



# Wind Erosion Solutions: Surface Roughness, Soil Moisture, and Emergency Measures

FARM PRODUCTION AND CONSERVATION  
FSA | NRCS | RMA | Business Center

NRCS Agronomist Susan Tallman, CPAg

# SOLUTIONS



Increase high carbon residue



Increase vegetation



Decrease unsheltered distance

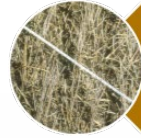


Increase surface roughness



Increase soil moisture

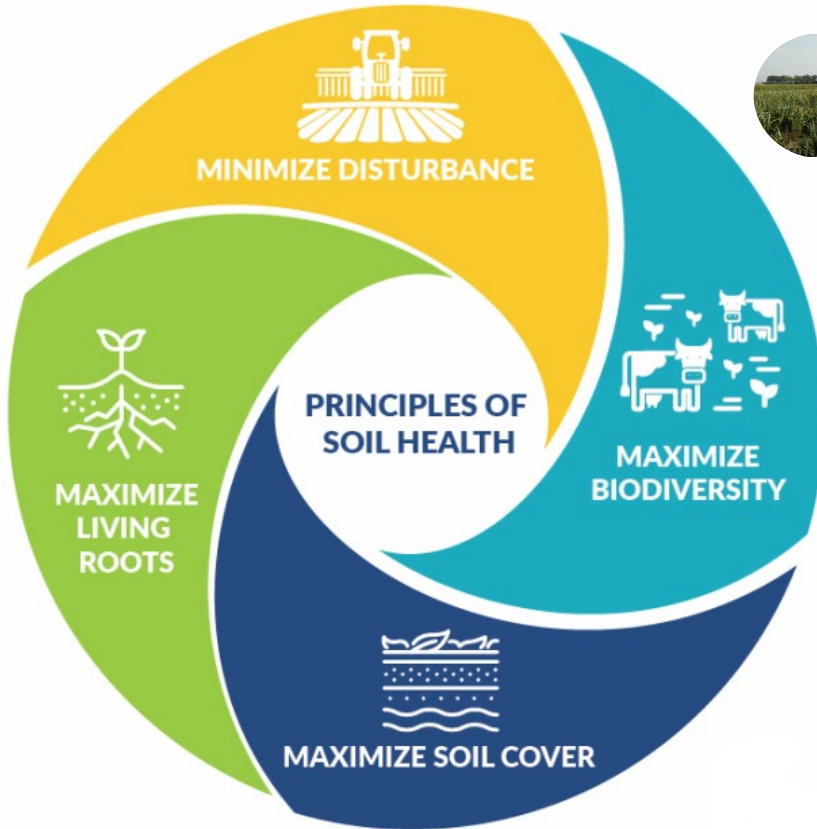
# Soil Health



Increase high carbon residue



Increase vegetation



The cardinal rule of wind erosion control is to strive to keep the land covered with **vegetation** or **crop residue** at all times.

