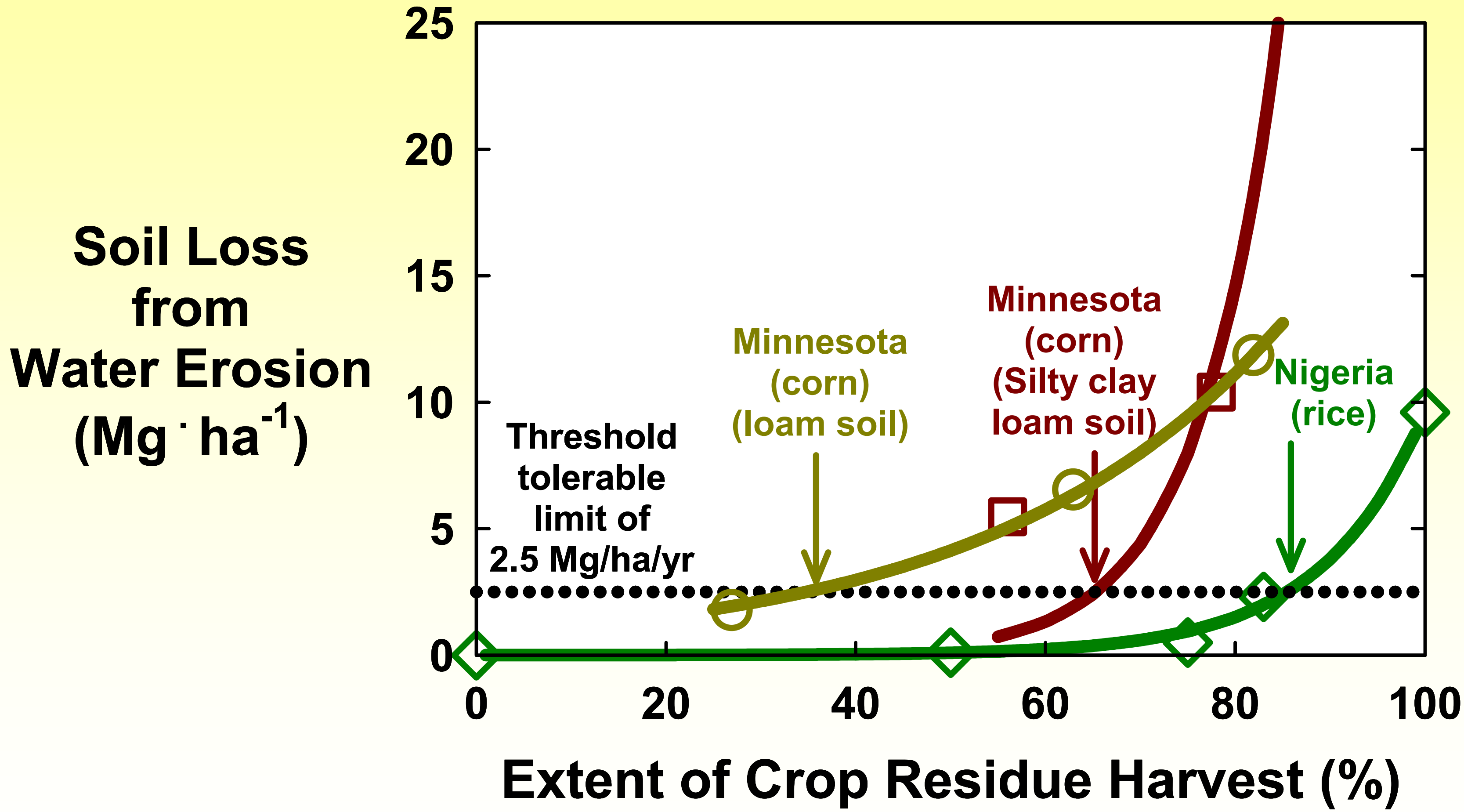
Impact of surface crop residues



Data from Erenstein (2002) Soil Tillage Res. 67:115-133
Lindstrom (1986) Agric. Ecosyst. Environ. 16:103-112

Water Quality

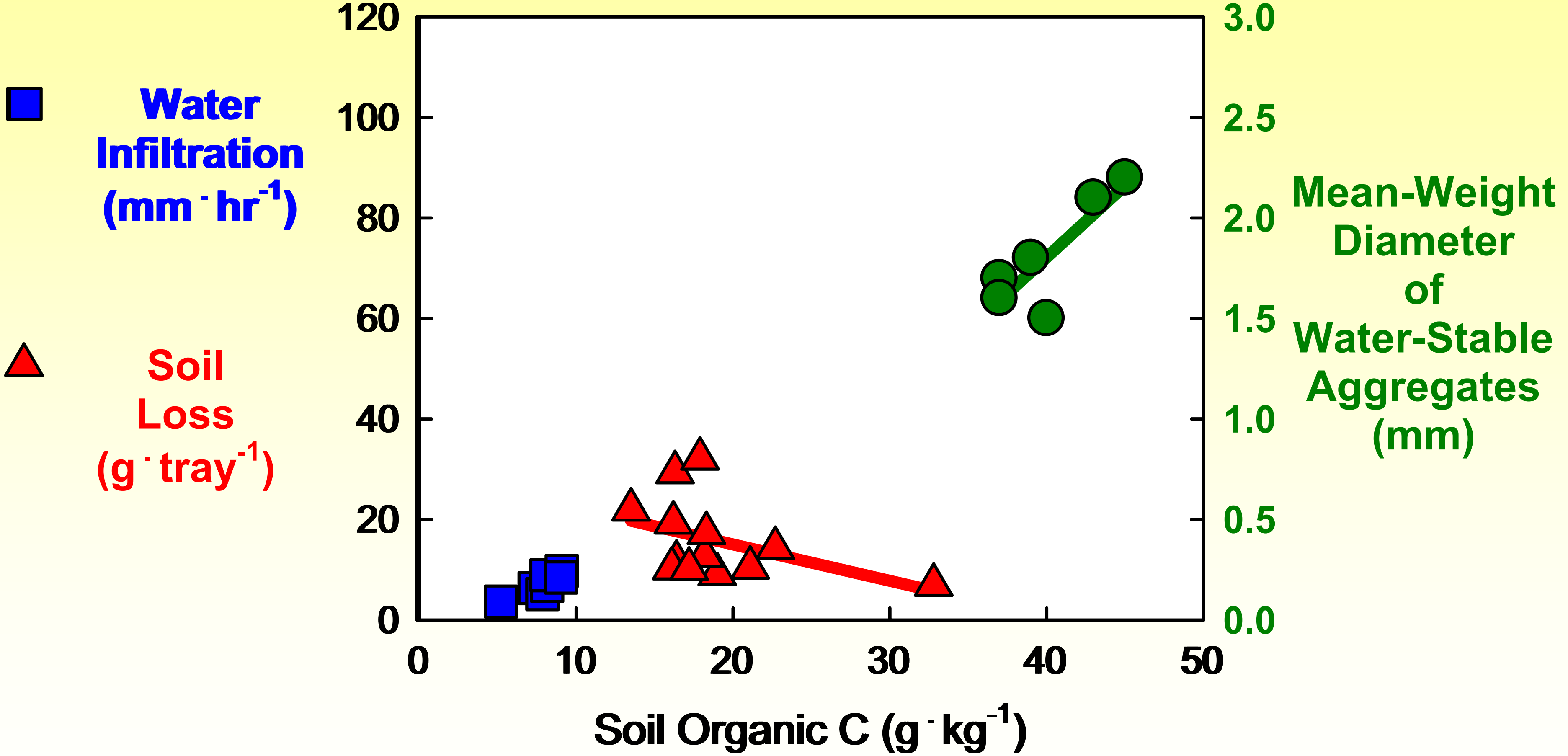
Impact of surface crop residues



Data from Erenstein (2002) Soil Tillage Res. 67:115-133
Lindstrom (1986) Agric. Ecosyst. Environ. 16:103-112

