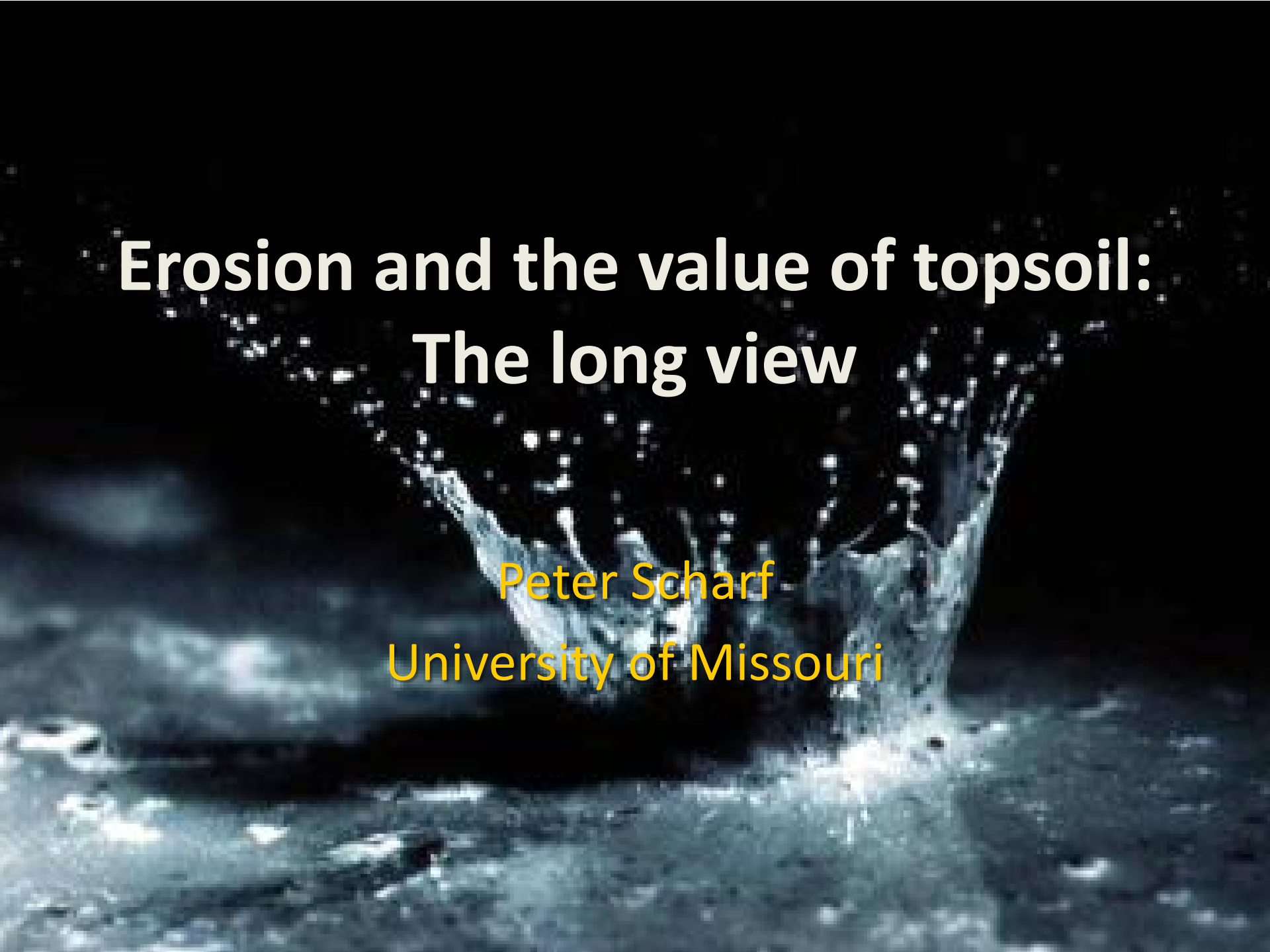
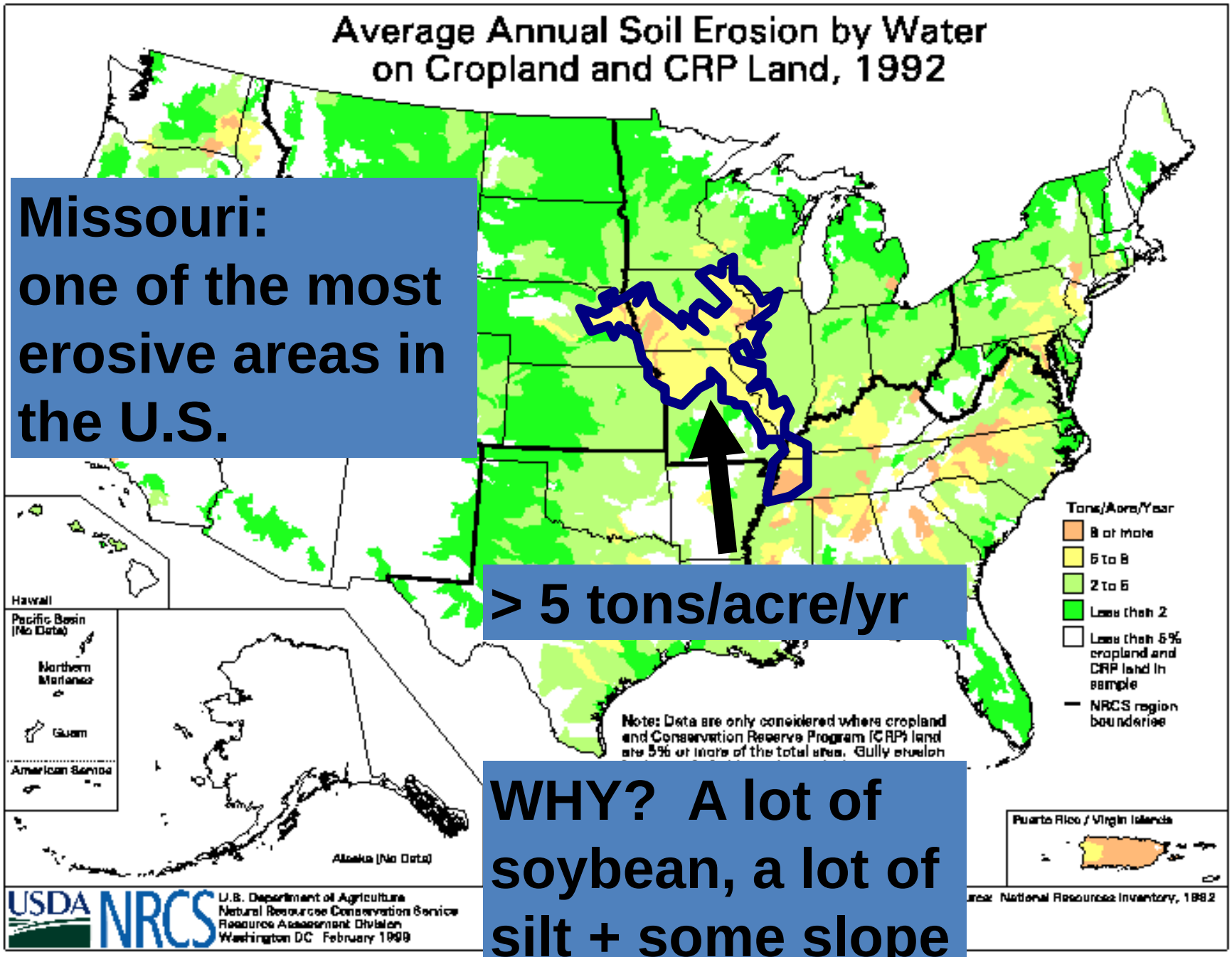
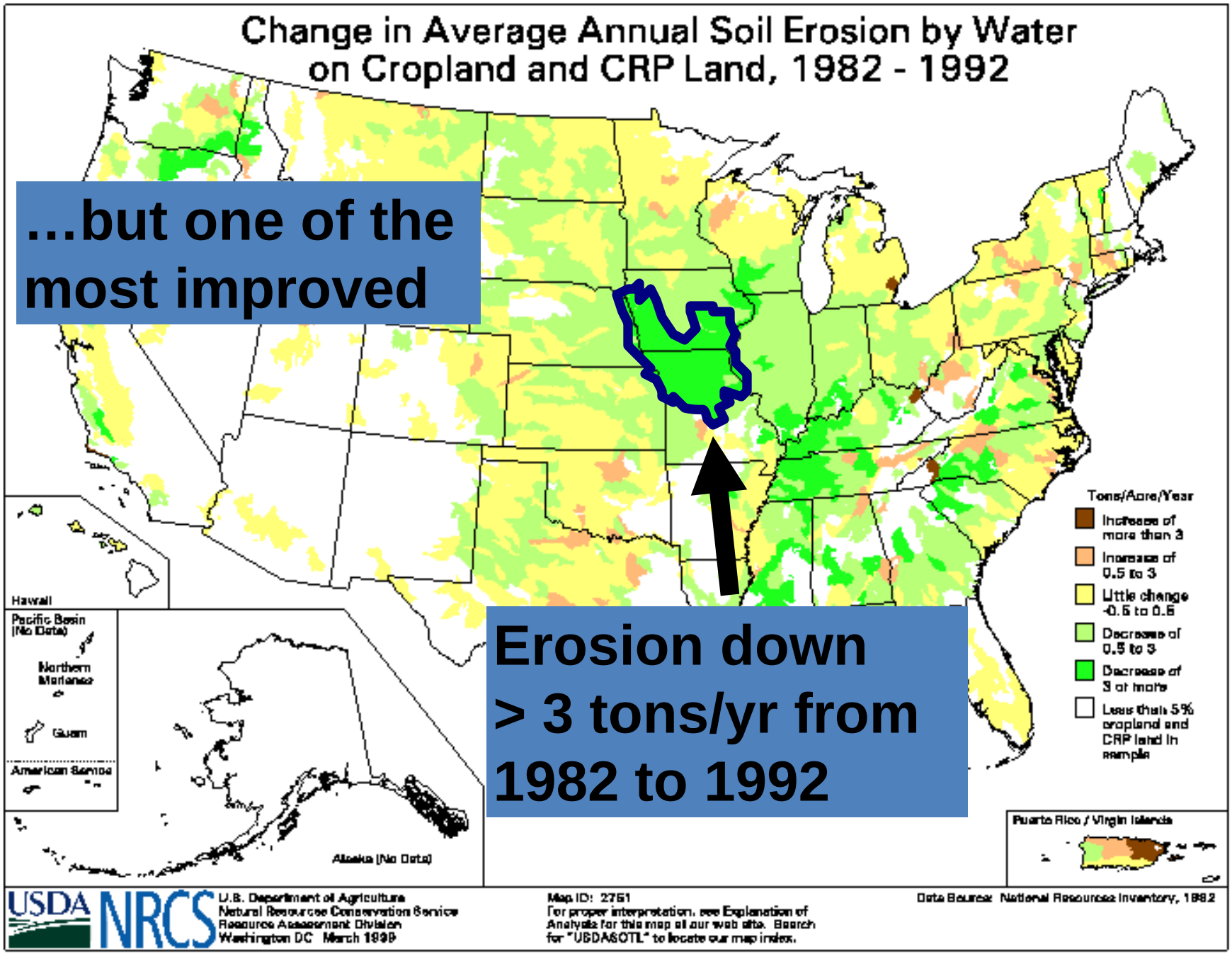