NRCS National Agronomy Manual, 2011



Decrease unsheltered distance



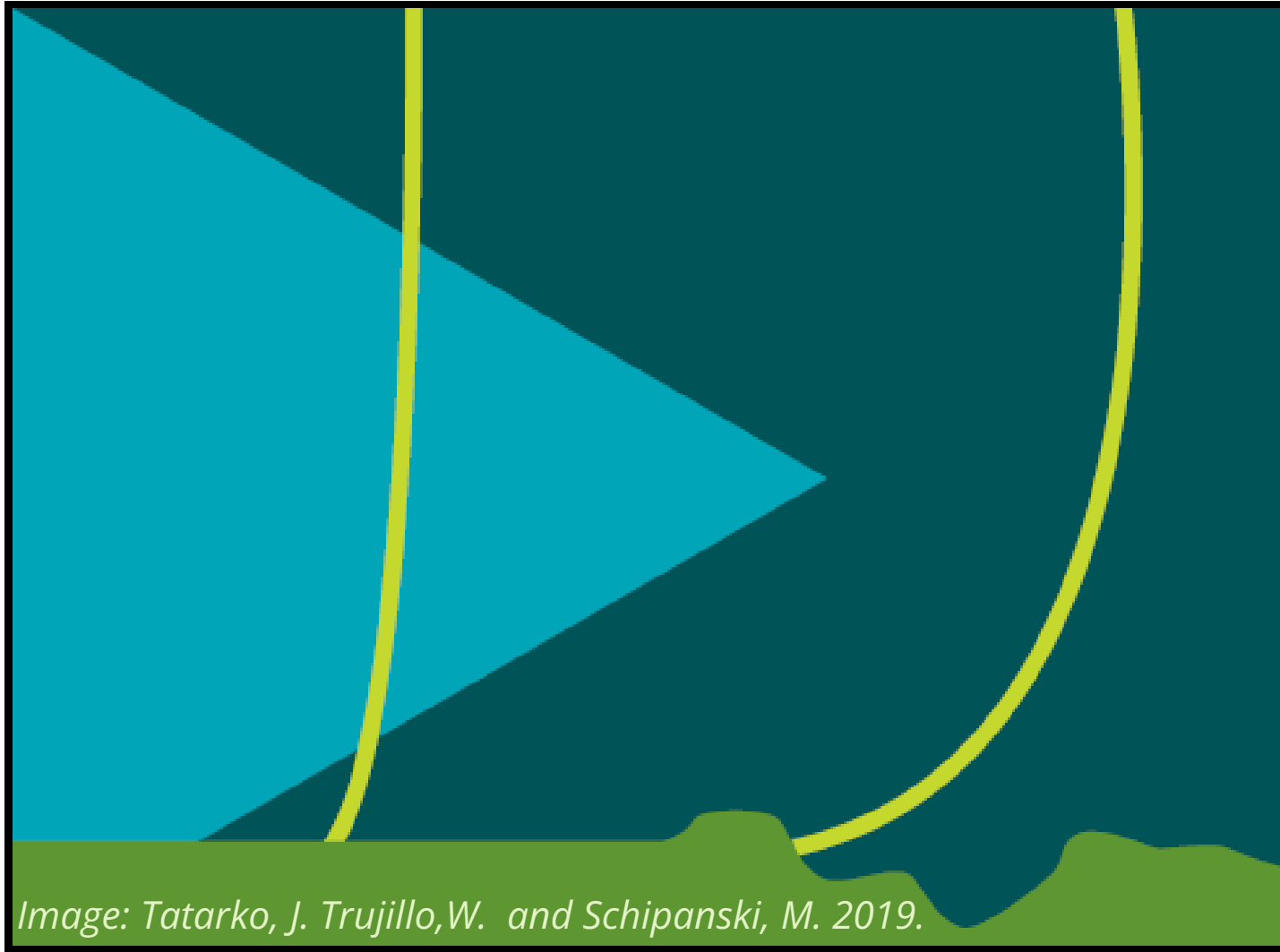
Increase surface roughness



Increase soil moisture



# Mechanism of surface roughness



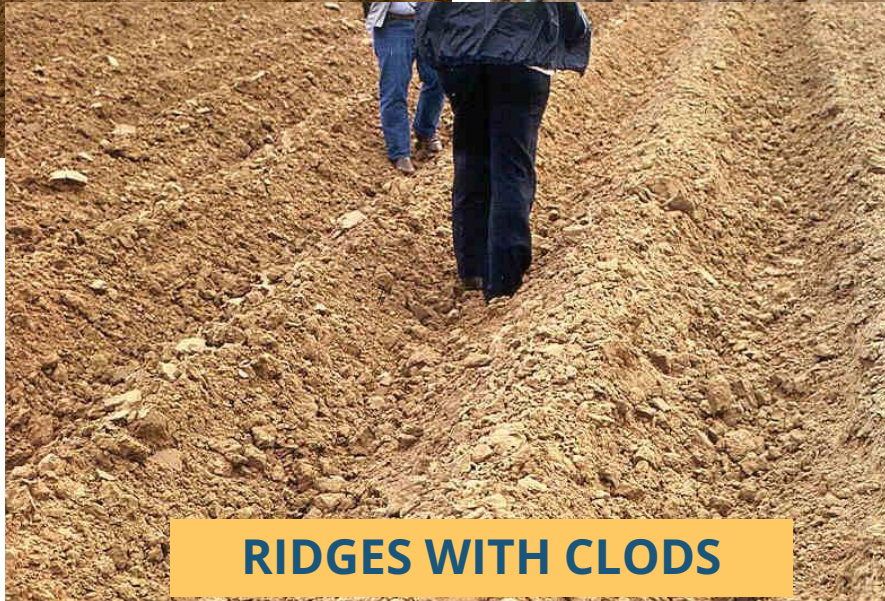
# Oriented and Random Roughness



**ORIENTED  
RIDGES**

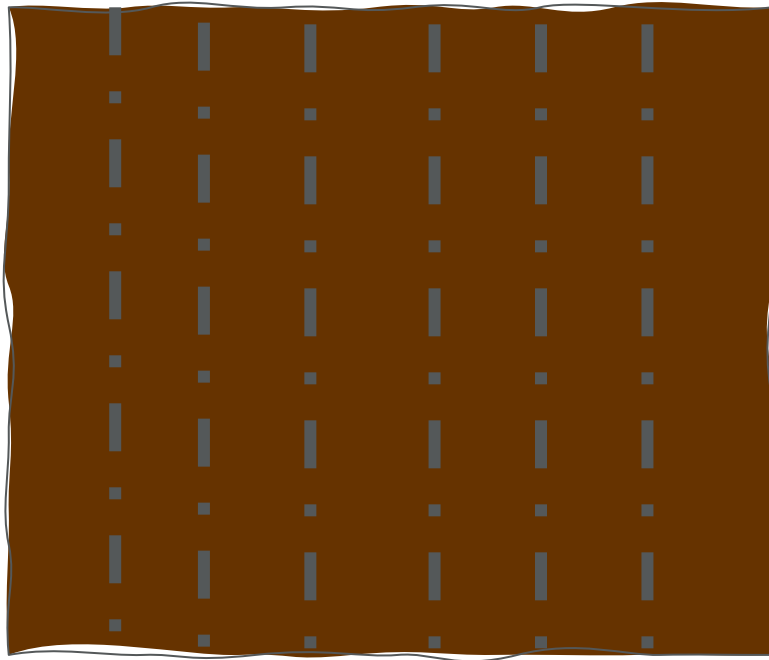


**RANDOM  
CLODS**

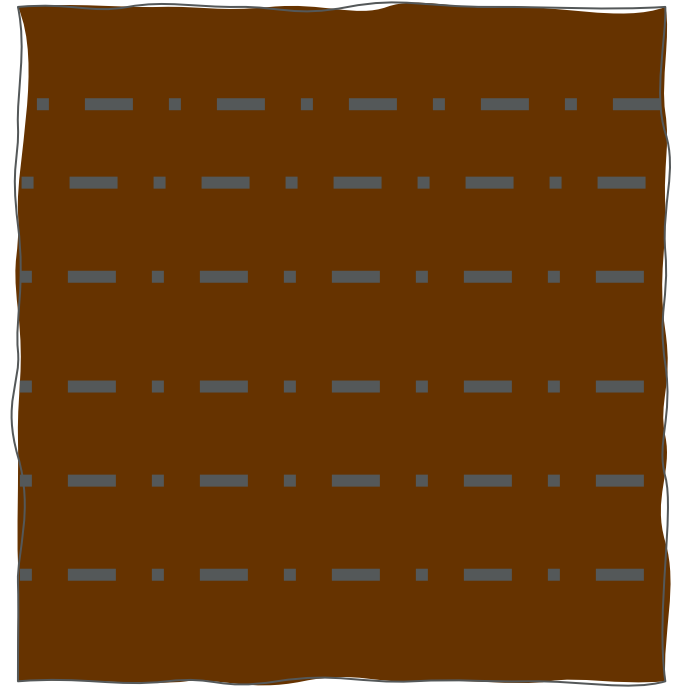


**RIDGES WITH CLODS**

# Ridge orientation – Cross Wind Ridges (CPS 588)



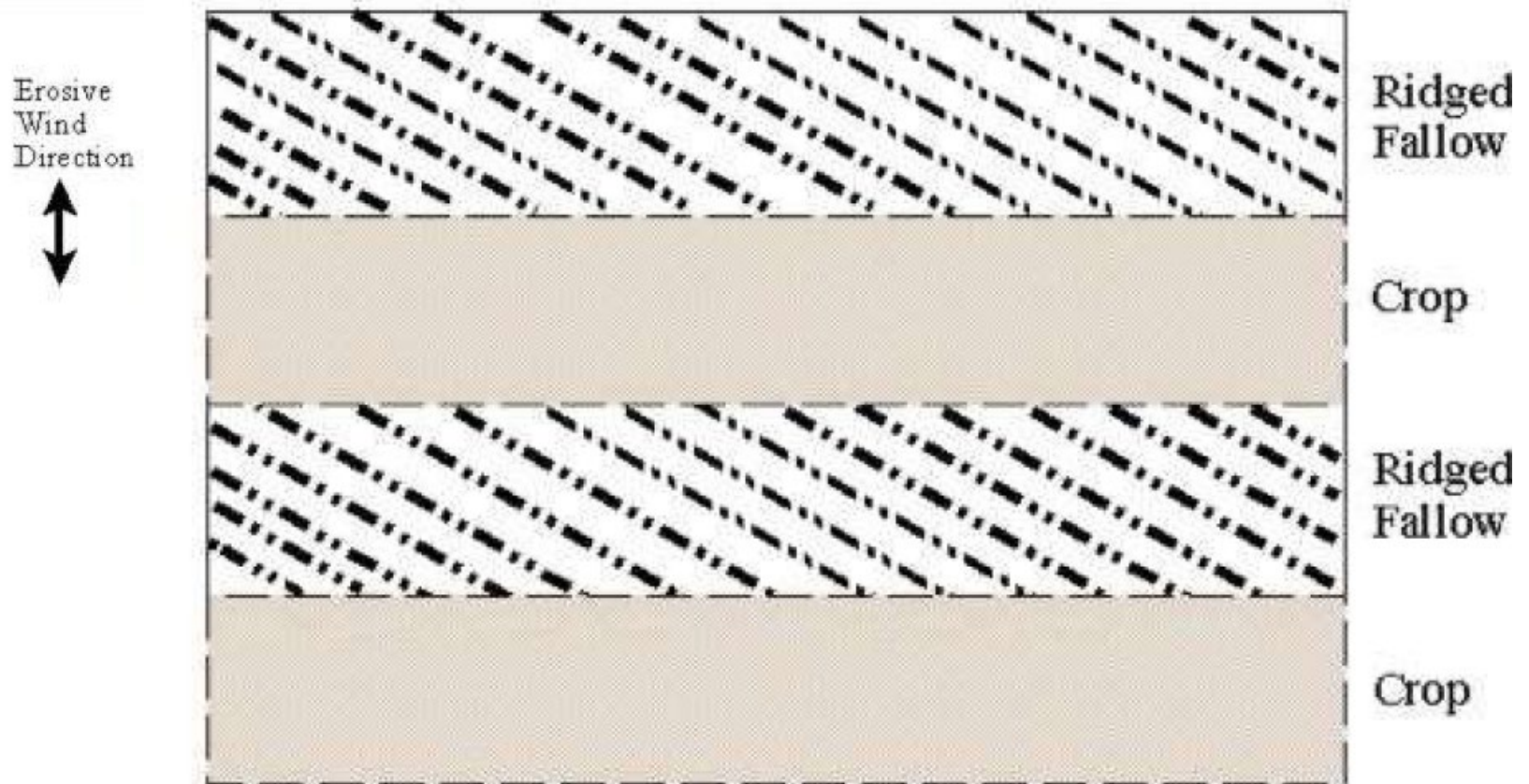
**LESS  
EROSIVE**



**MORE  
EROSIVE**



# Angled ridges with stripcropping



*Image: USDA-ARS. 2016. WEPS 1.5 User Manual*

# Clod Size and Effectiveness



**Rough Surface =  
Less Erosive**



**Smooth Surface =  
More Erosive**

# Smooth surfaces

## Alfalfa Rolling or Land Leveling

- Operations outside the critical erosion period
- Minimize field size
- Windbreaks and barriers
- Sprinkler irrigation