Water Quality

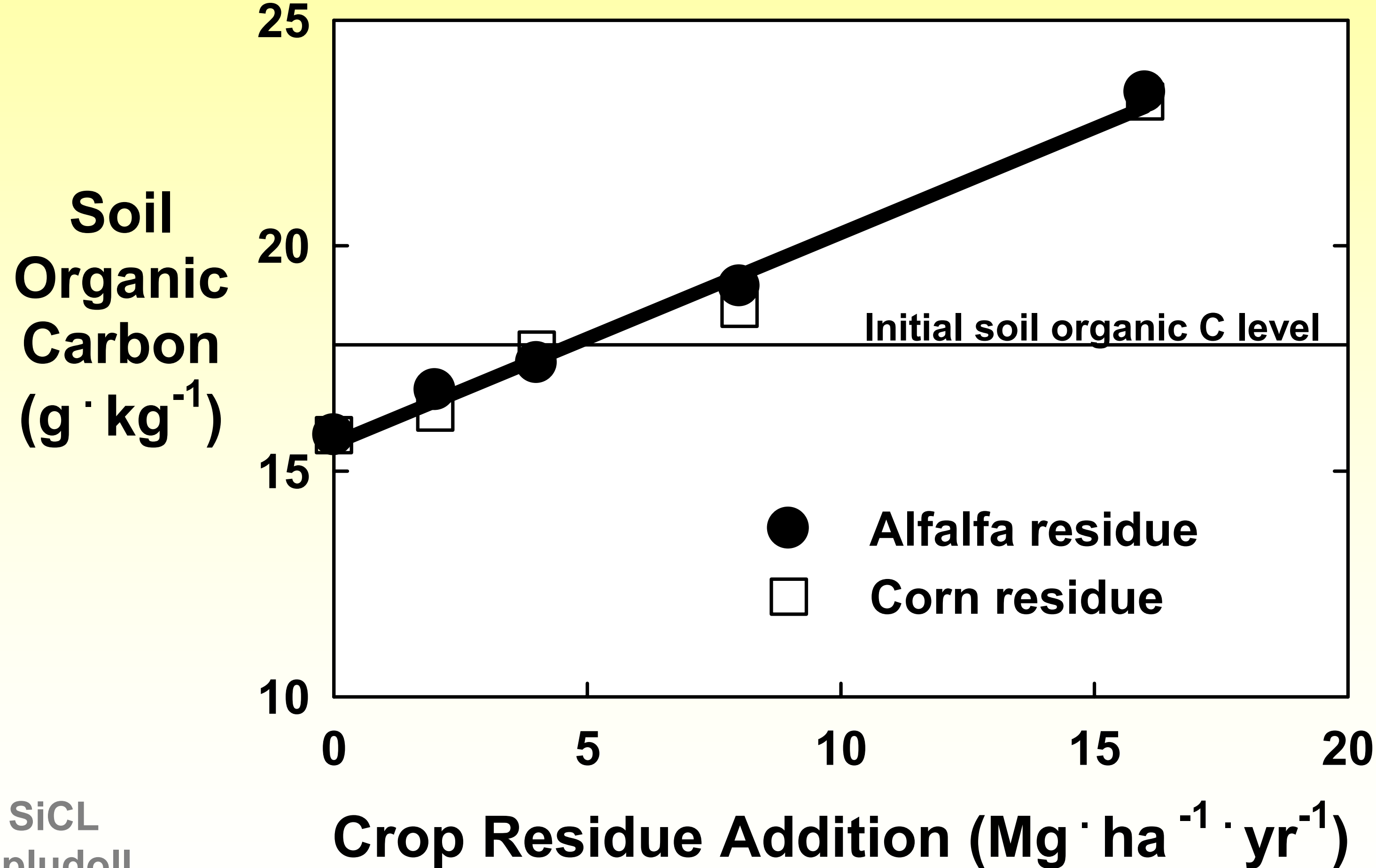
Impact of soil organic C



Water infiltration data from Carreker et al. (1977) ARS-S-160
Soil loss data from McDowell and Sharpley (2003) J. Environ. Qual. 32:207-214
Aggregation data from Arshad et al. (2004) Soil Till. Res. 77:5-23