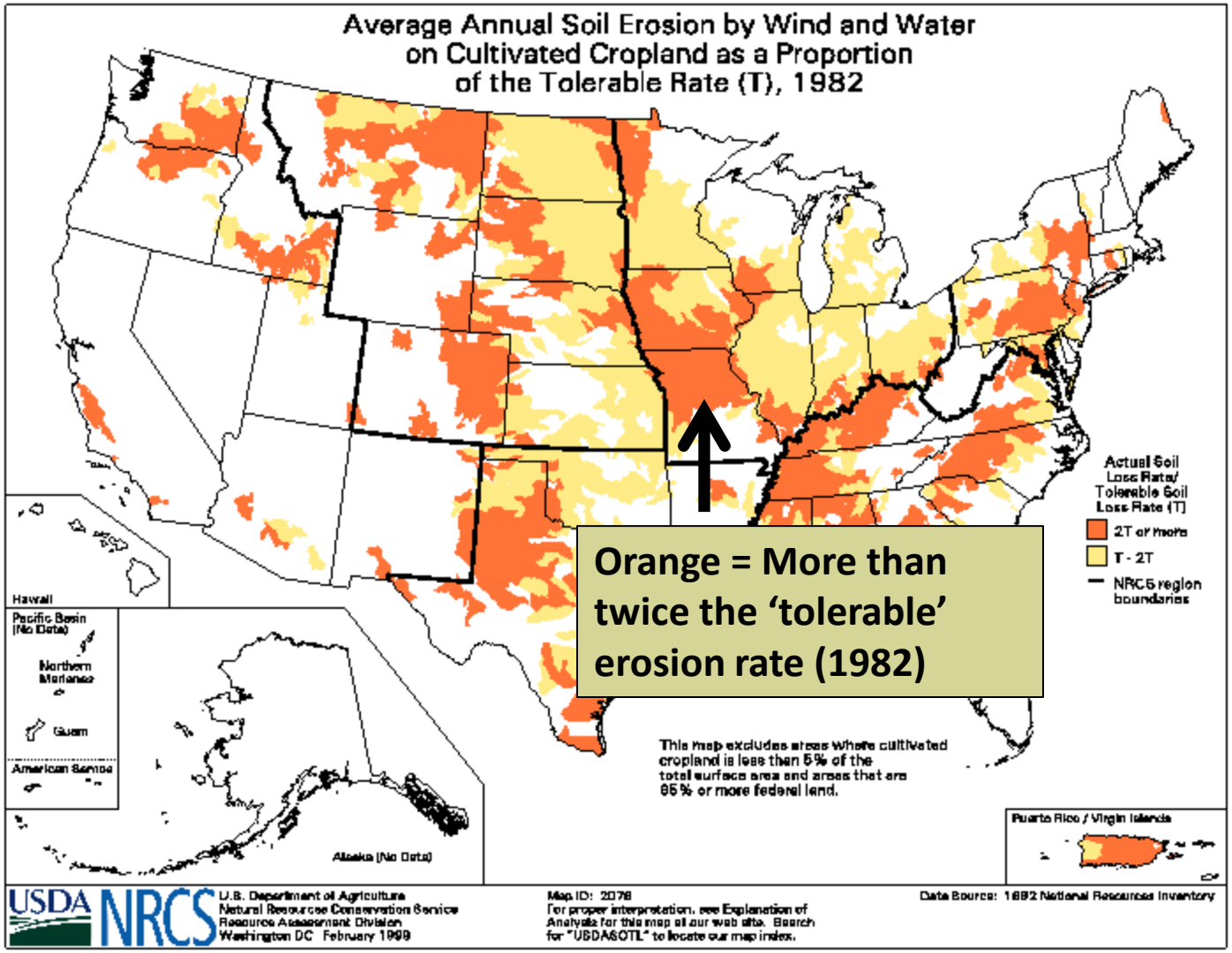
Erosion and the value of topsoil: The long view

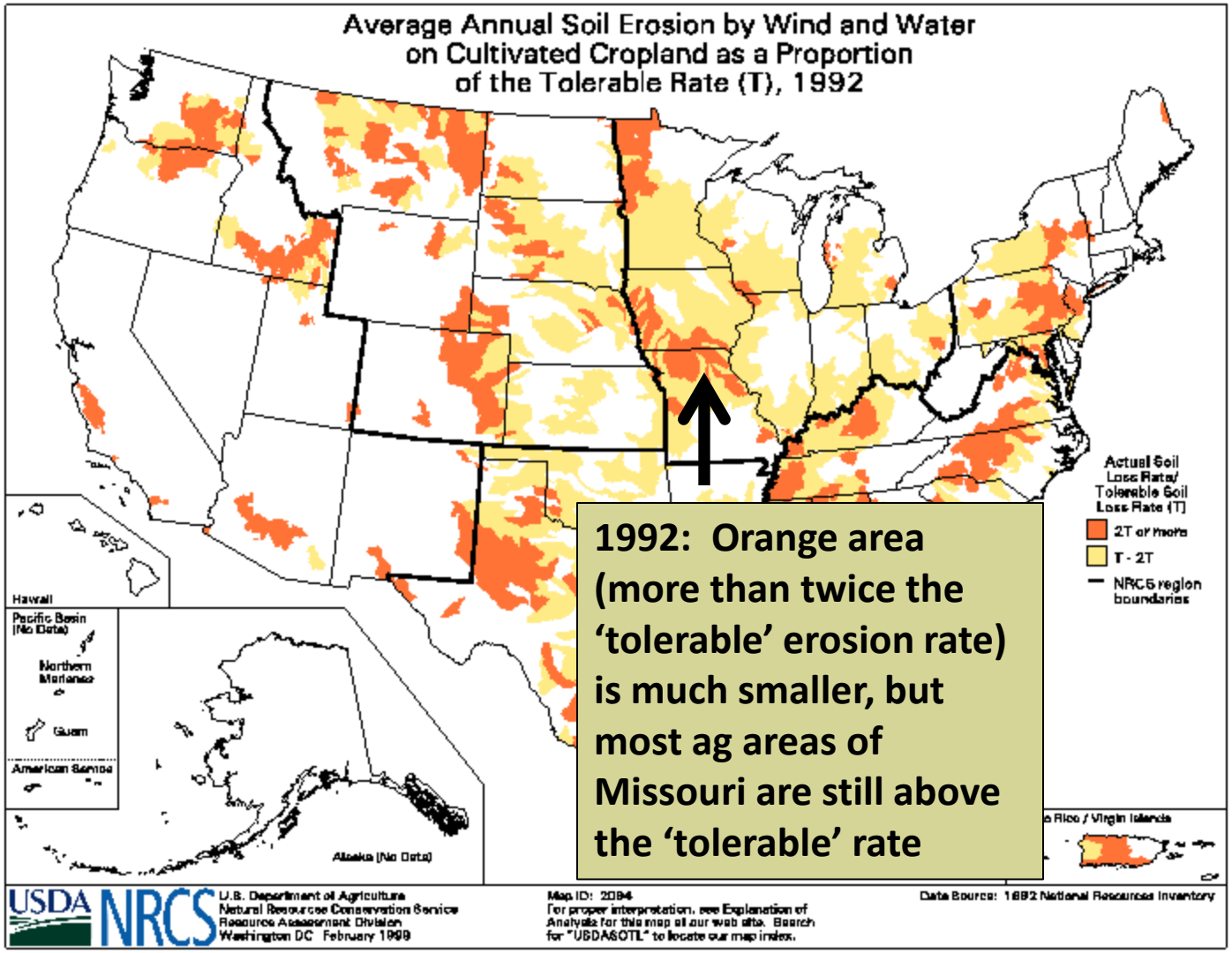
Peter Scharf
University of Missouri

We’re a soybean state

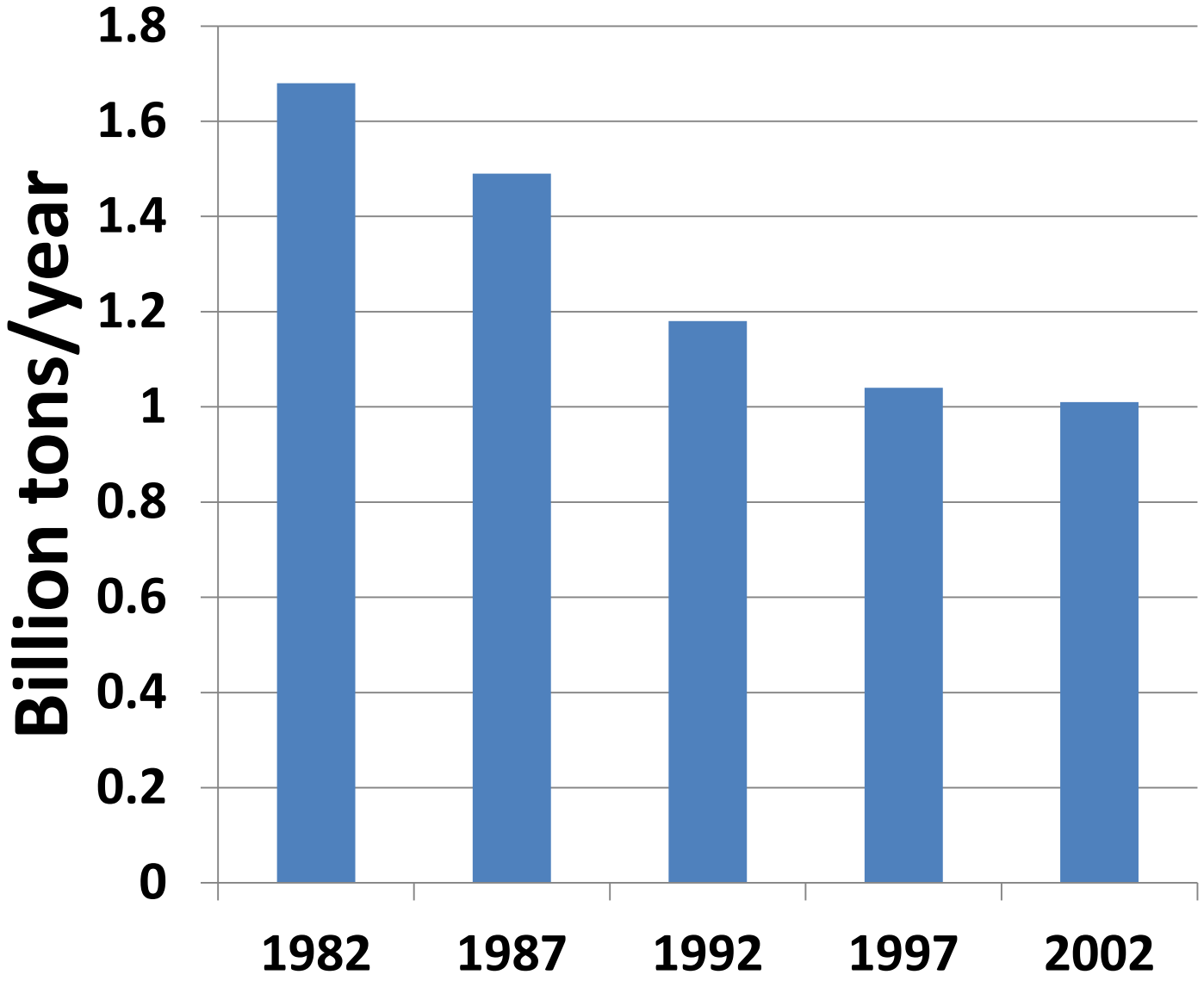

Average Annual Soil Erosion by Water on Cropland and CRP Land, 1992
Missouri: one of the most erosive areas in the U.S.
> 5 tons/acre/yr
WHY? A lot of soybean, a lot of silt + some slope
Tons/Acre/Year
8 or more
5 to 8
2 to 5
Less than 2
Less than 5% cropland and CRP land in sample
NRCS region boundaries
Note: Data are only considered where cropland and Conservation Reserve Program (CRP) land are 5% or more of the total area. Gully erosion
Hawaii
Pacific Basin (No Data)
Northern Marianas
Guam
American Samoa
Alaska (No Data)
Puerto Rico / Virgin Islands
USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service
Resource Assessment Division
Washington DC February 1999
National Resources Inventory, 1992