## Ridged Systems

- Immediate installation of ridges
- Minimize time field is a smooth surface



# The Importance of No-till Cover

Without adequate residue or vegetation, a smooth no-till surface can be highly prone to wind erosion.



*Image: Ryan Cassillas, near Great Falls, MT, Jan 2021*

# Roughness Breakdown and Soil Texture



**TIME** 

*Image: Tatarko, J. Trujillo, W. and Schipanski, M. 2019.*

# Soil Aggregation



**Good Aggregation =  
Less Erosive**



**Poor Aggregation =  
More Erosive**

- Disturbance physically degrades soil aggregates
- Disturbance accelerates residue decomposition

*[Soil Health Demonstration: Infiltration video](#)*

# Soil Crusts



**Crusted Surface =  
Less Erosive**



**Non-crusted Surface =  
More Erosive**

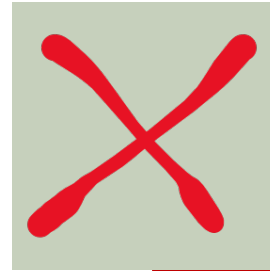


## Increase surface roughness



Pro

- Field-scale option for high tillage/low residue crop systems.



Con

- Less effective on sandy soils.
- Not a stand-alone strategy as roughness degrades over time.

# SOLUTIONS



Increase high carbon residue



Increase vegetation



Decrease unsheltered distance



Increase surface roughness

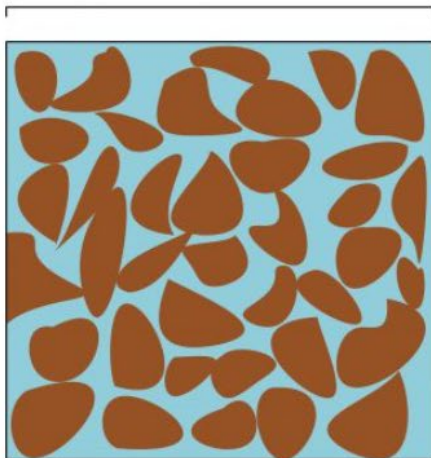


Increase soil moisture

# Mechanisms of Soil Moisture

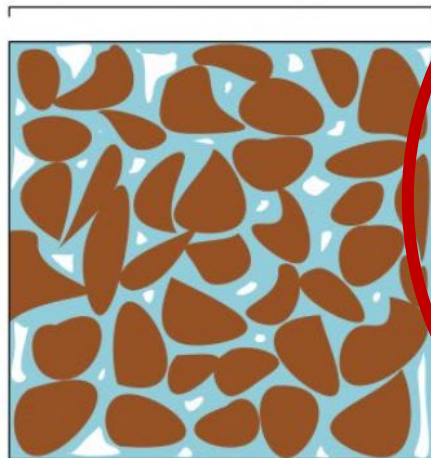
## Saturation

All pores are filled with water



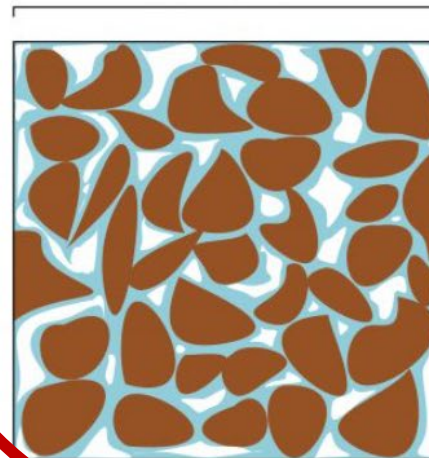
## Field Capacity

Water in larger pores has drained



## Permanent Wilting Point

Plants can no longer extract water

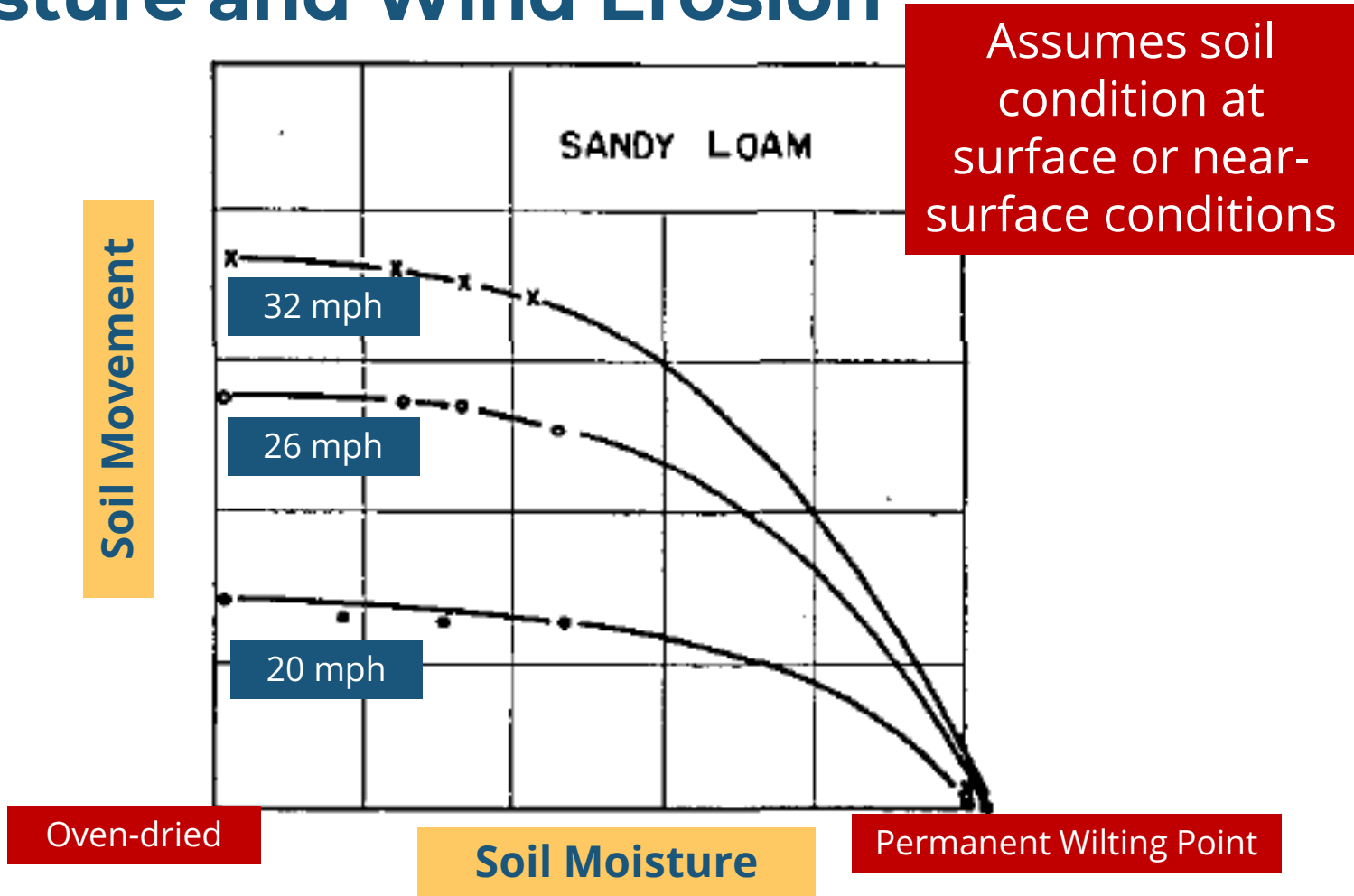