Water Quality

Relationship of crop residues and soil organic C

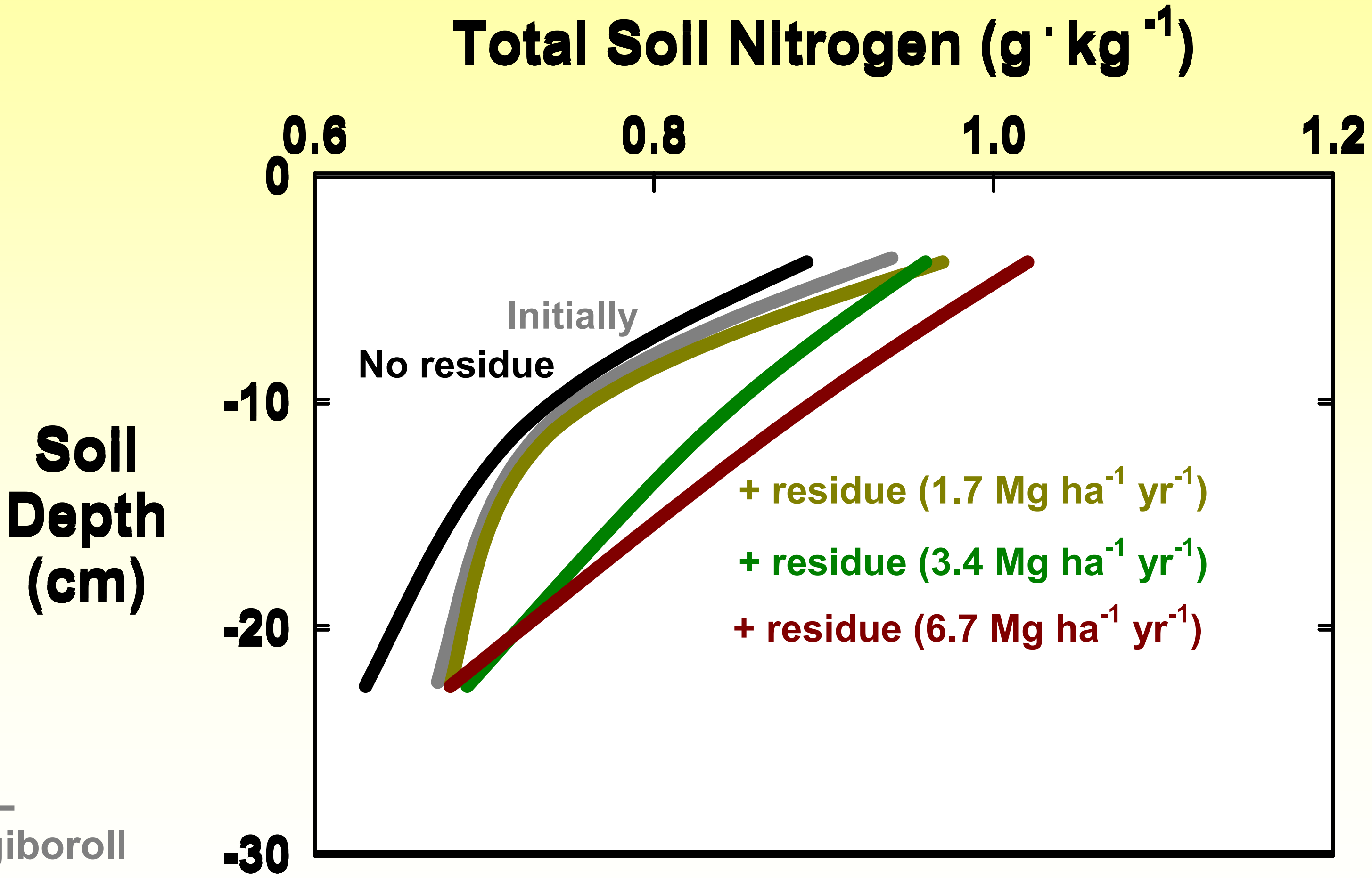


Iowa
Marshall SiCL
Typic Hapludoll
11-yr study
Plow tillage

Data from Larson et al. (1972) Agron. J. 64:204-208

Water Quality

Relationship of crop residues and total soil N

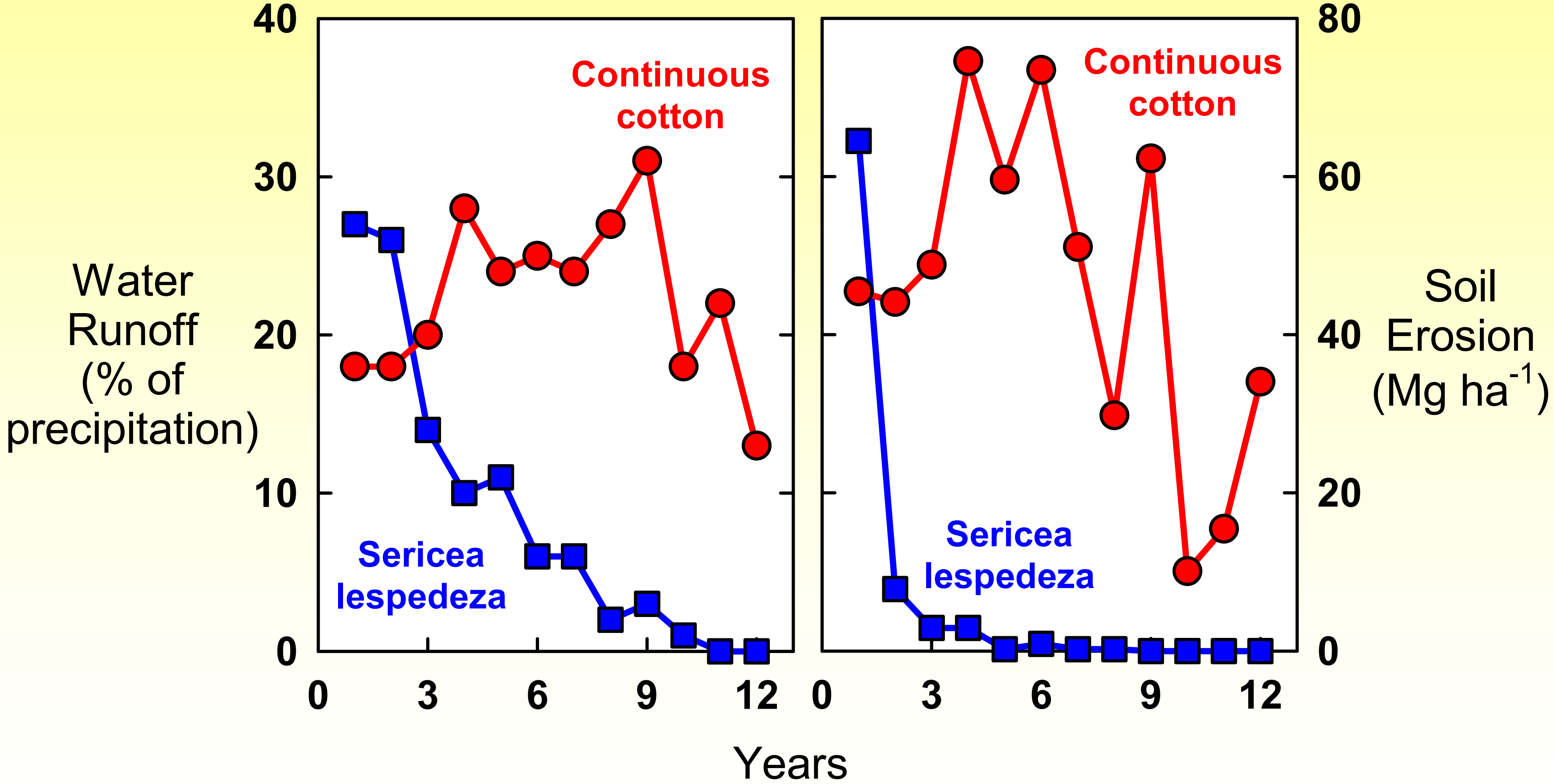


Montana
Dooley SL
Typic Argiboroll
8-yr study
Wheat-fallow
V-blade tillage

Data from Black (1973) Soil Sci. Soc. Am. Proc. 37:943-946

Water Quality

Impact of perennial vegetation



Data from Barnett (1965) J. Soil Water Conserv. 20: 212-215.

Water Quality

Separation of soil and surface residue impacts

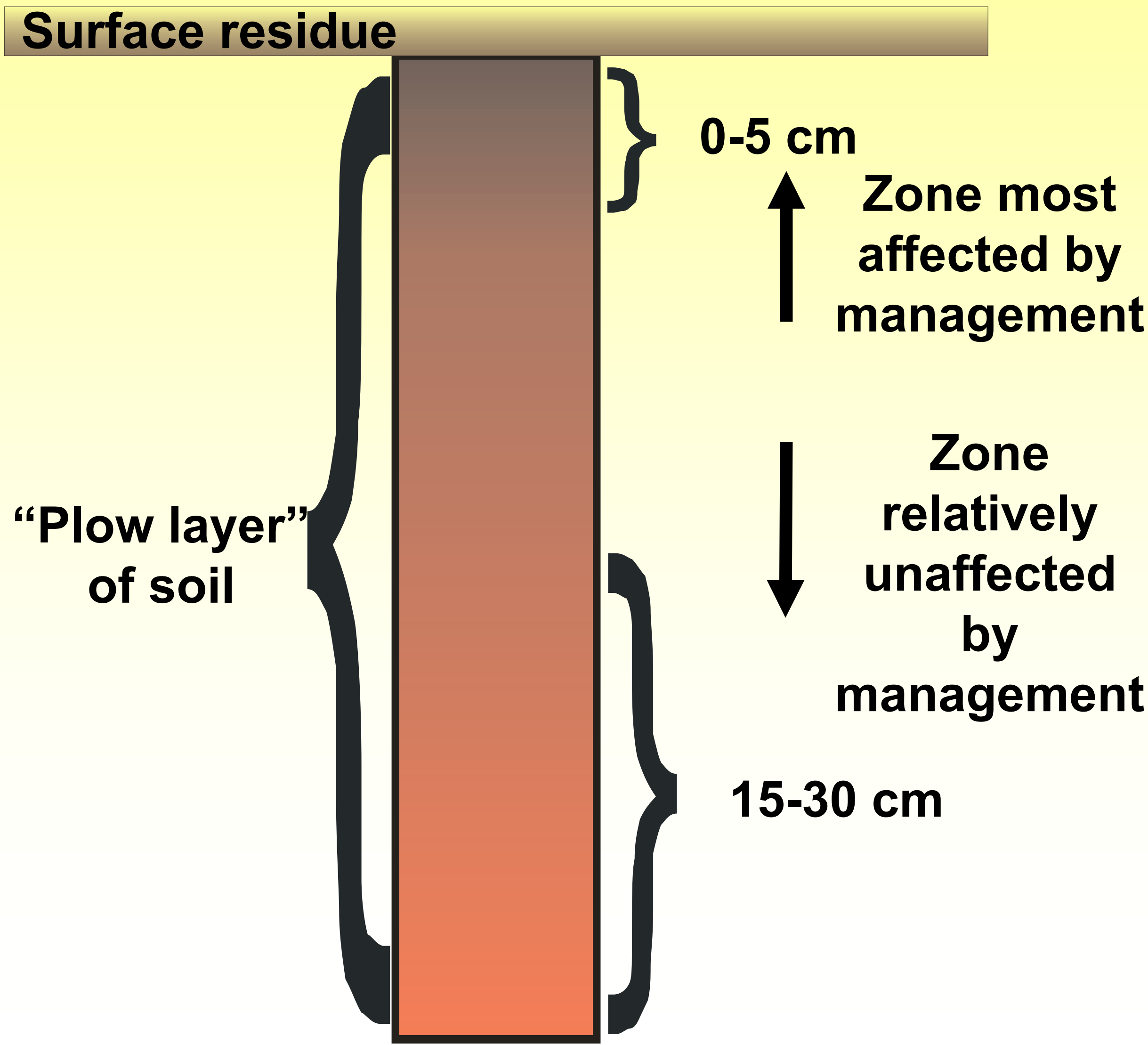
Response	Condition	Surface Residues –	Surface Residues +
Illinois			
Water runoff (% of applied)	NT – 15 yrs	33	0
	CT – 1 yr	49	9
Georgia			
Water runoff (% of applied)	CT – 5 yr	29	18
	NT – 5 yr	7	2
Soil loss (Mg/ha)	CT – 5 yr	4.5	1.4
	NT – 5 yr	1.3	0.4