Change in Average Annual Soil Erosion by Water on Cropland and CRP Land, 1982 - 1992
...but one of the most improved
Erosion down > 3 tons/yr from 1982 to 1992
Tons/Acre/Year
Increase of more than 3
Increase of 0.5 to 3
Little change -0.5 to 0.5
Decrease of 0.5 to 3
Decrease of 3 or more
Less than 5% cropland and CRP land in sample
Hawaii
Pacific Basin (No Data)
Northern Marianas
Guam
American Samoa
Alaska (No Data)
Puerto Rico / Virgin Islands
USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service
Resource Assessment Division
Washington DC March 1999
Map ID: 2751
For proper interpretation, see Explanation of Analysis for this map at our web site. Search for "USDASOTL" to locate our map index.
Data Source: National Resources Inventory, 1992


Average Annual Soil Erosion by Wind and Water
on Cultivated Cropland as a Proportion
of the Tolerable Rate (T), 1982
Orange = More than twice the 'tolerable' erosion rate (1982)
Actual Soil Loss Rate/ Tolerable Soil Loss Rate (T)
2T or more
T - 2T
NRCS region boundaries
Hawaii
Pacific Basin (No Data)
Northern Marianas
Guam
American Samoa
Alaska (No Data)
This map excludes areas where cultivated cropland is less than 5% of the total surface area and areas that are 95% or more federal land.
Puerto Rico / Virgin Islands
USDA NRCS
U.S. Department of Agriculture
Natural Resource Conservation Service
Resource Assessment Division
Washington DC February 1999
Map ID: 2078
For proper interpretation, see Explanation of Analysis for this map at our web site. Search for "USDASOTL" to locate our map index.
Data Source: 1992 National Resources Inventory


Average Annual Soil Erosion by Wind and Water
on Cultivated Cropland as a Proportion
of the Tolerable Rate (T), 1992
Actual Soil Loss Rate/ Tolerable Soil Loss Rate (T)
2T or more
T - 2T
NRCS region boundaries
1992: Orange area (more than twice the 'tolerable' erosion rate) is much smaller, but most ag areas of Missouri are still above the 'tolerable' rate
Hawaii
Pacific Basin (No Data)
Northern Marianas
Guam
American Samoa
Alaska (No Data)
Puerto Rico / Virgin Islands
USDA NRCS
U.S. Department of Agriculture
Natural Resource Conservation Service
Resource Assessment Division
Washington DC February 1999
Map ID: 2084
For proper interpretation, see Explanation of Analysis for this map at our web site. Search for "USDASOTL" to locate our map index.
Data Source: 1992 National Resources Inventory

Water erosion on U.S. cropland



How big of a problem is erosion?

Late April 2012, 30 miles north of Columbia

Gullies following the planter rows (channeled by the planter furrow) About 12 inches wide, 30 inches apart

Average erosion loss 1.0 inches of topsoil
Could be replaced by growing grass for 100 years

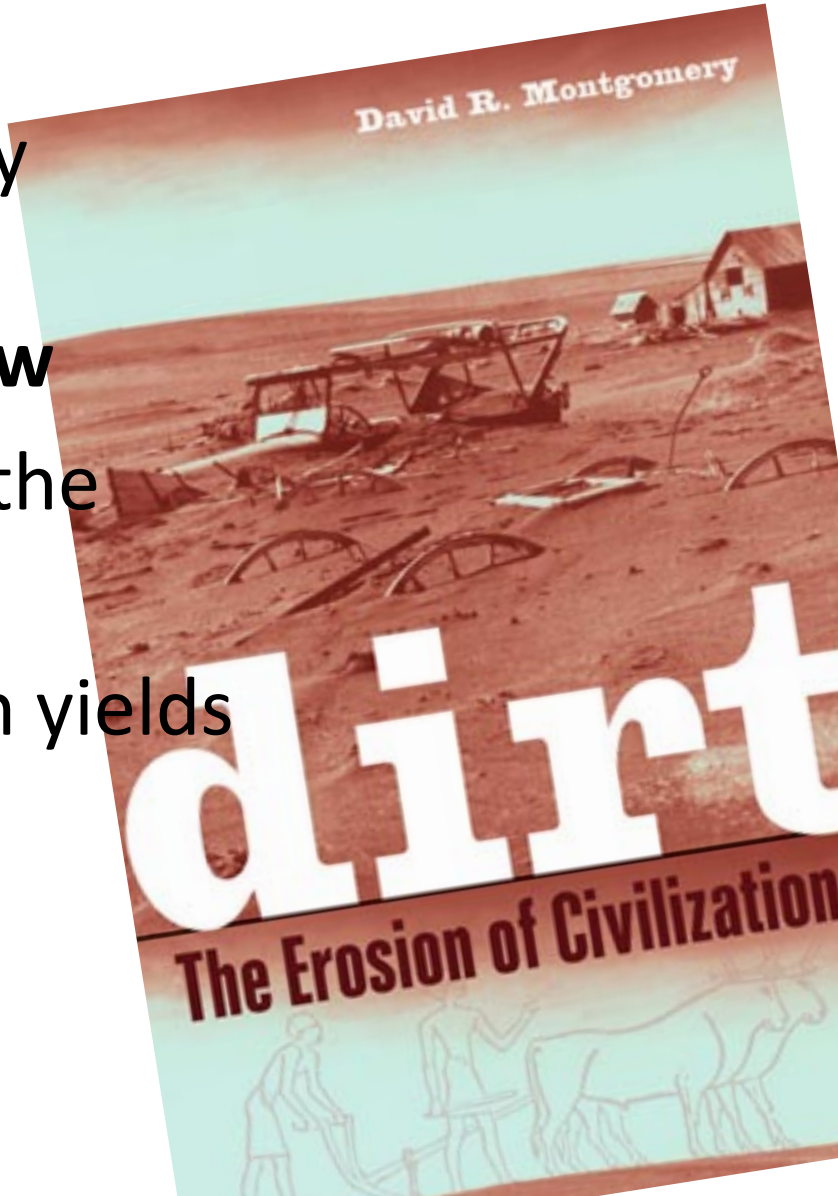

Erosion just outside Columbia
Late April, 2012

Residue matters


3” rainfalls:
50 to 100% more than 50 years ago

Impacts of erosion

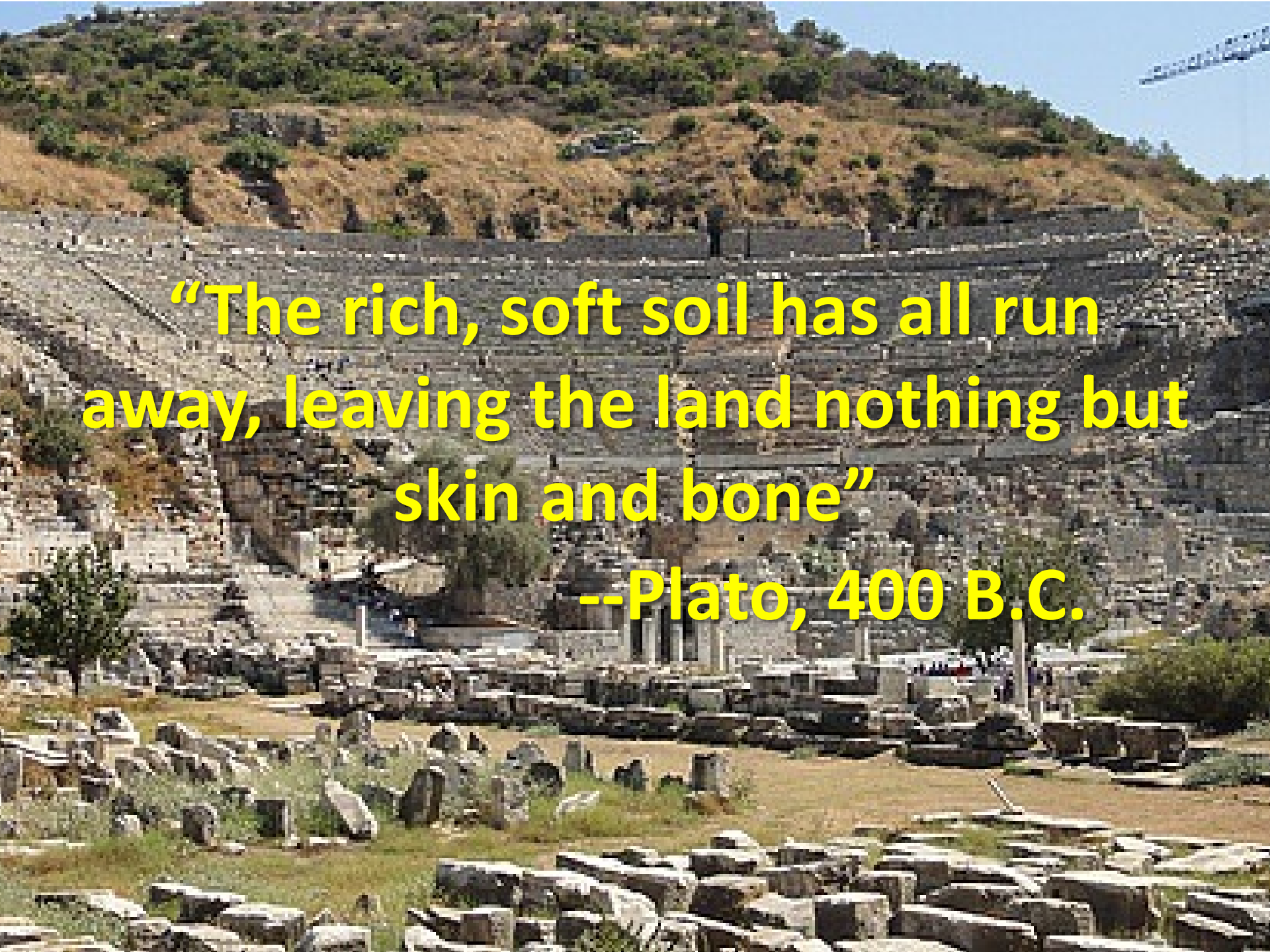
- Collapse of dozens of early historic and prehistoric civilizations: **The long view**
- Collapse of agriculture in the U.S. Piedmont
- Impact on corn & soybean yields in central Missouri



Argolis, Greece

- 7000 B.C.—Simple agriculture begins
- 4000 B.C.—Agriculture intensifies
- 3000 B.C.—Major civilization
- 2500 B.C.—Civilization collapses — SOIL EROSION
- 1500 B.C.—New civilization
- 200 B.C.—Civilization collapses — SOIL EROSION
- 900 A.D.—New civilization
- 1200 A.D.—Civilization collapses — SOIL EROSION

Importing half of their food from Sicily and Egypt


“The rich, soft soil has all run away, leaving the land nothing but skin and bone”
--Plato, 400 B.C.