## Volumetric Water Content

Saturation	Field Capacity	Permanent Wilting Point
30 – 60%	20 – 40%	7 – 24%

Image: Datta, S., S. Taghvaeian, J. Stivers. 2017. Understanding soil water content and thresholds for irrigation management. Oklahoma State Extension. BAE-1537.

# Soil Moisture and Wind Erosion



Chepil, W.S. 1956. Influence of moisture on erodibility of soil by wind. Soil Science Society of America Journal, 20 (2): 288-292

# Permanent Wilting Point

## Appearance of fine sand and loamy fine sand soils at various soil moisture conditions.

### Available Water Capacity 0.6-1.2 inches/foot

**Percent Available:** Currently available soil moisture as a percent of available water capacity.

**In/ft. Depleted:** Inches of water currently needed to refill a foot of soil to field capacity.

0-25 percent available  
1.2-0.5 in./ft. depleted

Dry, loose, will hold together if not disturbed, loose sand grains on fingers with applied pressure. (Not pictured)



50-75 percent available  
0.6-0.2 in./ft. depleted

Moist, forms a weak ball with loose and aggregated sand grains on fingers, darkened color, moderate water staining on fingers, will not ribbon.



25-50 percent available  
0.9-0.3 in./ft. depleted

Slightly moist, forms a very weak ball with well-defined finger mark



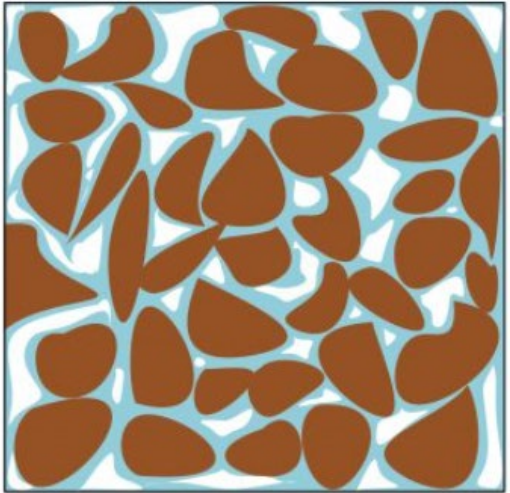
75-100 percent available  
0.3-0.0 in./ft. depleted

Wet, forms a weak ball, loose and aggregated sand grains remain on fingers, darkened color, heavy water staining on fingers, will not ribbon