CT = conventional tillage, NT = no tillage

Illinois data from Bradford and Huang (1994) Soil Till. Res. 31:353-361
Georgia data from West et al. (1991) Soil Sci. Soc. Am. J. 55:460-466

Water Quality

Stratification ratio of soil organic carbon



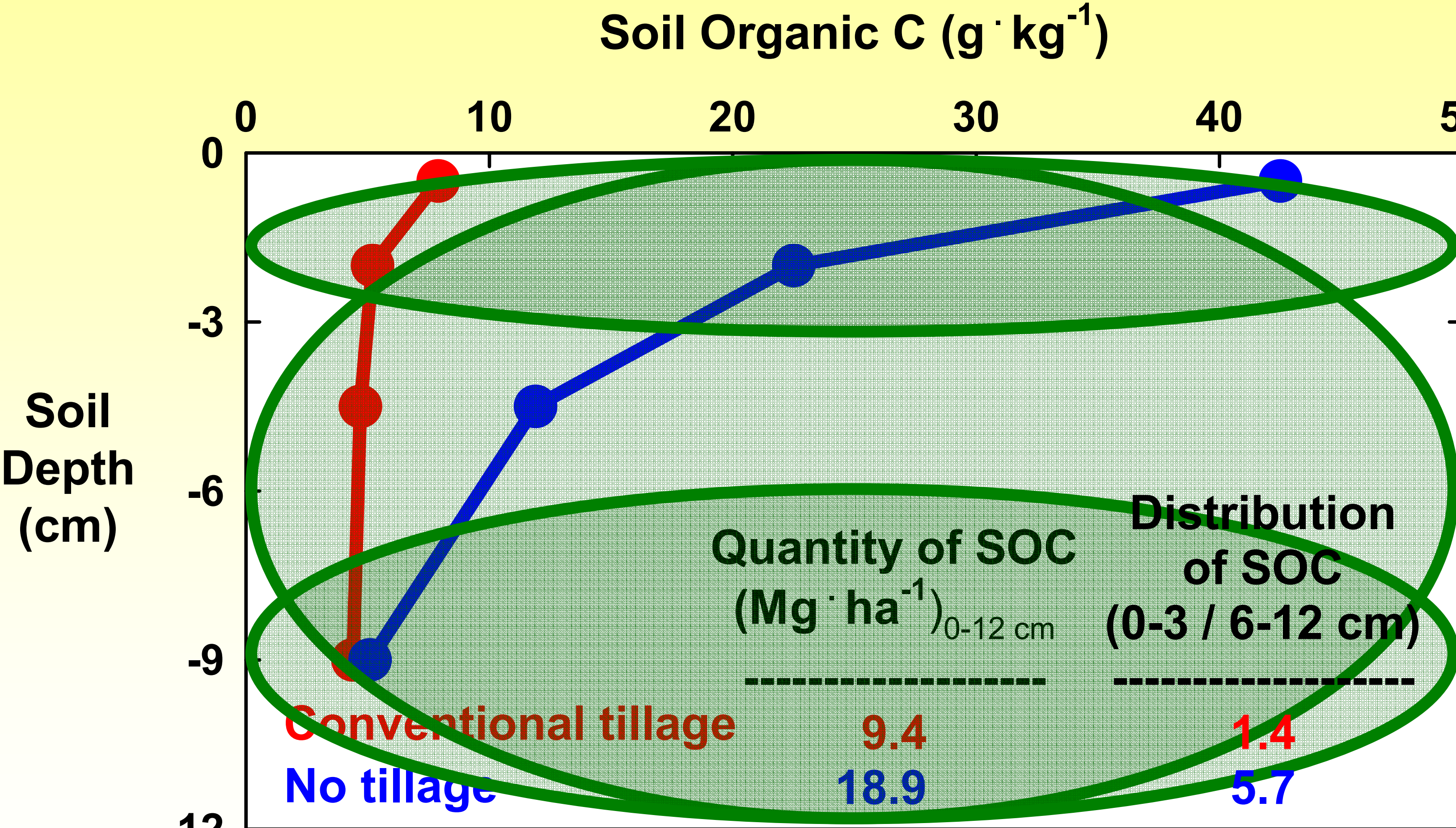
Stratification Ratio

$$\frac{\text{SOC (0-5 cm)}}{\text{SOC (15-30 cm)}}$$

Plowed soils tend to have values near 1

Water Quality

Stratification of soil organic matter



NT / CT 2.0 4.1

Franzluebbers (2002) Soil Till. Res. 66:197-205

Water Quality

Stratification of soil organic matter

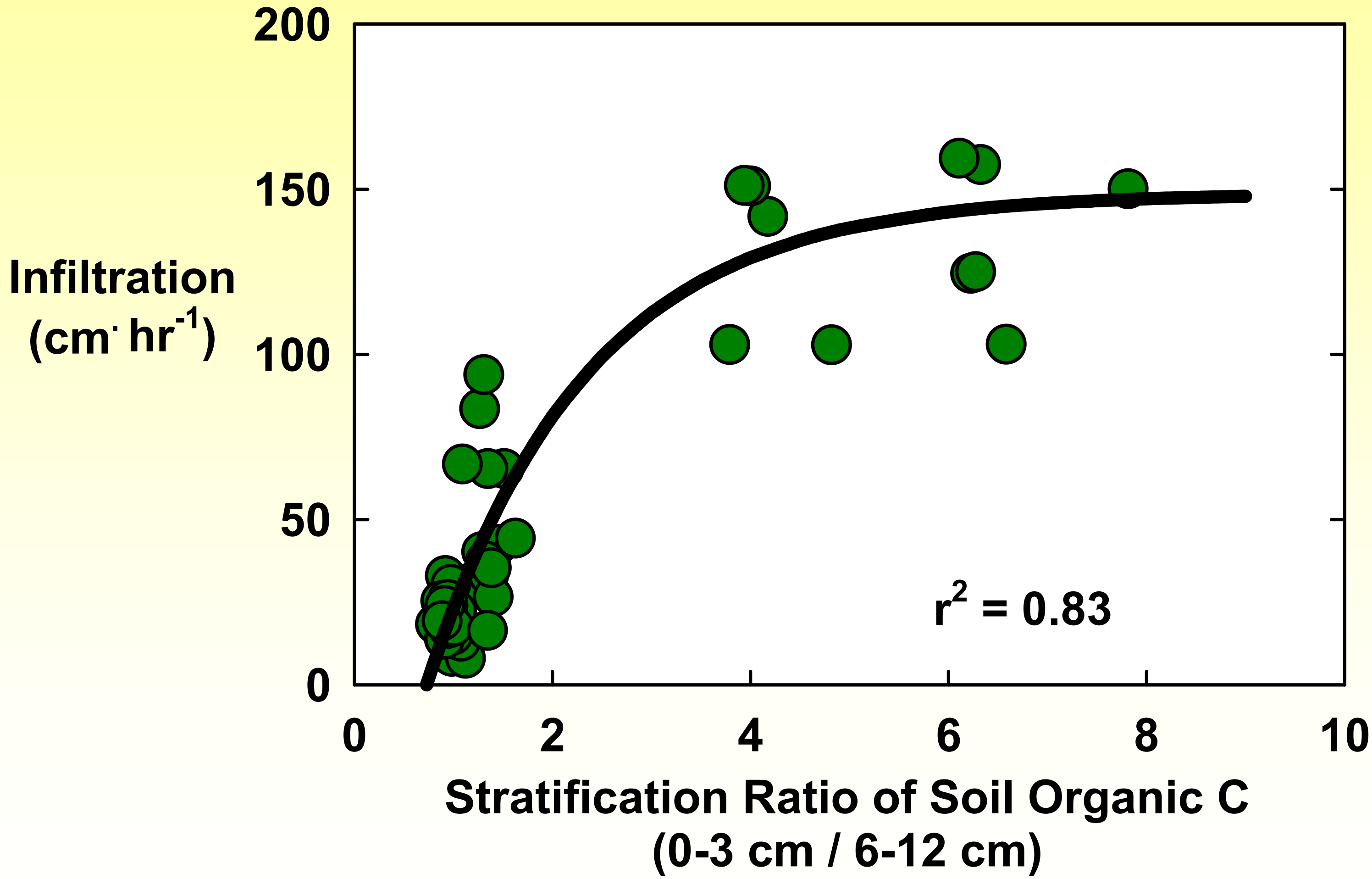
	Infiltration Rate ($mm\ min^{-1}$)		
	CT		NT
2x quantity Sieved	2.7	<	3.8
4x distribution Intact	2.2	<<	8.2