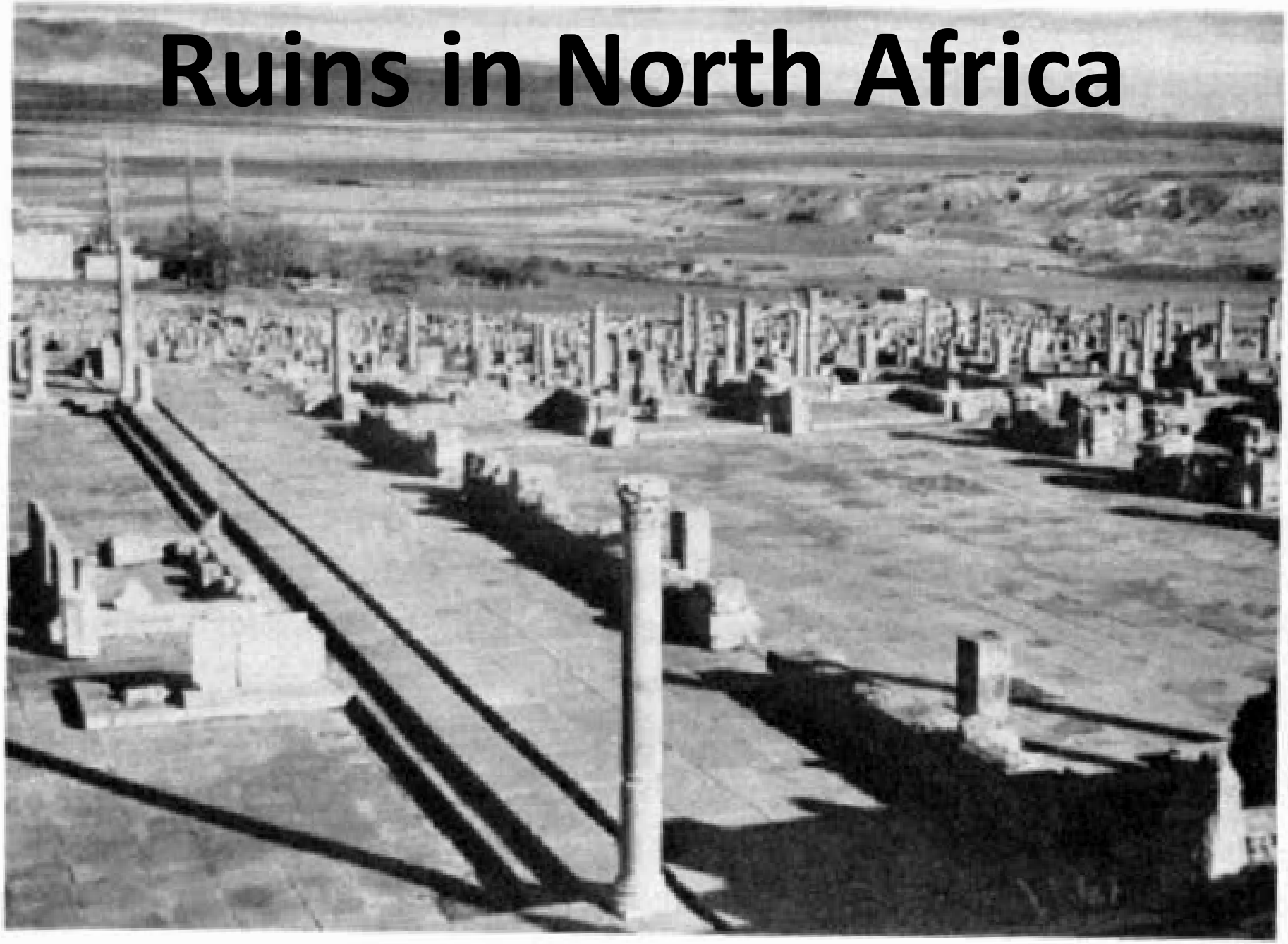
Rome & Soil Erosion

- Rome founded 750 B.C., Roman Empire started 500 B.C.
- By A.D. 400 (900 years of Empire):
  - 75,000 farms had been abandoned in central Italy
  - It was a crime for the son of a farmer to leave the farm
  - Most food was imported from conquered lands

Rome & Soil Erosion

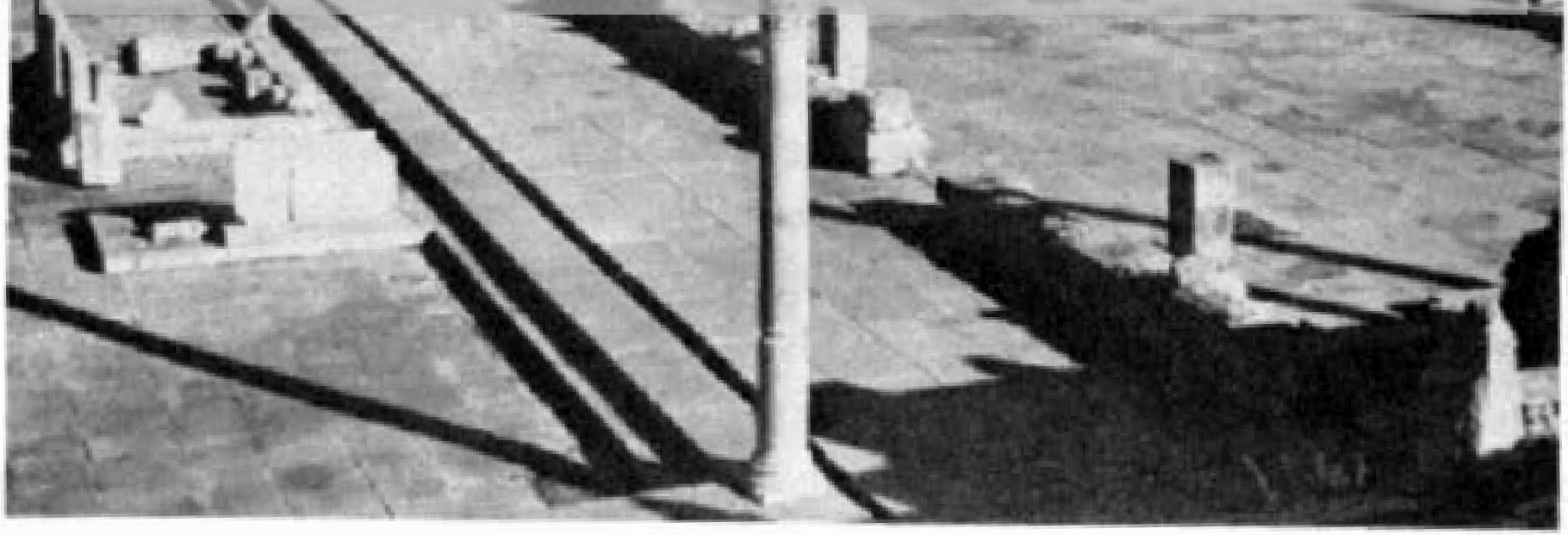
- Erosion estimates based on current position of ancient structures:
- Roman cistern 36” above current soil line
- Via Prenestina (basalt road) several feet above surrounding soil

Ruins in North Africa

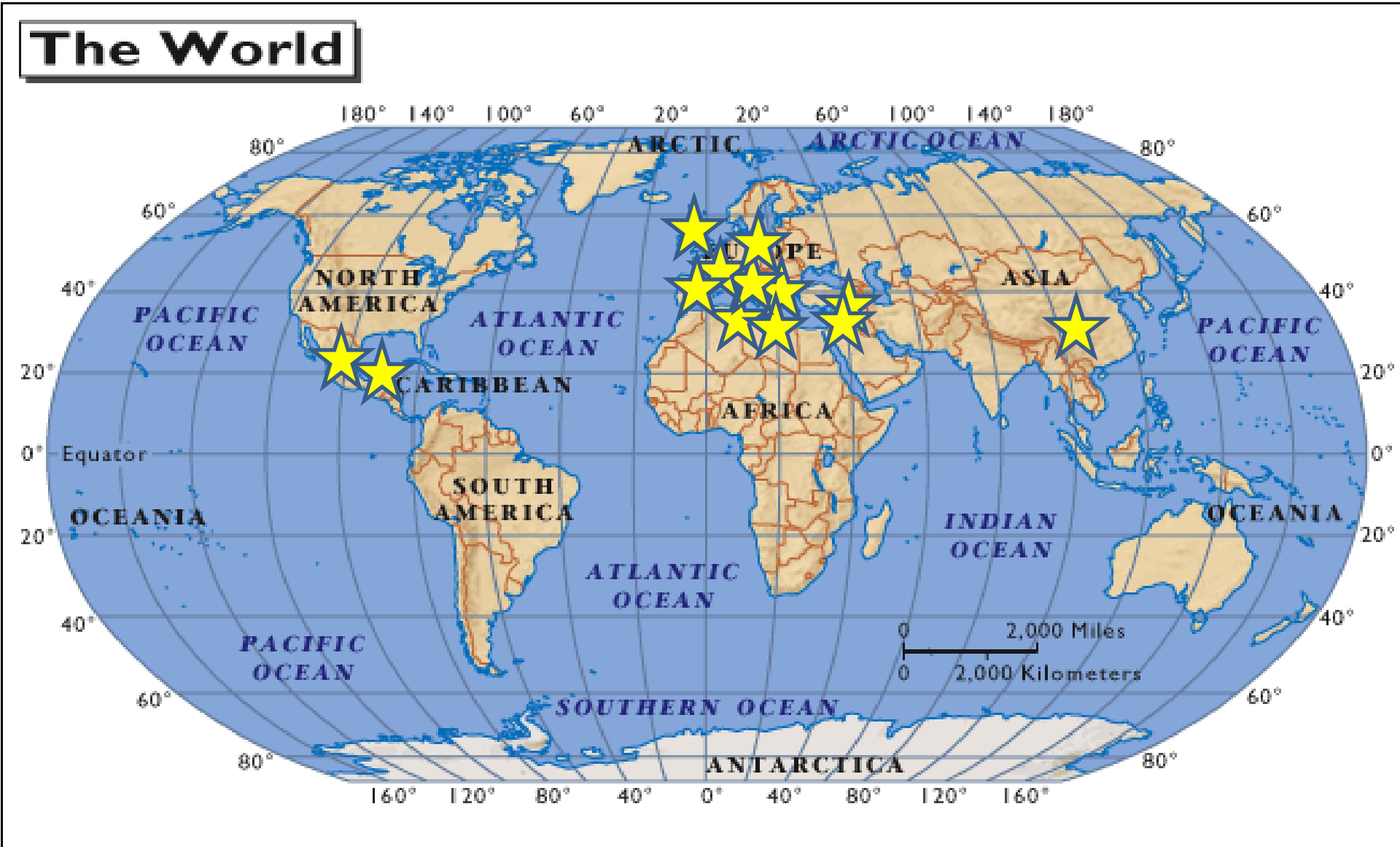


Ruins in North Africa

- 60,000 seat Roman amphiteater suggests large population
- But Roman agriculture ruined the soil
- Today's population is 5,000 within a day's walk

