

# Manure Use and Soil Physical Properties

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# Soil property interactions

- Soil components are >99.5% inanimate (d.wt.)
  - habitat for much plant and microbial life.
- The science and management of interactions of soil properties (physical x chemical x biological) x crops x climate = **agronomy**

# Soil physical properties

## Properties that affect response to manure

- Landscape position
- Texture
- Aggregation
- Susceptibility to erosion

## Physical properties affected by manure

- Aggregation, etc.
- Susceptibility to erosion

# Soil in the landscape

- Understanding soil associations in landscapes is important to good soil management
- Effects of erosion & sedimentation important to manure effects

*Soil Survey of*

*Yankton County, South Dakota*

United States Department of Agriculture  
Soil Conservation Service

in cooperation with  
South Dakota Agricultural Experiment Station



# Soil texture

- Sand, silt and clay content gives a soil texture class, e.g. silt loam, clay.
- Fundamental to other properties and interactions
- Manure effect on soil physical properties tend to be greater for high sand or high clay soil

# Soil aggregation

- Formed from soil particles; prevents soil from being a massive, inert block
- Size and strength affected by other soil properties, e.g. soil organic matter, and management, including manure application





# Susceptibility to erosion

- Wind erosion (sheet erosion; movement of fine particles)
- Water erosion
  - Sheet erosion, includes splash effect: most erosive; much downslope deposition
    - Often not noticed
  - Rill and gully: occurs with concentrated flow
- Aggregate size and stability:
  - small aggregates easily carried;
  - weak aggregates break down for easy transport and sealing of soil for reduced water infiltration