Greater rate of infiltration due to stratified distribution of organic C, rather than quantity of organic C

Franzluebbers (2002) Soil Till. Res. 66:197-205

Water Quality

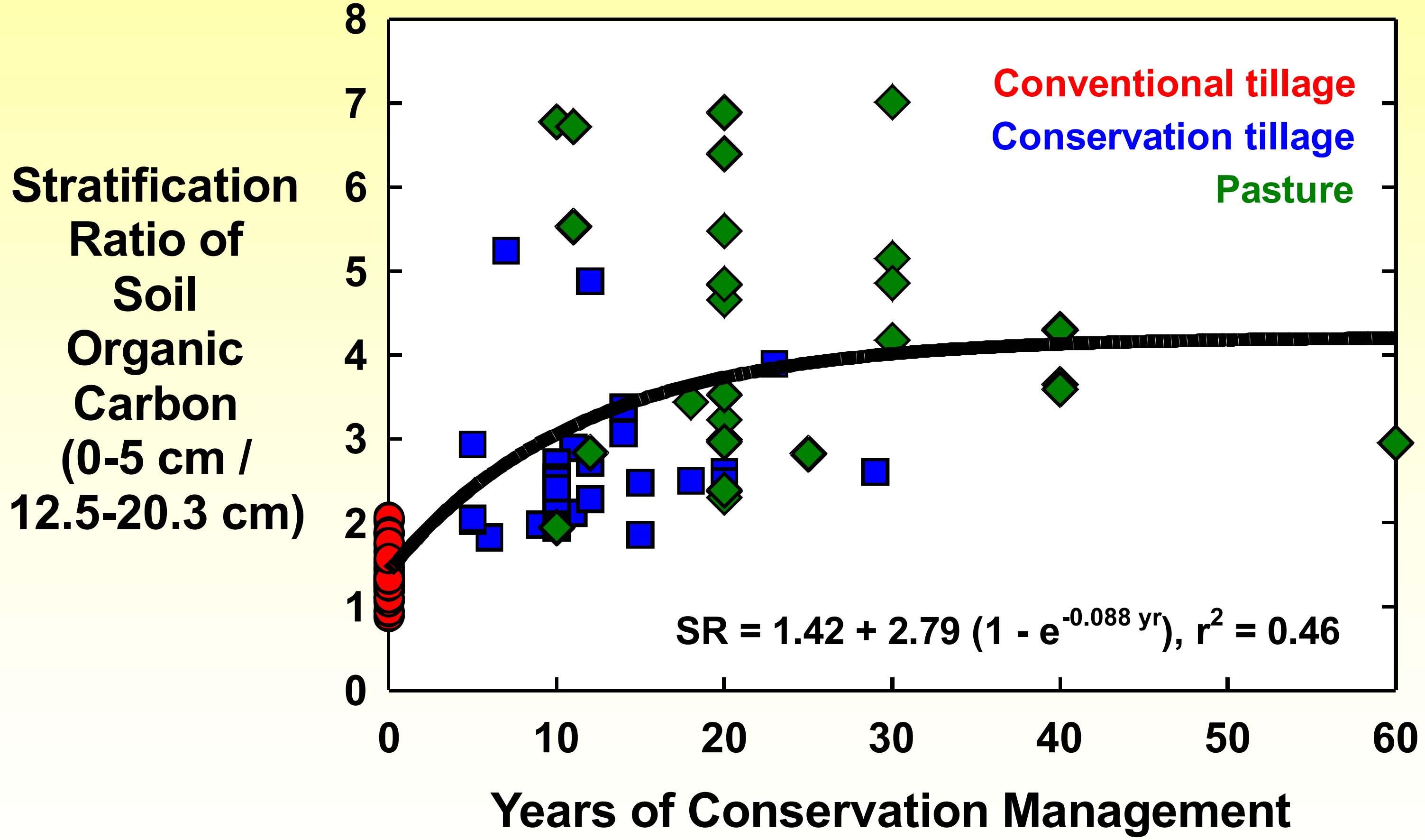
Stratification of soil organic matter



Data from Franzluebbers (2002) Soil Till. Res. 66:197-205

Water Quality

Stratification of soil organic matter



Data from Causarano et al. (2008) Soil Sci. Soc. Am. J. 72:221-230

Water Quality

Water runoff from rainfall simulations

Wisconsin	1.4 m^2 plots		Phosphorus Loss	
Tillage	Runoff	Soil Loss	Total	Bioavailable
	% applied	$Mg\ ha^{-1}$	$kg\ ha^{-1}\ event^{-1}$	
CT: Conventional	45	4.2	1.3	0.2
NT: No Tillage	22	0.3	0.2	<0.1

Surface organic C was 33 $Mg\ ha^{-1}$ under CT (Conventional Tillage) and 38 $Mg\ ha^{-1}$ under NT (No Tillage).

Surface soil P was 39 $mg\ kg^{-1}$ under CT and 62 $mg\ kg^{-1}$ under NT.

Despite higher soil P under NT than under CT, runoff P loss was lower due to greater water infiltration and less soil loss.

Data from Andraski et al. (1985) Soil Sci. Soc. Am. J. 49:1523-1527

Water Quality

Water runoff from rainfall simulations

Virginia, 112 m² plots			Runoff Nutrients	
Tillage	Runoff	Soil Loss	Nitrogen	Phosphorus
	% applied	Mg ha^{-1}	kg ha^{-1}	
CT: Conventional	53	3.6	10.3	4.1
NT: No Tillage	12	<0.1	0.5	0.3

Surface organic C was not reported, but expected to be greater under NT (No Tillage) than under CT (Conventional Tillage) due to long-term management.

If so, then distribution of organic C was important in preventing soil erosion and water quality deterioration.