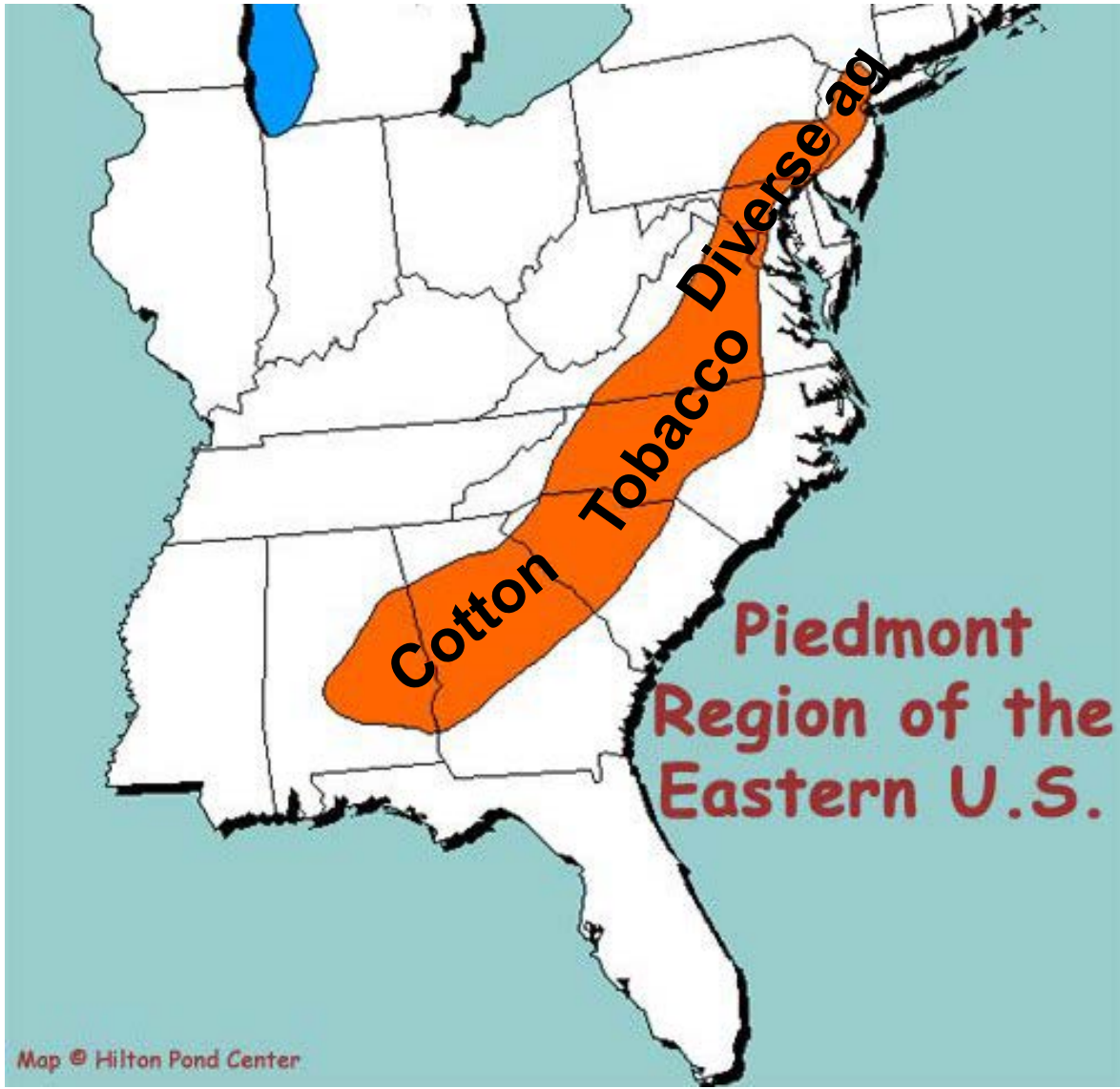


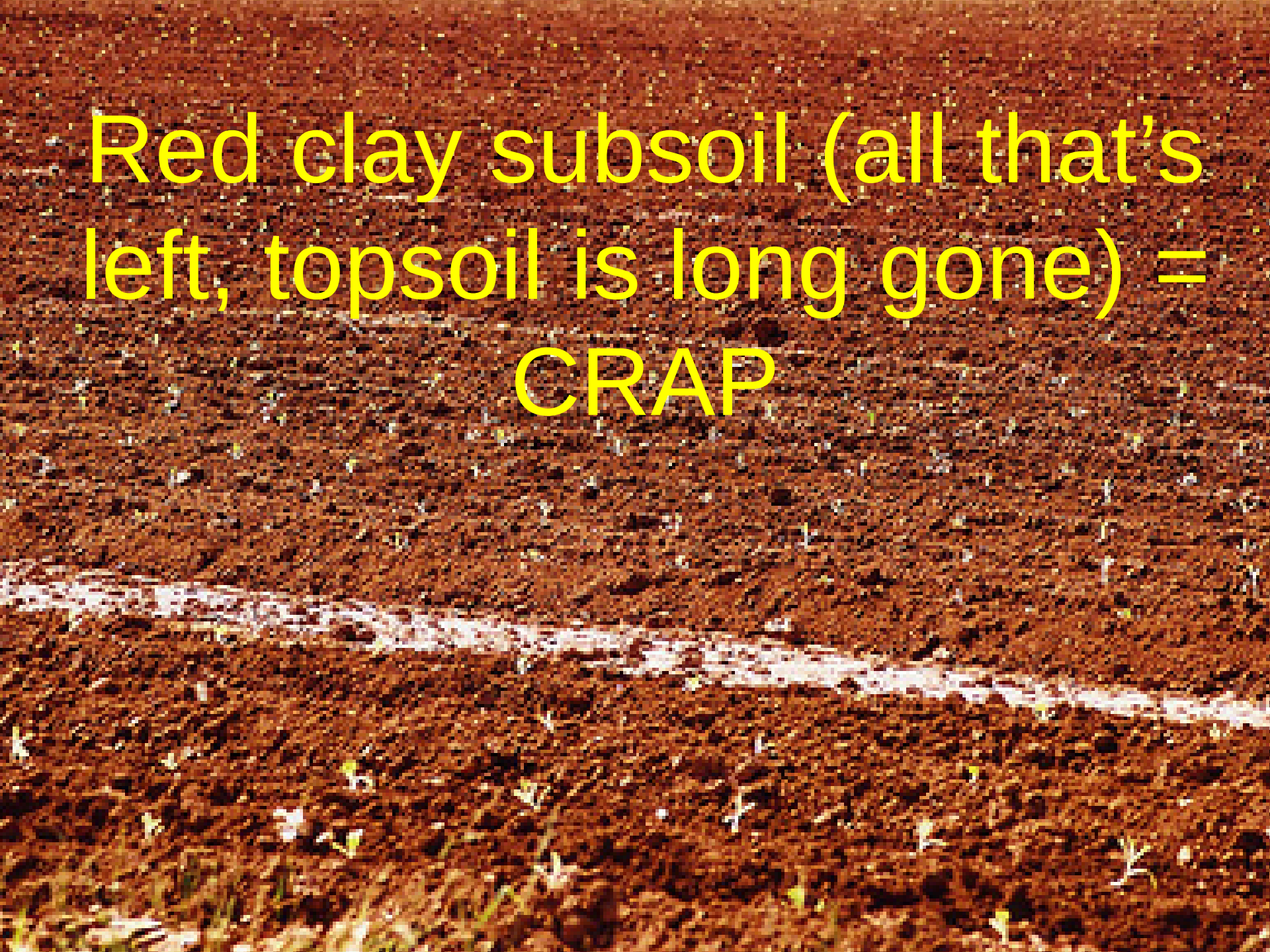
Devastating erosion



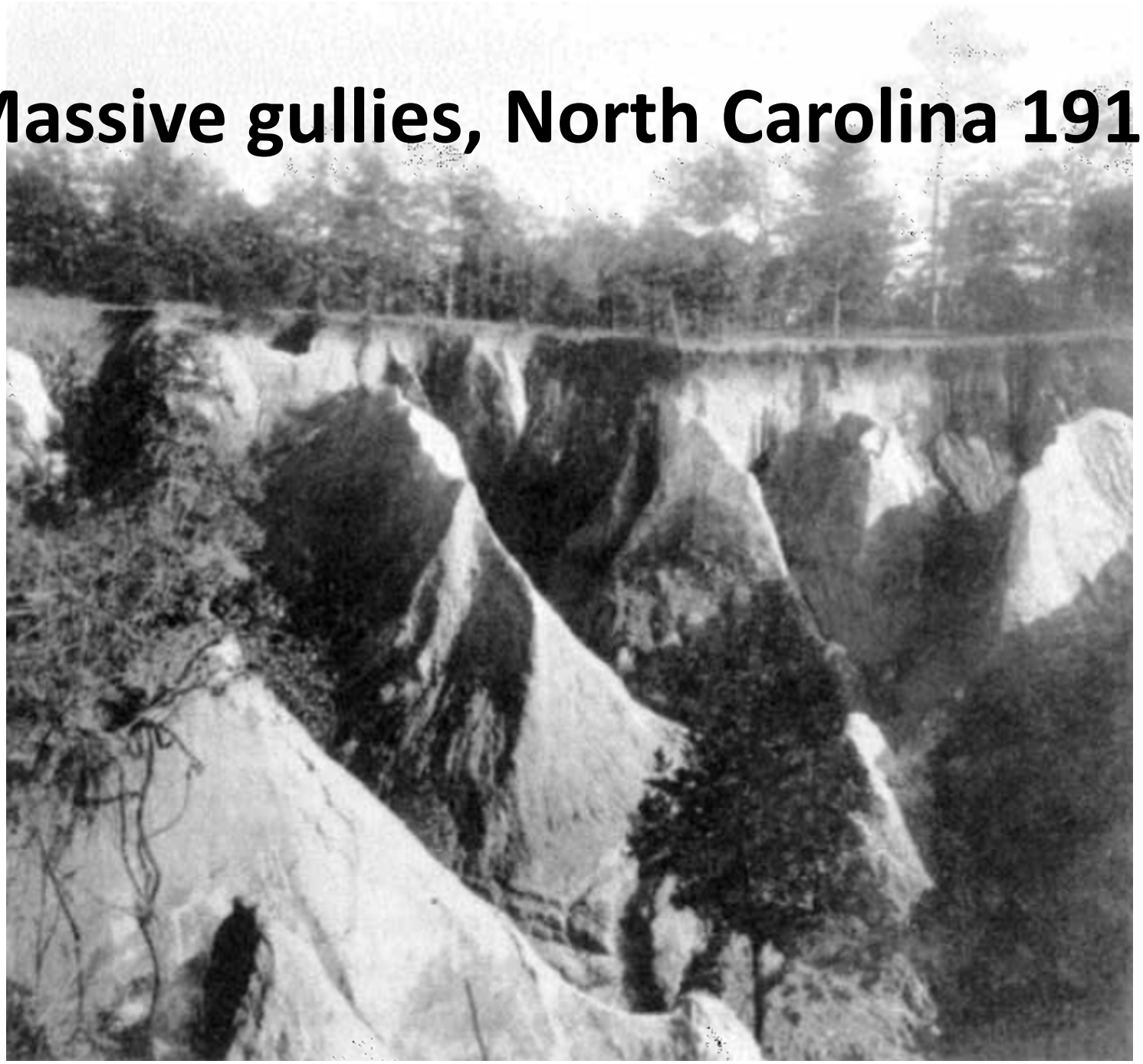
Closer to home

- Used to be a major ag region
- “Soil erosion was rampant from early times”
- “Most old agricultural fields are now in pine forests”

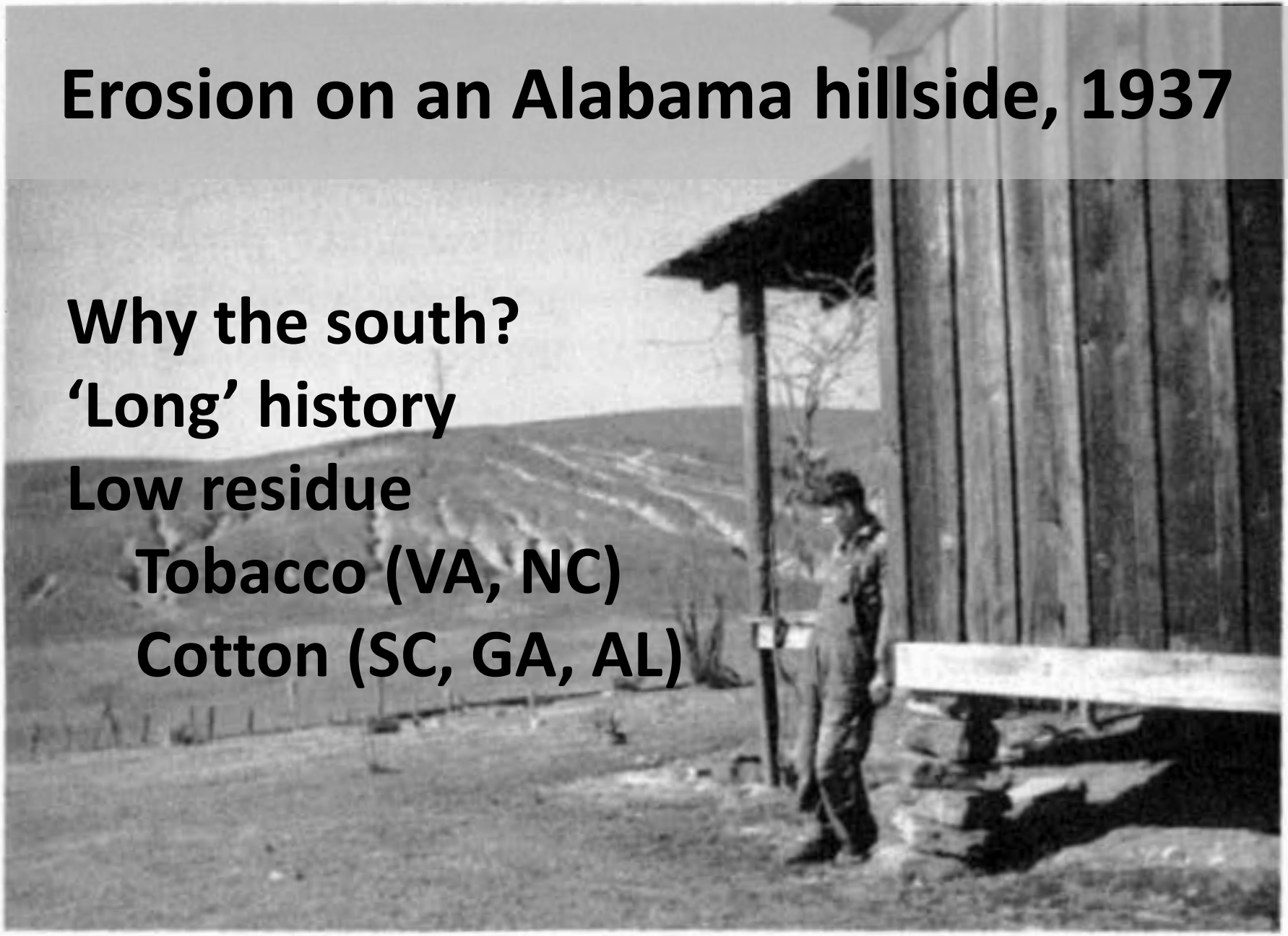



Red clay subsoil (all that's left, topsoil is long gone) = CRAP

Massive gullies, North Carolina 1911



Erosion on an Alabama hillside, 1937



Why the south?

‘Long’ history

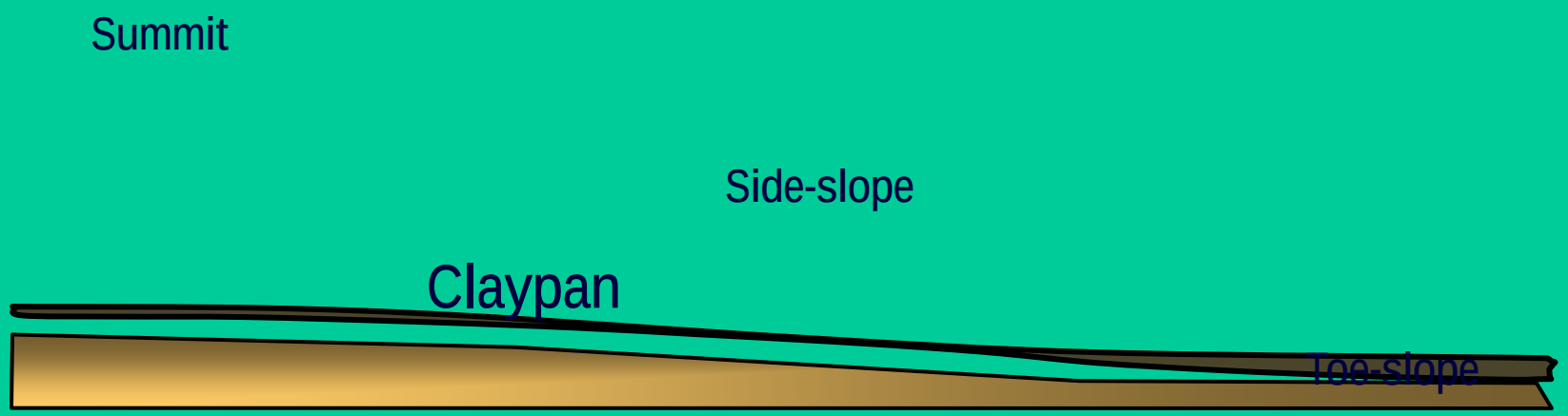