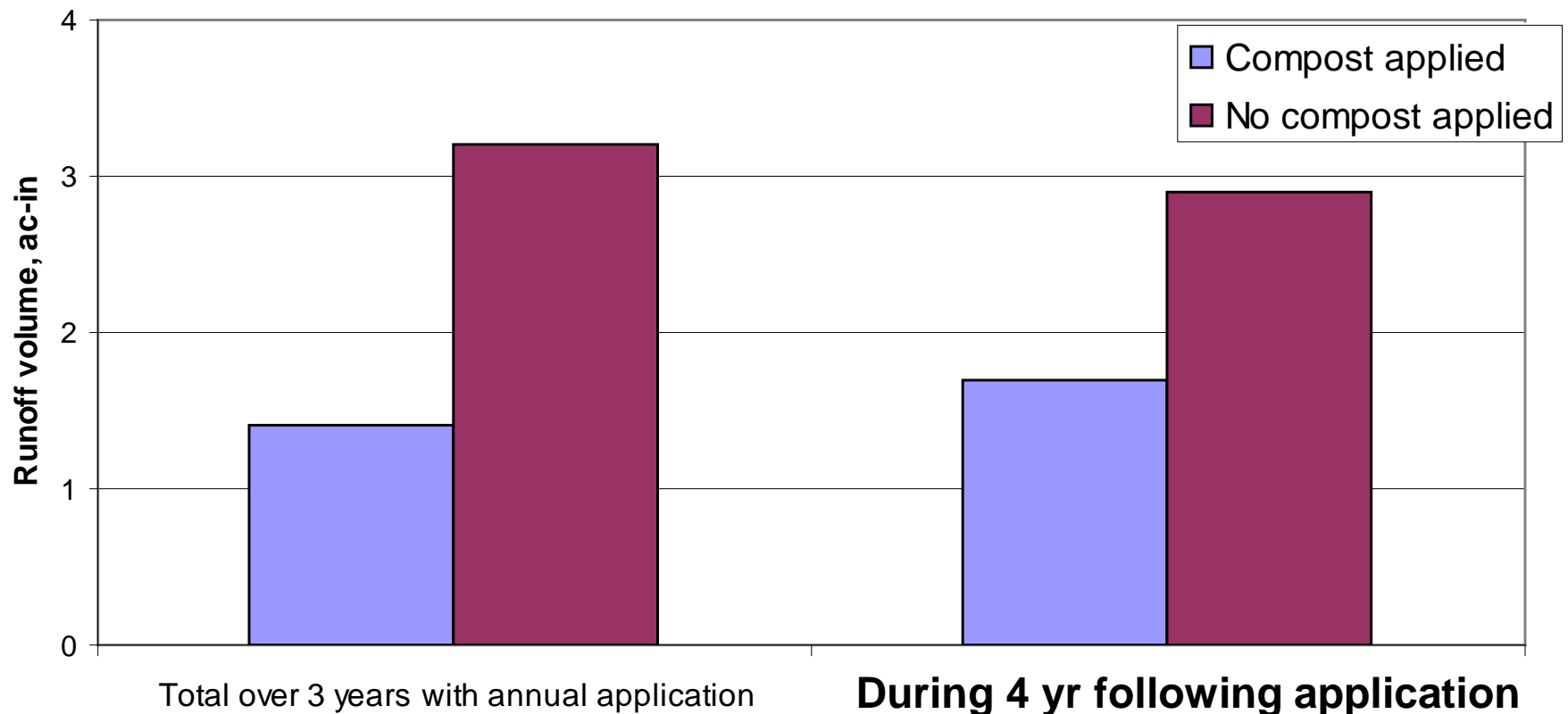


**Manure P Runoff Study, UNL ARDC:  
7 treatments, 3 replications, silt loam  
soil, 5.5% slope, 1999-2008**

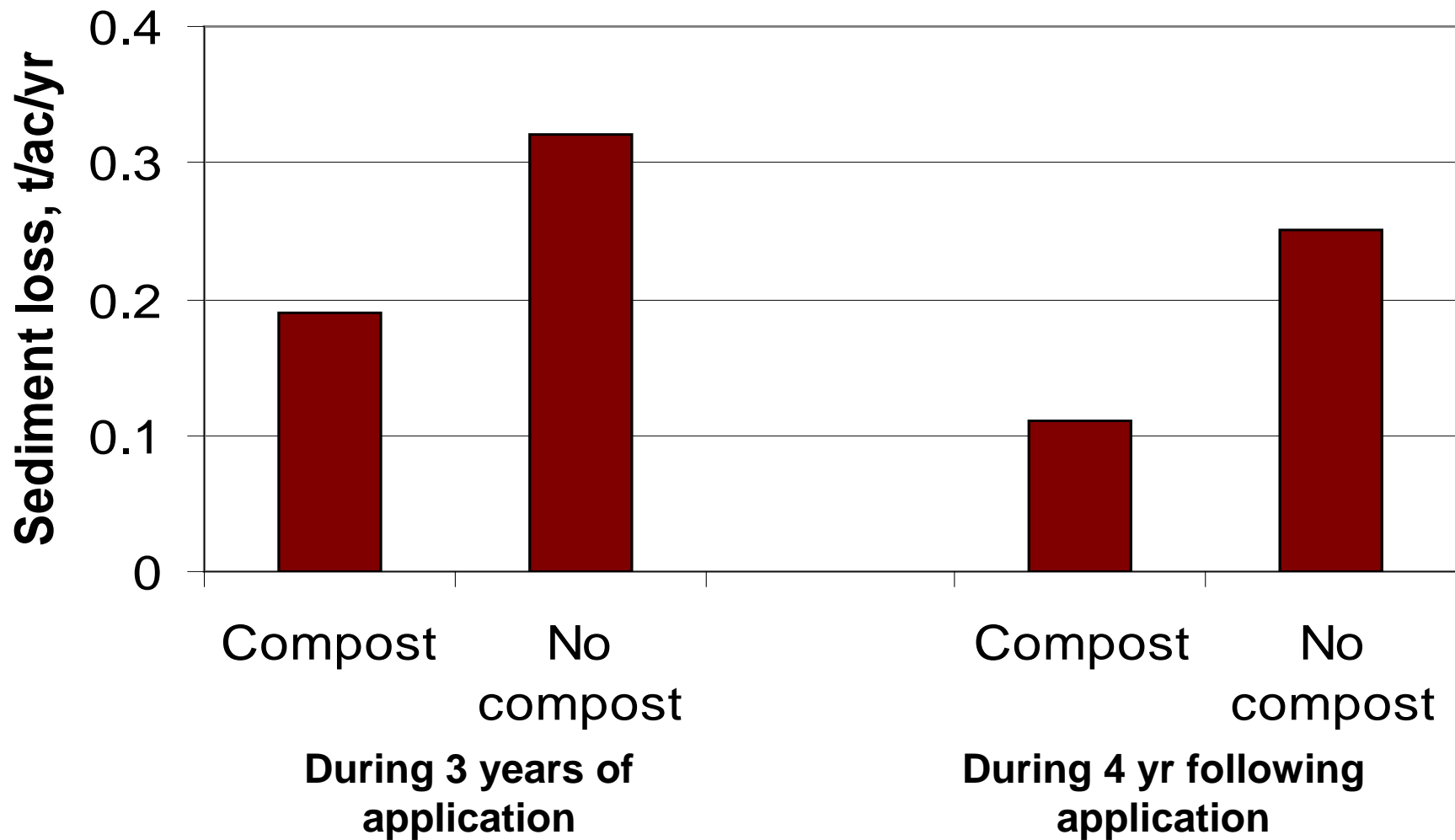


# Manure decreases runoff; increased water infiltration

Effect of composted manure on runoff during years of application  
and for 3 years following application.