100 percent available  
0.0 in./ft. depleted (field capacity)

Wet, forms a weak ball, moderate to heavy soil/water coating on fingers, wet outline of soft ball remains on hand. (Not pictured)

## Permanent Wilting Point Plants can no longer extract water



*“When pressed in the palm of the hand, the soil particles formed a fragile ball that crumbled readily as it was pressed between the fingers.”*

- Chepil, 1956

USDA-NRCS. 1998. *Estimating soil moisture by feel and appearance.*

# Soil Surface Conditions



# PWP = Water Content, 15 Bar

The screenshot displays the USDA websoilsurvey interface. At the top, it says "View Soil Information By Use: All Uses". Below this are tabs for "Intro to Soils", "Suitabilities and Limitations for Use", and "Soil Properties and Qualities". The "Soil Properties and Qualities" tab is active, showing a search bar and a list of "Properties and Qualities Ratings". "Soil Physical Properties" is circled in red. Below this list are two boxes: "Map unit symbol" containing "PxA" and "Rating (percent)" containing "22.4". To the right is a map titled "Map - Water Content, 15 Bar" with a toolbar. A detailed view window for "Water Content, 15 Bar" is open on the right, also circled in red. It shows "View Options" (Map, Table, Description of Rating, Rating Options) and "Advanced Options" (Aggregation Method: Dominant Component; Component Percent Cutoff; Tie-break Rule: Higher; Interpret Nulls as Zero: Yes; Layer Options: Depth Range (Weighted Average) with Top Depth 0 and Bottom Depth 2, Inches selected).

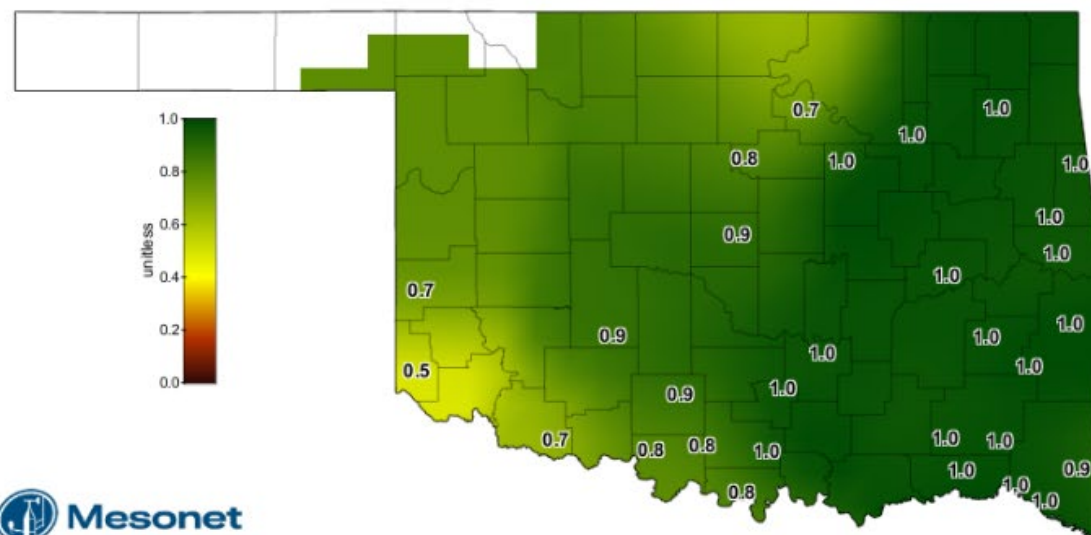
Map unit symbol
PxA

Rating (percent)
22.4

<https://websoilsurvey.nrcs.usda.gov/app/>

# Finding Information - Mesonet

## 1-day Average 4-inch Bare Soil Fractional Water Index



1-day Average 4-inch Bare Soil Fractional Water Index

February 23, 2025

Created 6:30:14 AM February 24, 2025 CST. © Copyright 2025

Fractional Water Index (FWI)	Generalize Plant Response
1.0	As wet as sensor can read
>0.7	Optimum for plant growth
0.4 to 0.7	Water stress possible
<0.4	Wilting likely occurring
0.0	As dry as sensor can read

<https://www.mesonet.org/weather/soil-moisture/1-day-average-4-inch-bare-soil-fractional-water-index?ref=1257>

# Timing of Fall Seeding and Soil Moisture

- Minimize disturbance prior to critical wind erosion period (Nov – April).
- Ok to seed in fall into adequate residue and moisture
  - Soil moisture > Permanent Wilting Point
- Consider waiting until spring if residue cover and soil moisture is low.