Low residue

- **Tobacco (VA, NC)**
- **Cotton (SC, GA, AL)**

Hugh Bennett, first Soil Conservation Service director

- Timed his testimony to the Senate to coincide with the arrival of a massive dust storm in Washington, D.C.—April 2, 1935
- Led to the formation of the Soil Conservation Service

Topsoil depth affects water delivery to crops



55-65% clay **25-30 % clay**

Plant-Available Water Capacity (inches H_20 / 40 inches of soil):

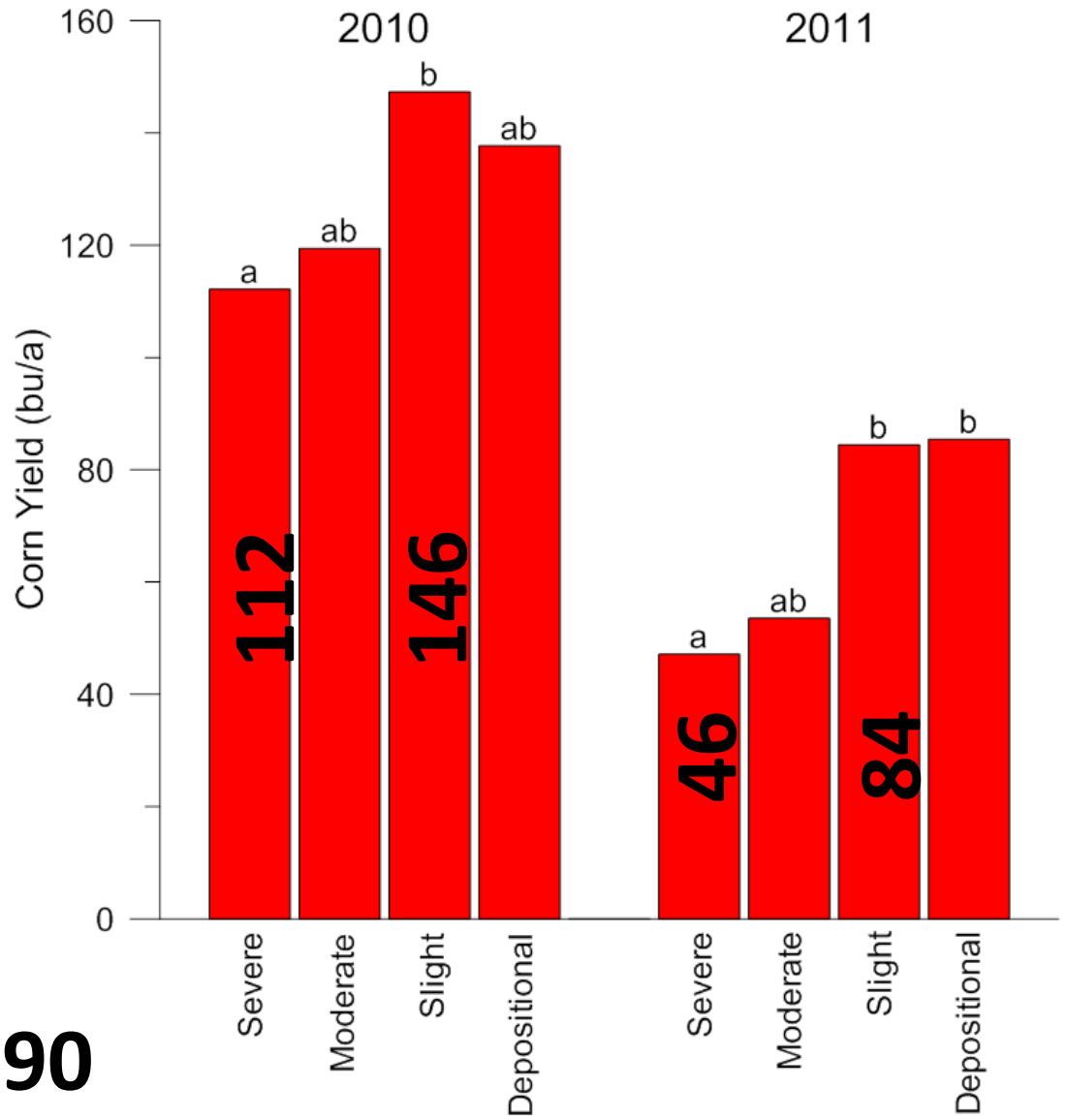
7 6 5 4 7 10 12

How do erosion and topsoil depth affect yield?