Data from Ross et al. (2001) Final Report from Virginia Tech, Blacksburg VA

Water Quality

Water runoff from water catchments

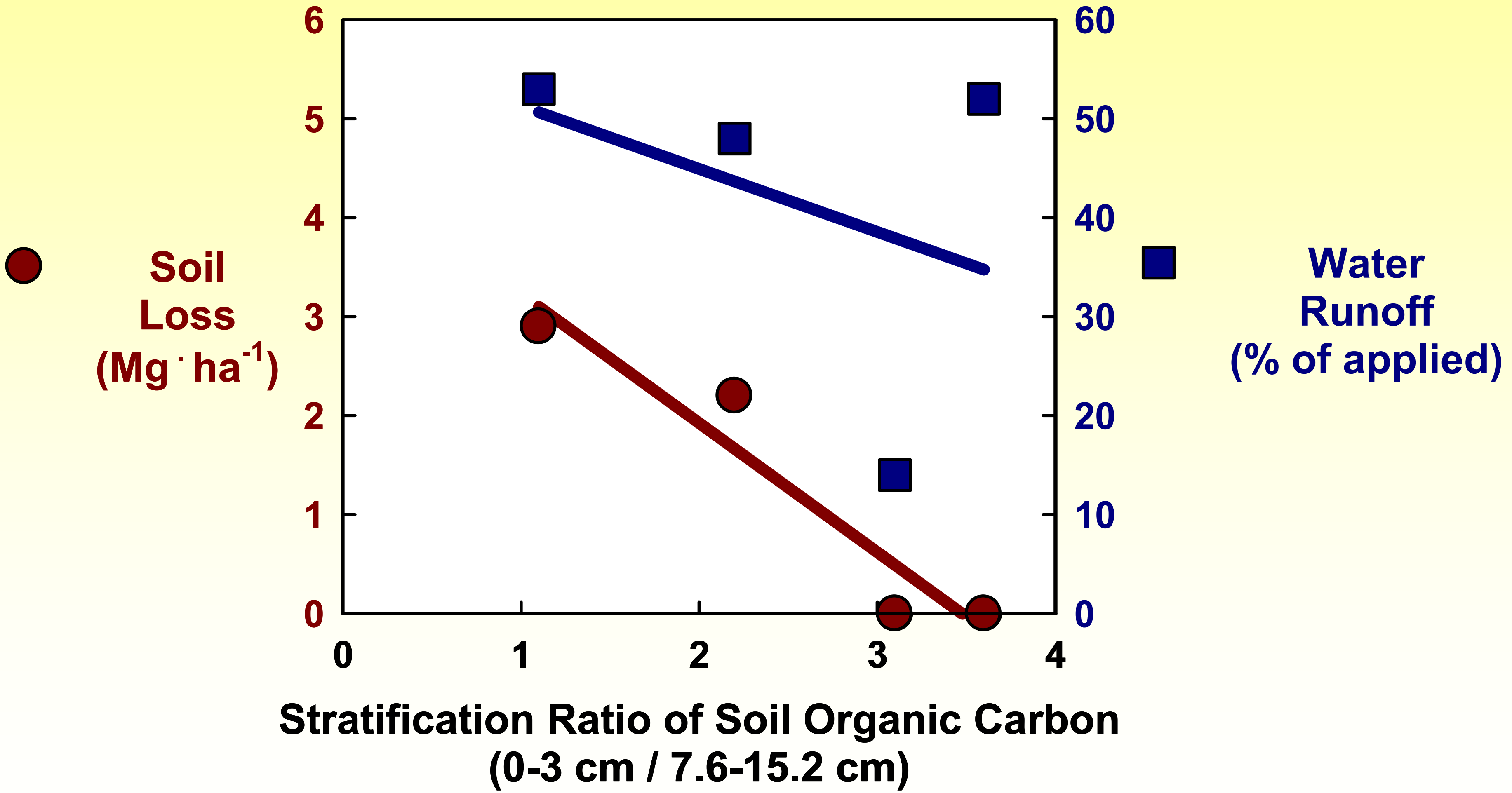
Oklahoma, 1.6-ha catchments, 5 years			Phosphorus Loss		
Tillage	Runoff	Soil Loss	Total	Particulate	Soluble
	% rainfall	Mg ha^{-1}	---------- kg ha^{-1} yr^{-1} ----------		
CT: Conventional	19	7.2	4.2	3.8	0.4
NT: No Tillage	24	0.4	1.7	0.5	1.2
Native	18	<0.1	0.3	0.1	0.2

Similar to other studies, distribution of organic C likely contributed to prevention of environmental degradation, but possibility for greater soluble P loss is of concern.