# Residue for Dryland

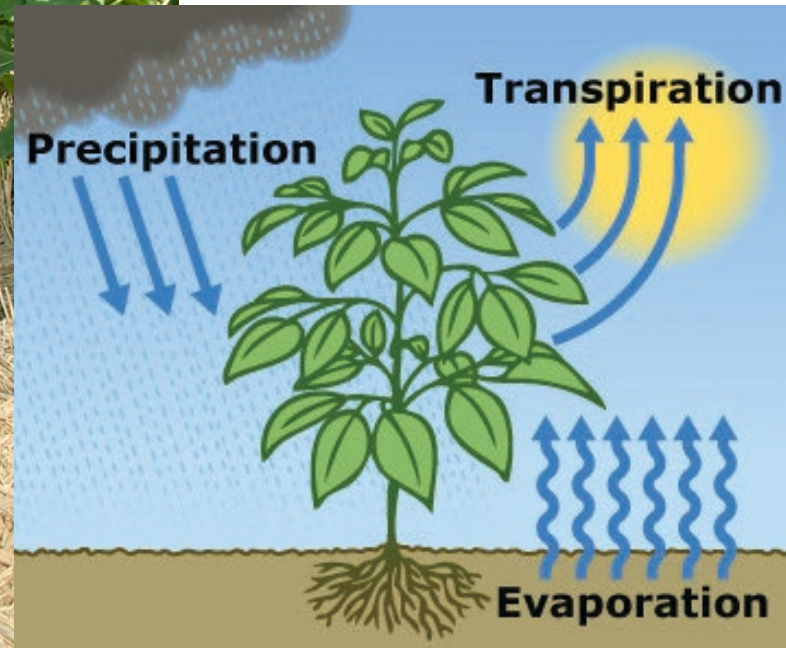


Image: USGS public domain

# Surface irrigation



# Irrigation Limitations

- Do not install the Sprinkler System (CPS 442) practice for wind erosion control. Only use if it's existing.
- Use for intermittent or emergency use.
- Not a long-term strategy for erosion control.
- Even if the system exists, water may not be available.
- Moisture evaporates within 24 hours and needs to be re-applied.
- Issues with groundwater depletion.
- Use additional solutions of minimum field size, surface roughness, cover crops, etc.

# Hydrology Manipulation



Subsurface Drainage  
(CPS 606)



Drainage Water  
Management (CPS 554)

Images: Ohio State University Extension

# Drought and Wind Erosion



Boise City, Oklahoma

- Dust Bowl context = no cover + sandy soils + drought
- Drought results in low residue and low vegetation. This creates a downward wind erosion spiral.
- Reminder that WEPS looks at an average year, not a drought year. It is possible to be in compliance (2T) or meeting T with WEPS and still have a major wind erosion event.
- Plan for the worst case, not the average.
- **Build redundancy** into these systems to provide insurance in case of drought.

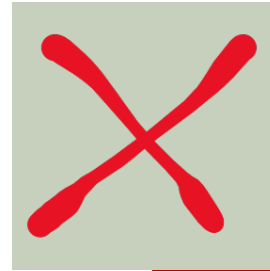


## Increase soil moisture



Pro

- Highly effective



Con

- Difficult to control
- Temporary - 24-hour maximum effectiveness
- Not a stand-alone solution

# Solutions



Increase high carbon residue



Increase vegetation



Decrease wind sheltered distance



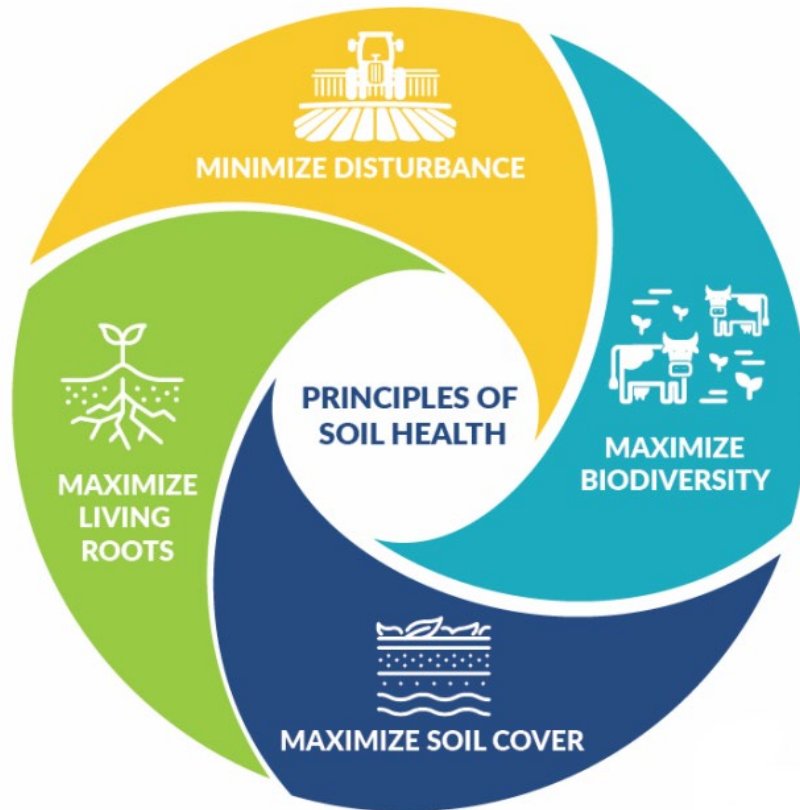
Increase surface roughness



Increase soil moisture

**Emergency**

# Soil Health



Wind erosion control relies on prevention and getting ahead of the problem, not emergency control measures.

# Timing and Location

- ASAP!
- Low cover areas
- Sandy soils
- Knolls
- Treat upwind areas first.