- Small-plot experiments 2009-2011 near Columbia—mostly 1 to 18” of topsoil
  - Newell Kitchen and others (Ag Research Service)
- Corn
  - 4.6 bu/acre per inch of topsoil in 2009
  - 1.1 bu/acre per inch of topsoil in 2010
  - 2.9 bu/acre per inch of topsoil in 2011
- **Average 2.9 bu/acre per inch of topsoil**
- Similar to 2.2 bu/acre per inch of topsoil measured in another field in 1999 & 2001

Corn Yield

2009 yields:
Severe erosion 105
Slight/no erosion 190

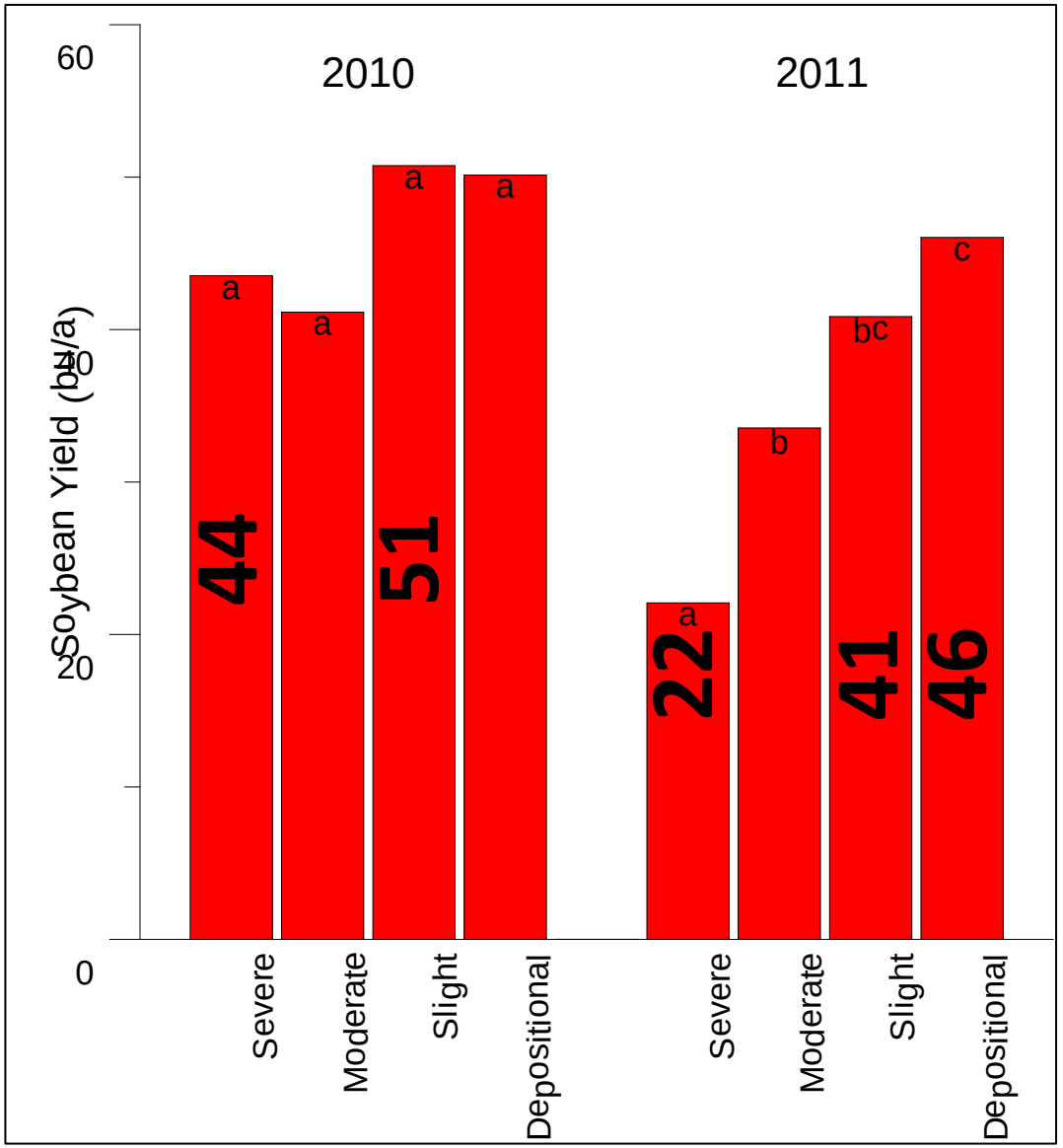


Level of erosion

How do erosion and topsoil depth affect yield?

- Soybean
  - 0.1 bu/acre per inch of topsoil in 2009
  - 0.5 bu/acre per inch of topsoil in 2010
  - 1.5 bu/acre per inch of topsoil in 2011
- **Average 0.7 bu/acre per inch of topsoil**