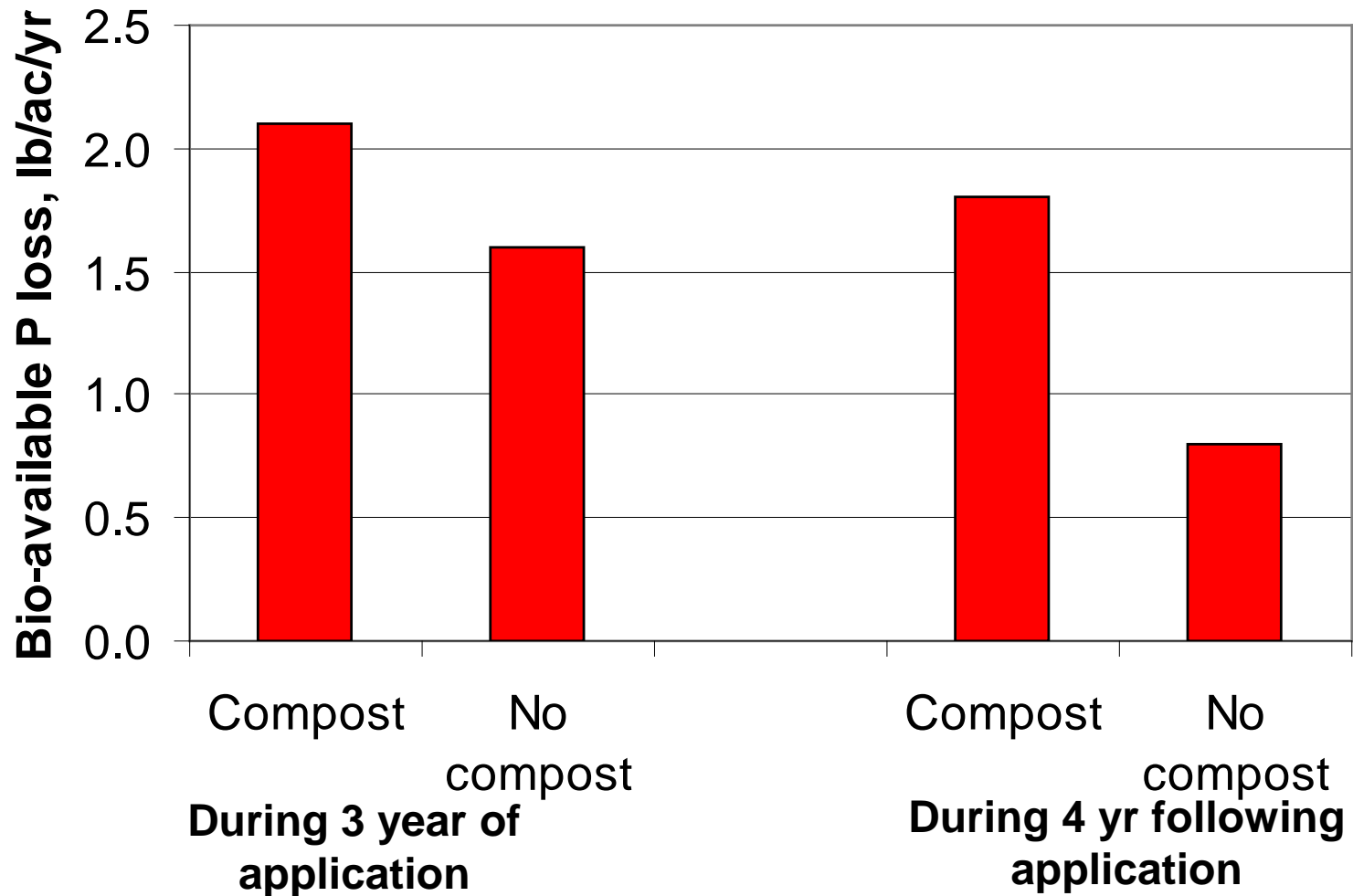


# Compost effect on erosion



# Compost effect on runoff P loss

Bray-1 in surface 1" for >500 ppm with compost vs. 20 ppm with no compost applied



# Years 5 & 6 after last application

- About 2.8 times as much sediment loss with no compost compared with compost previously applied.

# Time of application and incorporation

- No effects on runoff and losses of sediment and P for:
  - Winter vs spring without incorporation
  - Spring: with vs without incorporation
    - supported by ISU results

# Manure application & water quality

- Tends to reduce sediment and runoff but to increase runoff P concentration
- P loss may be increased or decreased
  - Does reduction in runoff and sediment loss fully compensate for increased runoff P concentration?
  - In this study, the greatly decreased erosion and runoff did not compensate for increased P concentration in runoff
    - P loss was greater with compost applied.

Microsoft Excel - NebraskaP-Index2011v3-example.xls

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## Nebraska Phosphorus Index

Please enter the required information in the white and blue boxes. The blue boxes have drop down lists. The yellow text boxes are locked and used for calculations only.

Help Clear Form

### 1. General Information

Run # :	6
Field name :	west 1/4
Option name :	change 5
Prepared By :	Leslie
Prepared For :	EC 195
County :	Colfax
County Number (FIPS Code) :	NE037
Landform Region :	11 - Till Plains
Soil Type :	Nora variant silty clay loam, 6 to 11 percent slopes, eroded
Soil Map Unit Symbol :	6836
Soil Phosphorus Test Result (ppm) :	95
Sample Depth :	0-2 inches
Phosphorus Test Type :	Bray-1 P, Mehlich-3



Find Landform Region

### 2. Irrigation Component

Type of Irrigation : None

### 3. Solid Manure Component

Manure Application Rate (Tons / Acre) : 10.00

0.80

### 4. Runoff Component

Factor

Precipitation Factor :	6.44
Runoff Curve Number :	85
RCN Fraction :	0.21
Factor :	1.09

~2% reduction in runoff and erosion per t/ac/yr of dry weight manure application.

Manure application is credited with reduced erosion in some tools such as RUSLE2 and the Nebraska P Index

Help and Instructions Nebraska P-Index Report Ephemeral Landform Regions Moisture Region

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# Manure application reduced runoff and erosion. What about soil aggregation?

## Water stable aggregates (WSA)

- A stack of  $\geq 4$  sieves are rotated up and down in water about 50 times
- Most studies sample to 1" depth