Chadron, NE, March 2013

# Web Soil Survey - Wind Erodibility Group

Area of Interest (AOI)
Soil Map
Soil Data Explorer
Download Soils Data
Shopping Cart (Free)

View Soil Information By Use: All Uses Printable Version Add to Shopping Cart

Intro to Soils
Suitabilities and Limitations for Use
Soil Properties and Qualities
Ecological Sites
Soil Reports

**Search**

**Properties and Qualities Ratings**

[Open All](#) [Close All](#)

Soil Chemical Properties

**Soil Erosion Factors**

K Factor, Rock Free

K Factor, Whole Soil

T Factor

**Wind Erodibility Group**

[View Description](#) [View Rating](#)

**View Options**

Map

Table

Description of Rating

Rating Options

Detailed Description

**Advanced Options**

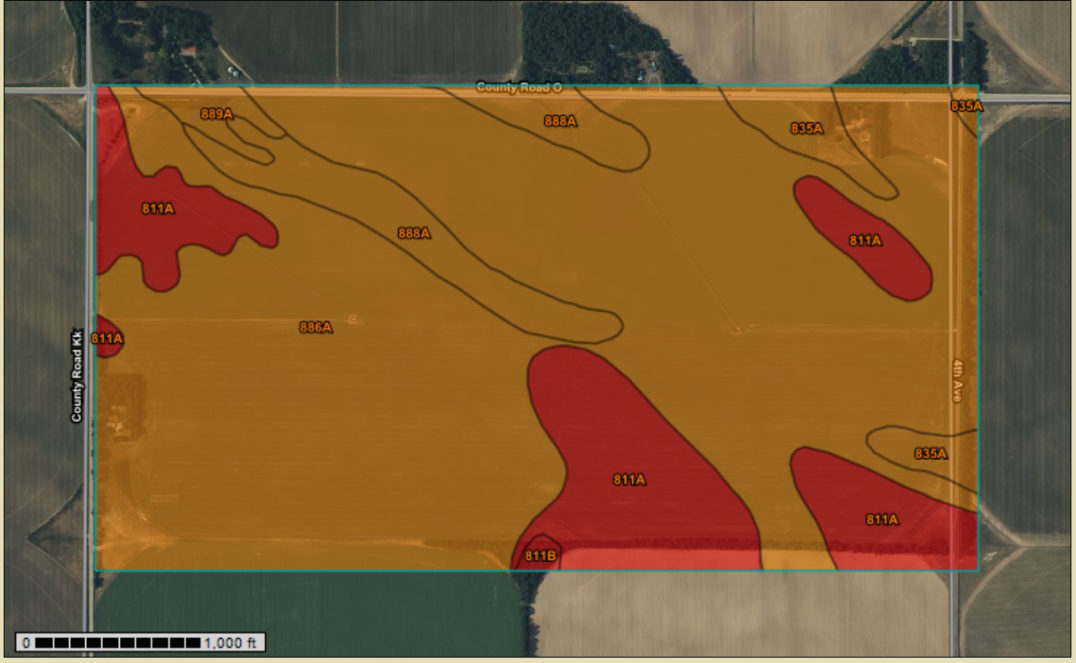
Aggregation Method Dominant Condition

Component Percent Cutoff

Tie-break Rule Lower

**Map — Wind Erodibility Group**

Scale (not to scale)



Warning: Soil Ratings Map may not be valid at this scale.

**Tables — Wind Erodibility Group — Summary By Map Unit**

# Emergency Tillage



Smith, J.A., D.J. Lyon. 2010. [Emergency wind erosion control](#). University Nebraska Extension. G2006.

# Sandfighter and Crusting



# Residue addition



**2000 – 4000 pounds/acre**

*Image: Tatarko, J. Trujillo, W. and Schipanski, M. 2019.*

# Manure addition



**6 - 8 tons/acre**

Tatarko, J. Trujillo, W. and Schipanski, M. 2019. [Wind erosion processes and control](#). Colorado State University Extension Publication.

# Temporary Artificial Barriers



*Images: Tatarko, J. Trujillo, W. and Schipanski, M. 2019.*

# Irrigation



# Soil additives



*Images: Tatarko, J. Trujillo, W. and Schipanski, M. 2019.*

# Putting it Together



## Gather Information

1. Wind energy and preponderance info - WEPS
2. Wind Erodibility Group - Web Soil Survey
3. Document crop rotation and history
4. Look at field size history - aerial images

# Putting it Together



## Apply Solutions

1. Increase high carbon residue – crop rotation
2. Increase vegetation – Crop rotation, cover crops
3. Decrease unsheltered distance
4. Increase surface roughness
5. Increase soil moisture

# References

- Chepil, W.S. 1956. Influence of moisture on erodibility of soil by wind. Soil Science Society of America Journal, 20 (2): 288-292
- Datta, S., S. Taghvaeian, J. Stivers. 2017. Understanding soil water content and thresholds for irrigation management. Oklahoma State Extension. BAE-1537.
- [www.mesonet.org](http://www.mesonet.org)
- Ohio State University Extension. *Controlled Drainage/Drainage Water Management (NRCS 554)*.
- Ohio State University Extension. *Subsurface Drainage (NRCS 606)*.
- Smith, J.A., D.J. Lyon. 2010. *Emergency wind erosion control*. University Nebraska Extension. G2006.
- Tatarko, J. Trujillo, W. and Schipanski, M. 2019. Wind erosion processes and control. Colorado State University Extension Publication.
- USDA-ARS. 2016. WEPS 1.5 User Manual
- USDA-NRCS. 1998. *Estimating soil moisture by feel and appearance*.