Data from Sharpley et al. (1992) J. Environ. Qual. 21:30-35

Water Quality

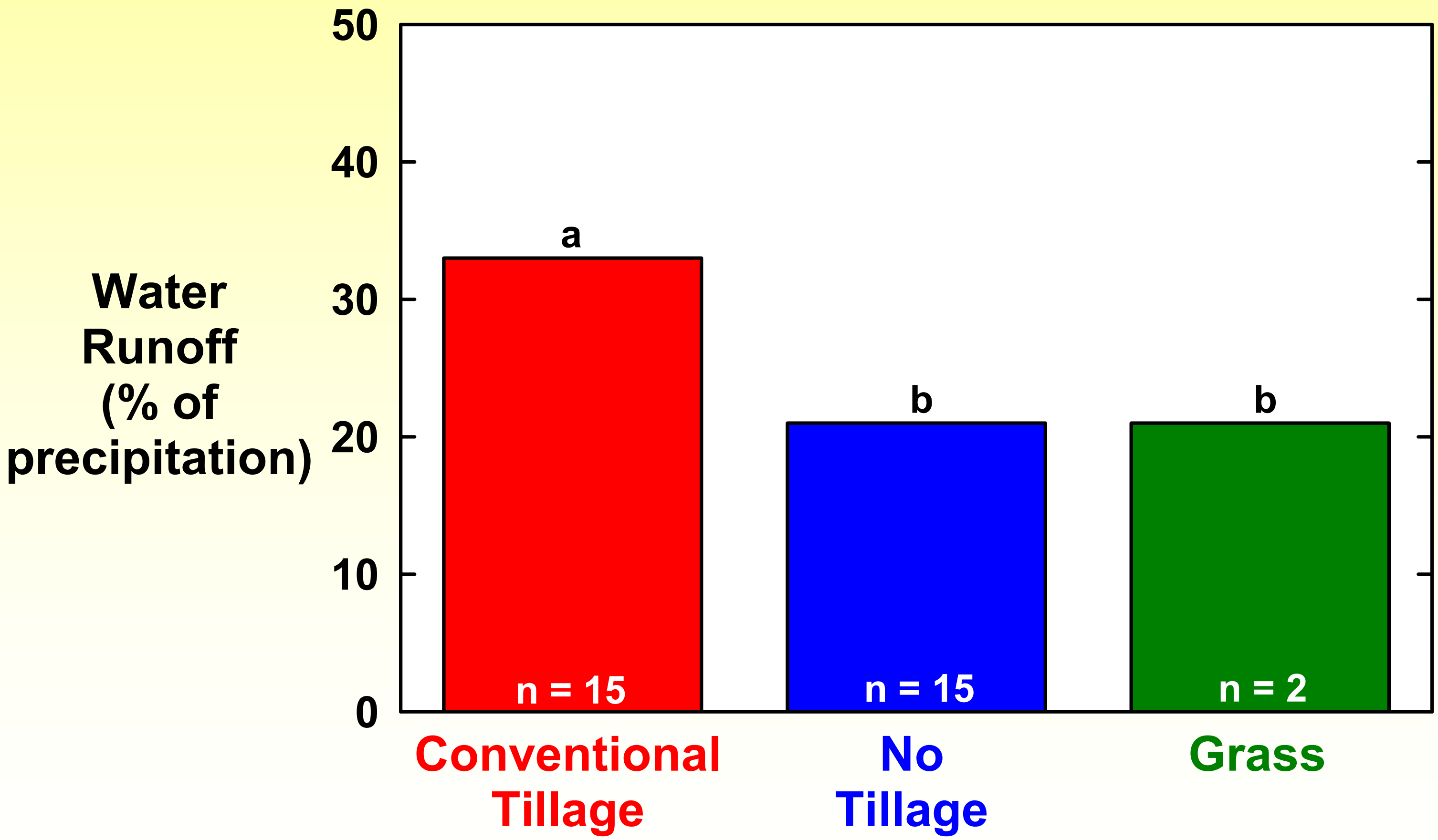
Linking soil and water quality



Data from Rhoton et al. (2002) Soil Till. Res. 66:1-11

Water Quality

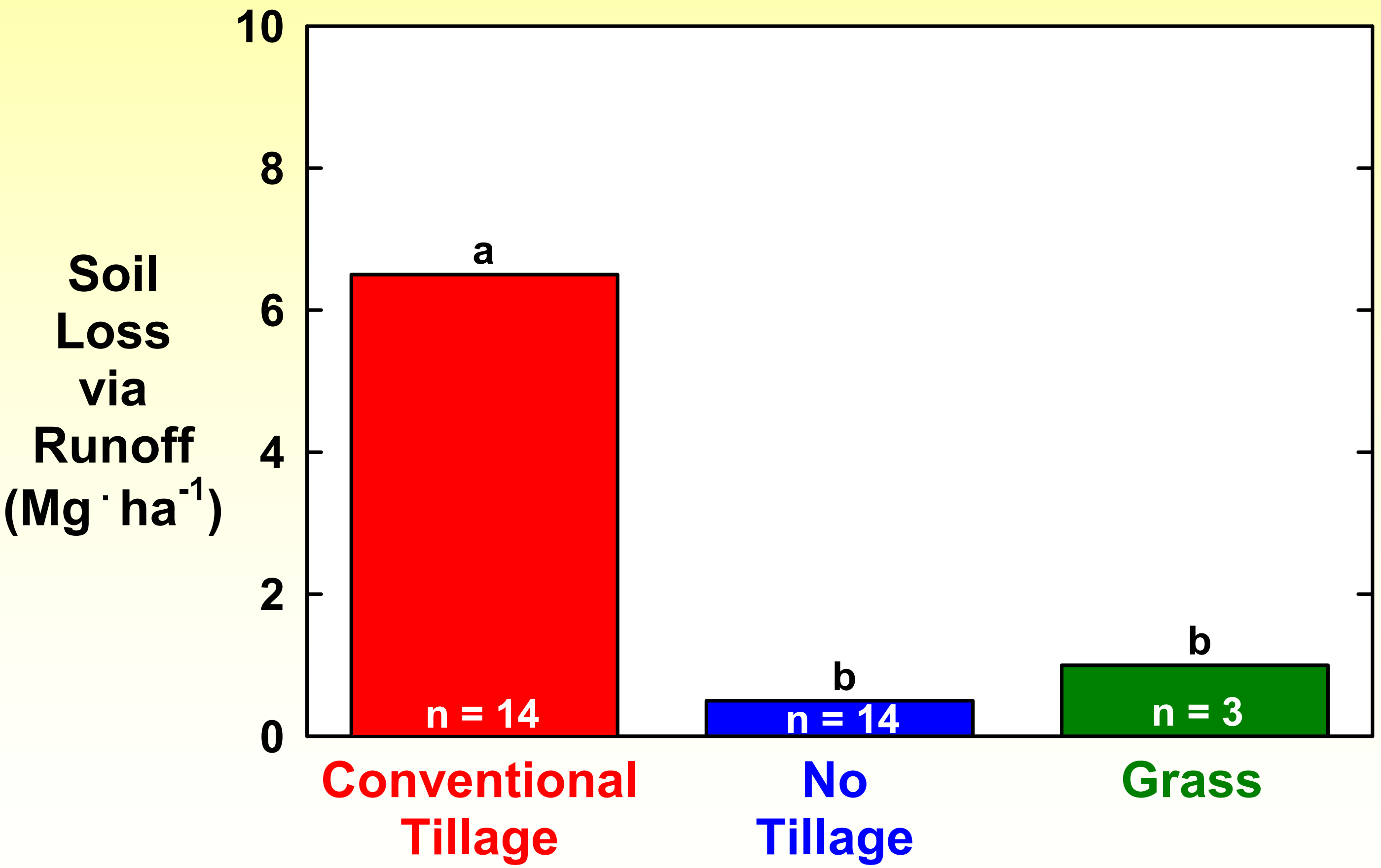
Land use effect on water runoff



Data from multiple literature sources

Water Quality

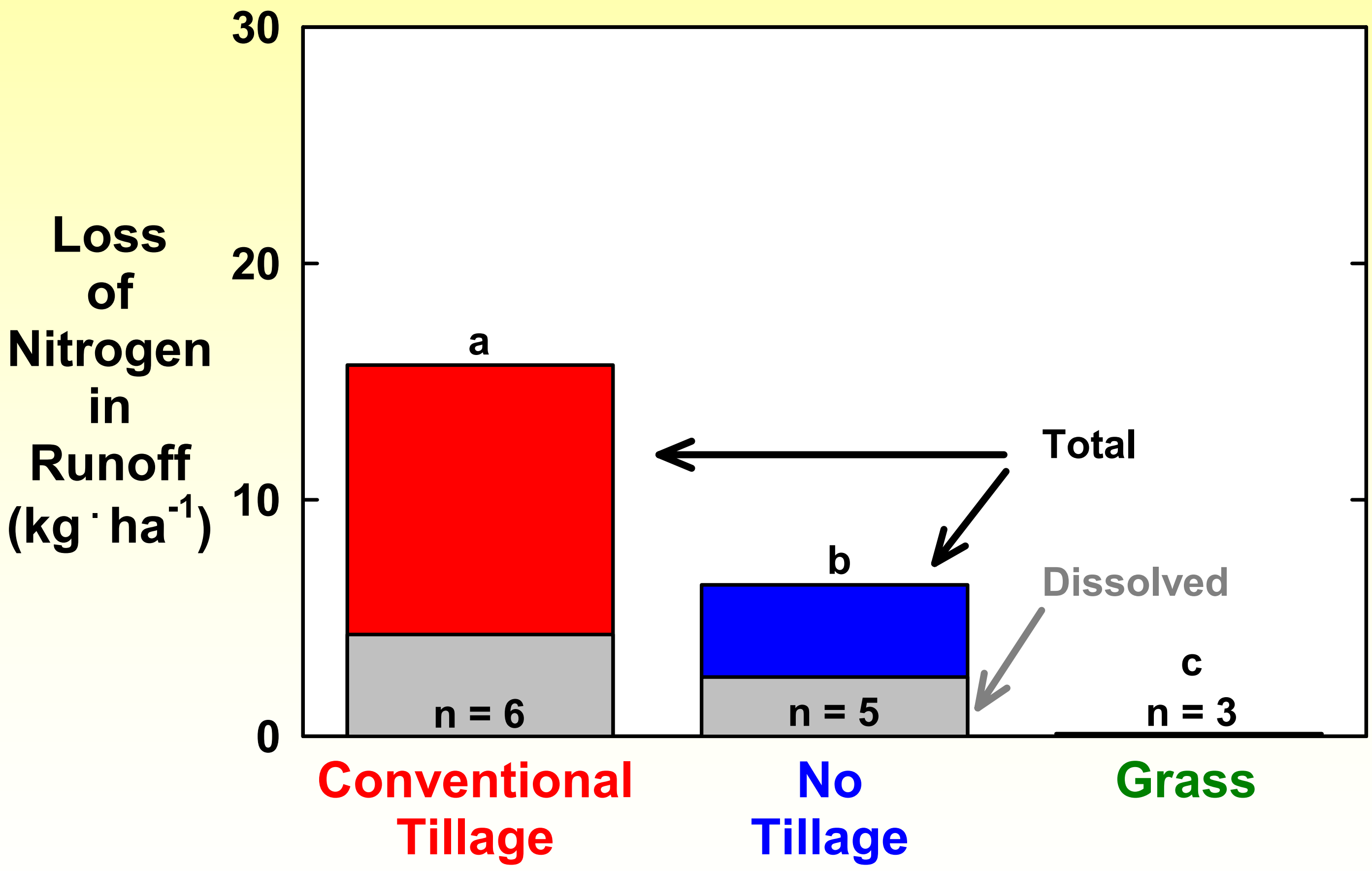
Land use effect on soil loss



Data from multiple literature sources

Water Quality

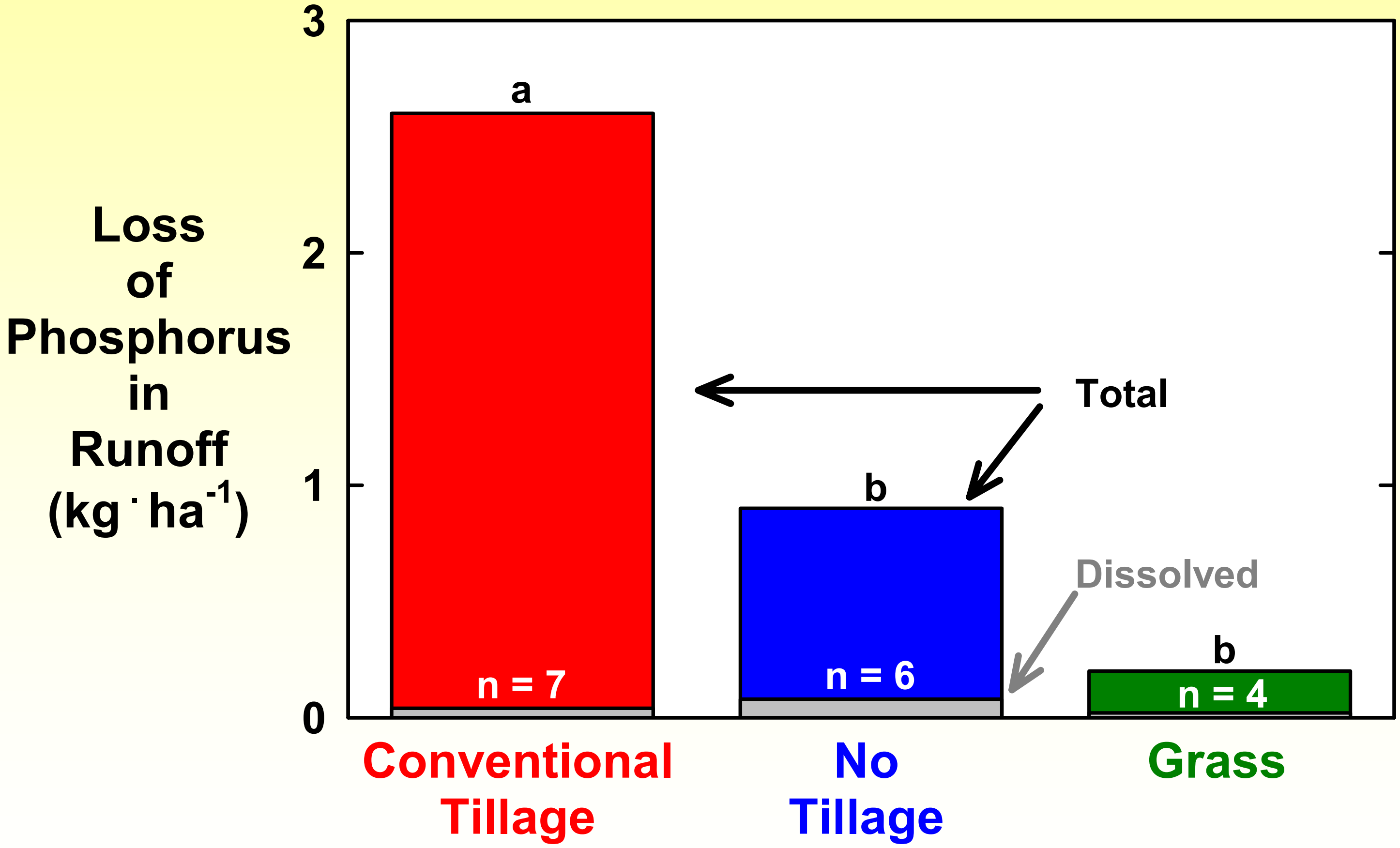
Land use effect on nitrogen loss in runoff



Data from multiple literature sources

Water Quality

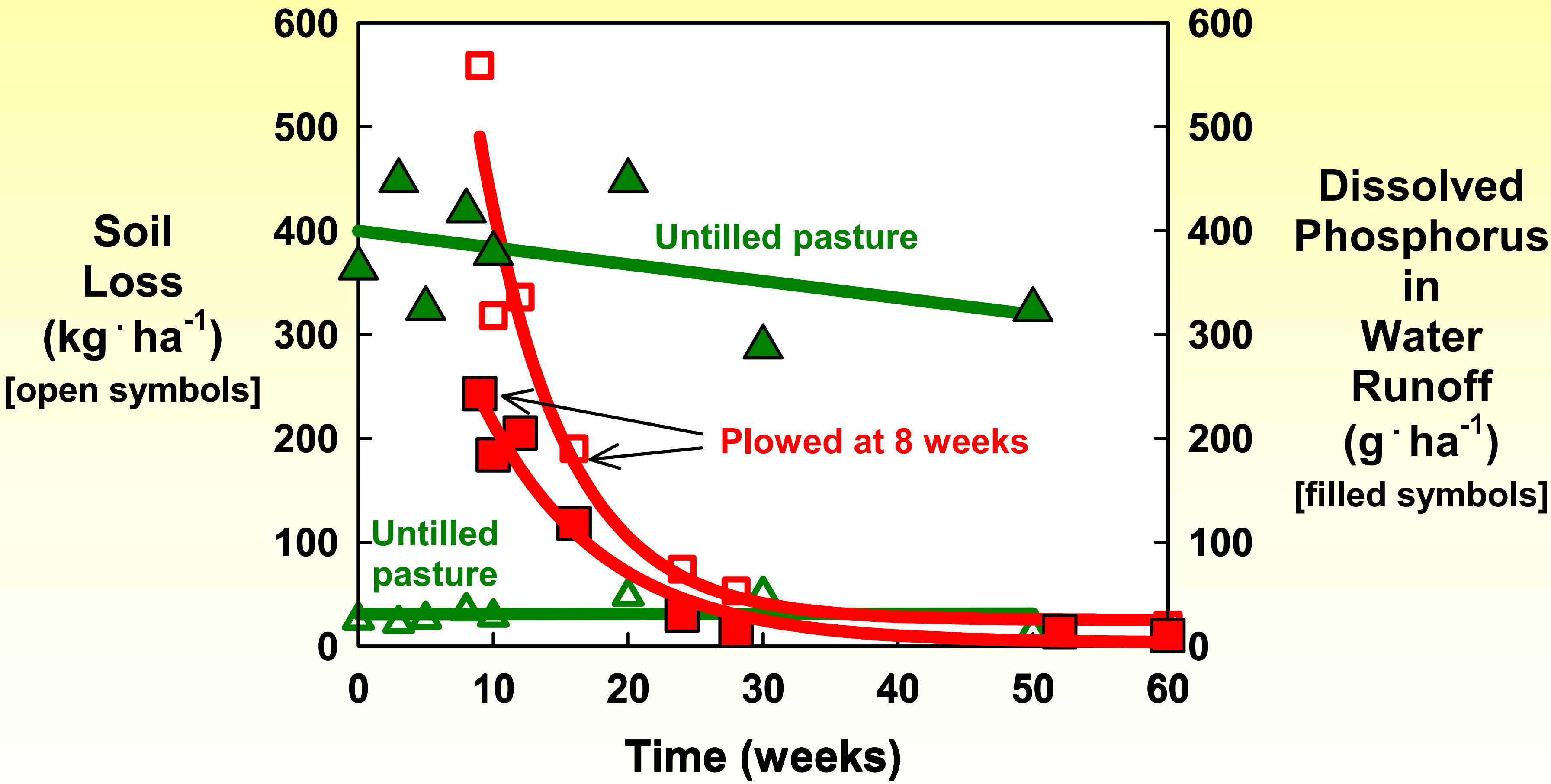
Land use effect on phosphorus loss in runoff



Data from multiple literature sources

Water Quality

Surface accumulation of nutrients



Data from Sharpley (2003) J. Environ. Qual. 32:1375-1384

Water Quality

Summary

- **Soil erosion and nutrient losses** from water runoff can be reduced with conservation tillage and pasture management
- **Surface residues** are important for channeling water vertically into soil rather than horizontally across soil
  - Improved soil aggregation
  - Permanent biopores
  - Enriched surface soil
- **Linkages between soil and water quality** can be improved with greater research effort focused on soil-profile distribution of organic C and N fractions
  - Technology transfer activities must also recognize this important linkage