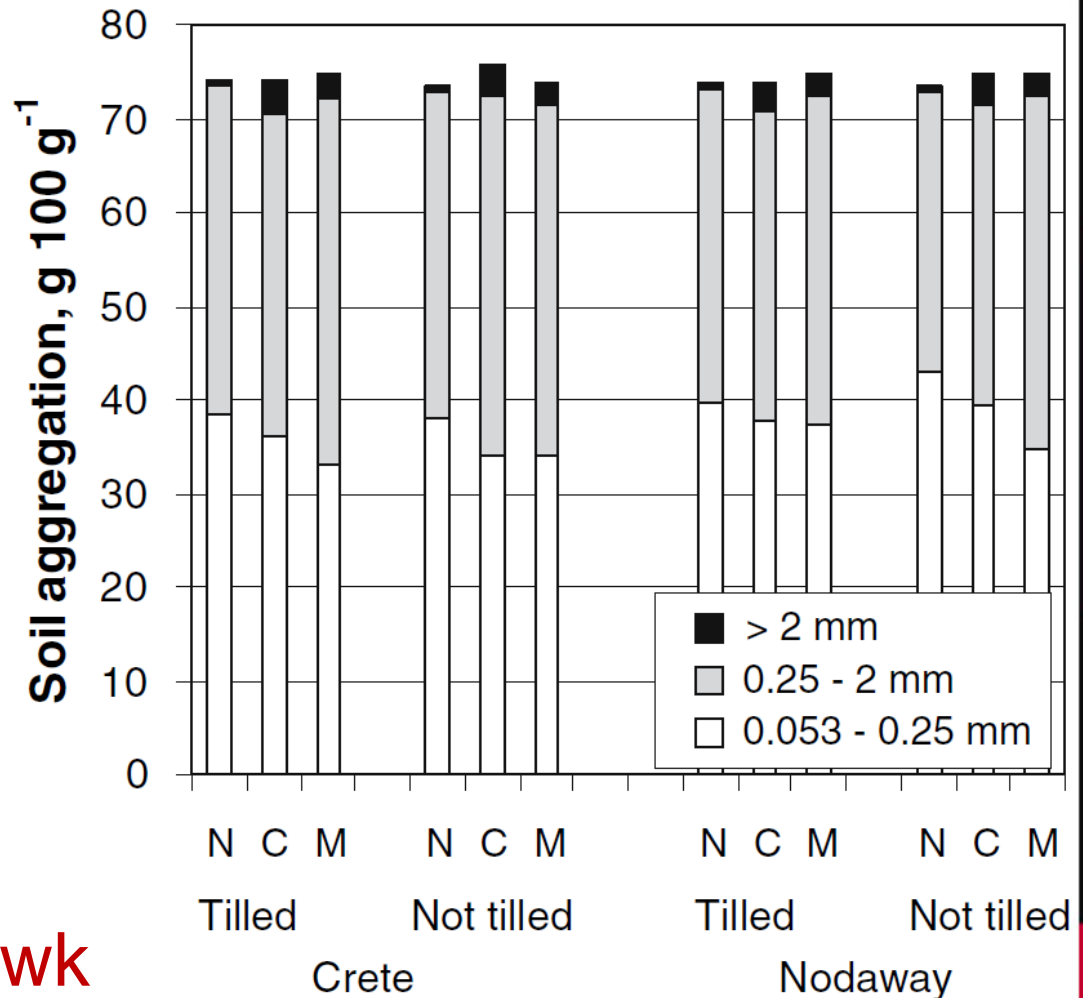


# Dry aggregate size: wind erodible fraction (WEF)

- Less than 0.84 mm (<0.033”) diameter is considered WEF
  - Larger aggregates are less easily moved
- Sieved dry through a stack of sieves to determine % in WEF

# Study 1: water stable aggregation (WSA)

- Feedlot manure:
  - Composted (C)
  - Stockpiled (M)
  - None (N)
- With and w/o tillage incorporation
- Upland Crete SiCL & Nodaway alluvial SiL
- Means of periodic sampling from 2 wk until 150 d after application



**WSA affected after 2 wk**

**Macro-WSA (>0.25 mm): 33% for no compost vs 39% for stockpiled manure.**

# Soil aggregation: synthesis from 4 studies

- Increased macro-aggregates within two weeks of application and effects persist for several years
- Stockpiled & composted feedlot manure, swine slurry, poultry manure, and municipal bio-solids were equally effective, depending on rate of application
- Incorporation versus surface application were equally effective
- Some well-aggregated soils were not improved for aggregated with organic material application
- Variations in C:N ratio and contents of lignin & cellulose were not important to aggregation

# Summary

- Manure effects on soil physical properties depends on initial soil properties
- Manure application
  - tends to reduce erosion and improve water infiltration but increase runoff P concentration
  - may increase or decrease runoff P loss
  - Increase of soil in macro WSA (>0.25 mm; >0.01”) within 2 weeks and persisting for several years
  - Diverse organic materials can be effective

Thank you