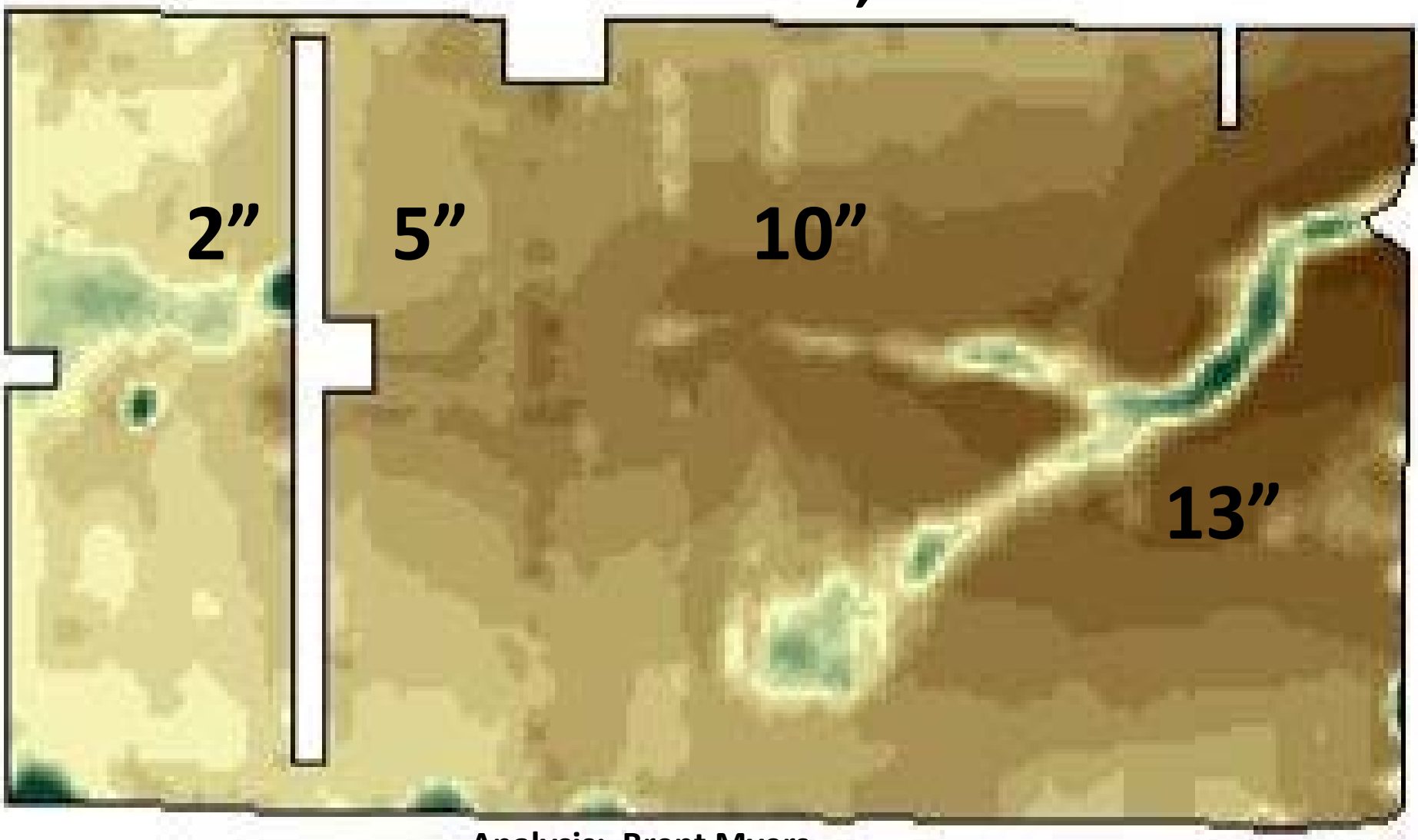
Soybean Yield



Level of erosion

120 Years of Erosion

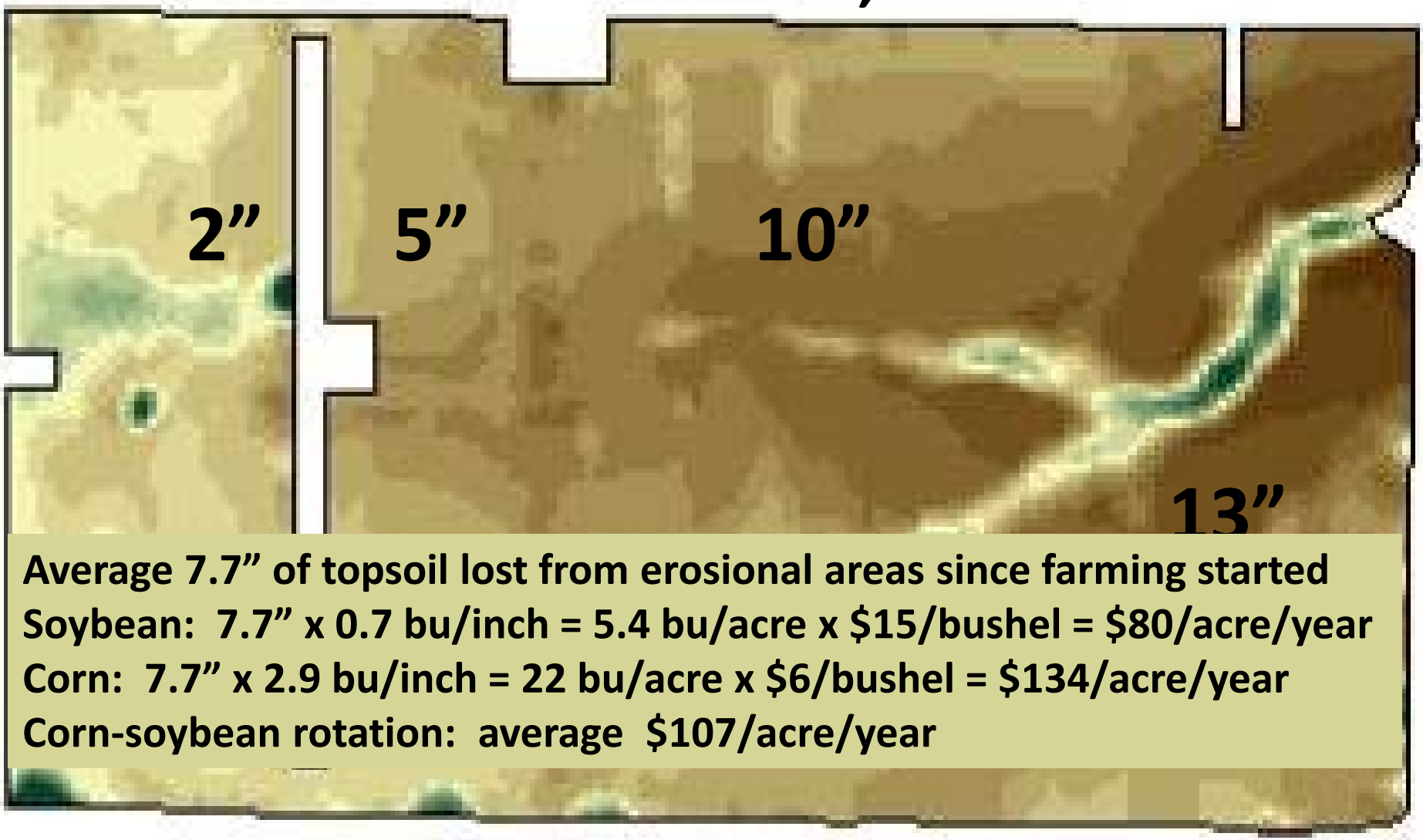
Field near Centralia, Missouri



Analysis: Brent Myers

120 Years of Erosion

Field near Centralia, Missouri



Average 7.7” of topsoil lost from erosional areas since farming started
Soybean: 7.7” x 0.7 bu/inch = 5.4 bu/acre x $15/bushel = $80/acre/year
Corn: 7.7” x 2.9 bu/inch = 22 bu/acre x $6/bushel = $134/acre/year
Corn-soybean rotation: average $107/acre/year

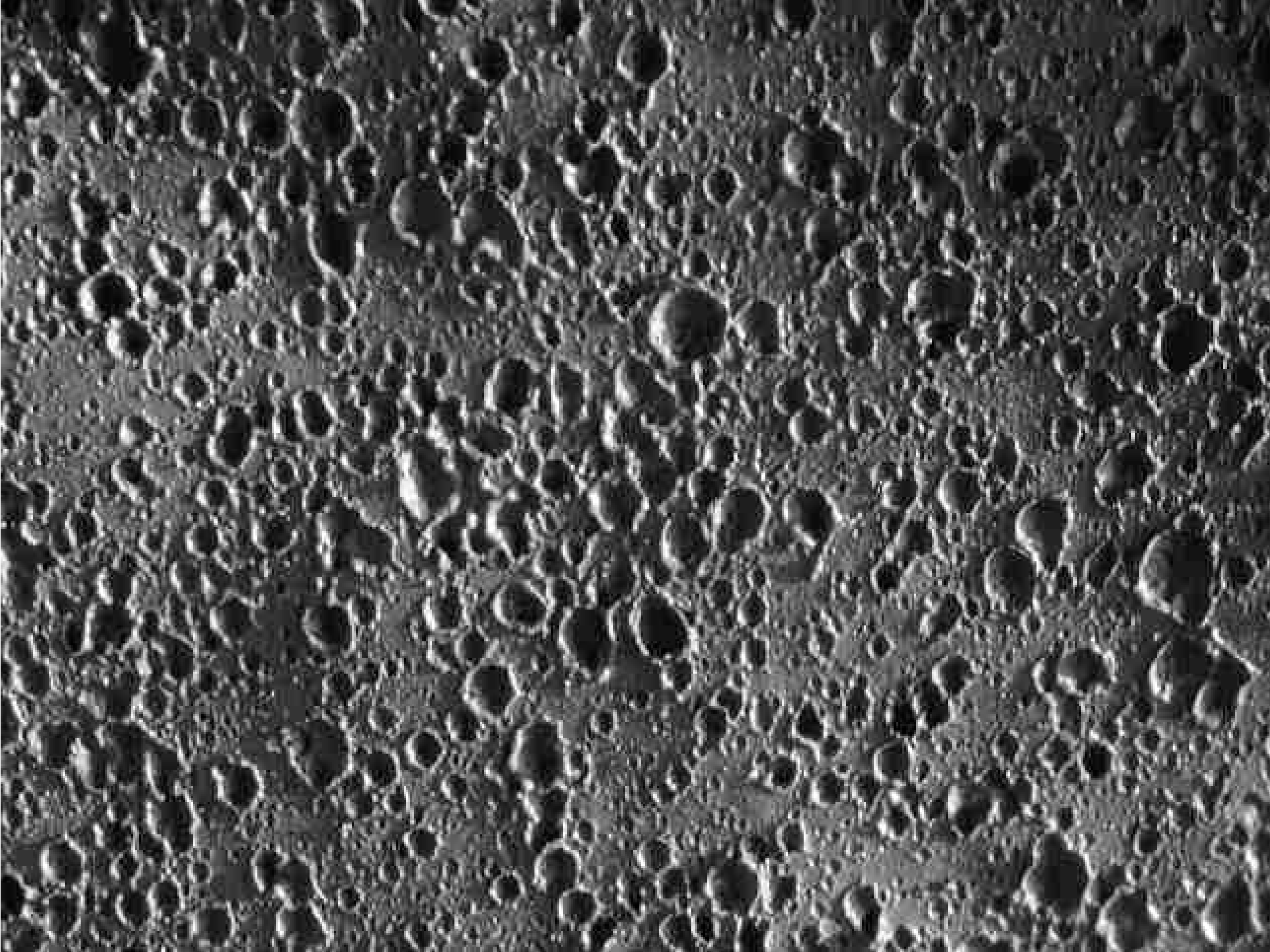
How big of a problem is erosion?

- It's a $107/acre problem in the field I just showed you
- Every year
- Add an extra $16/acre (every year) to this field from just one day's erosion

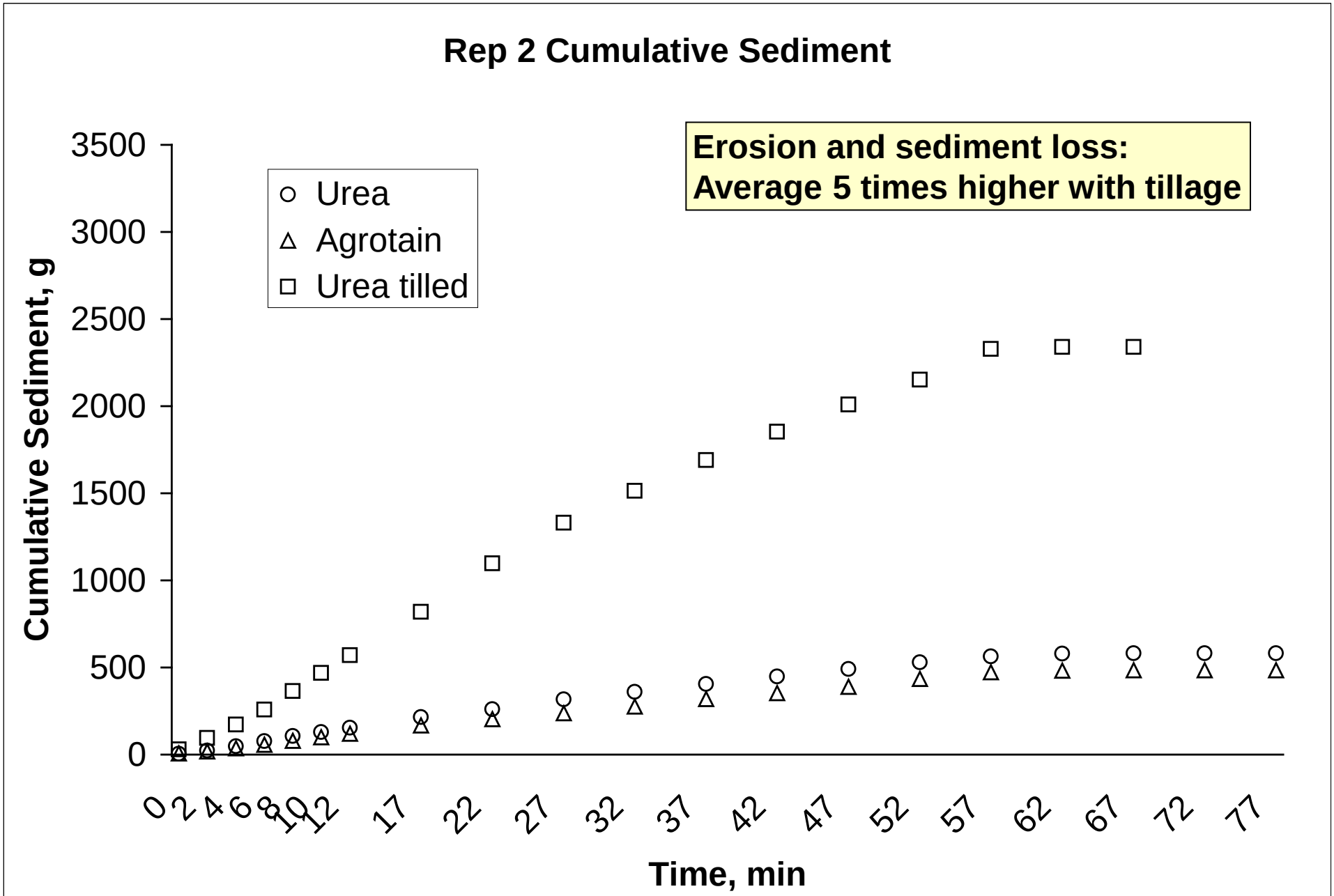
How can we reduce erosion & save our topsoil?

- **Reduce tillage intensity & frequency**
  - Leave residue to protect the soil surface
- **Grow cover crops to protect the soil surface**


tilled
no-till

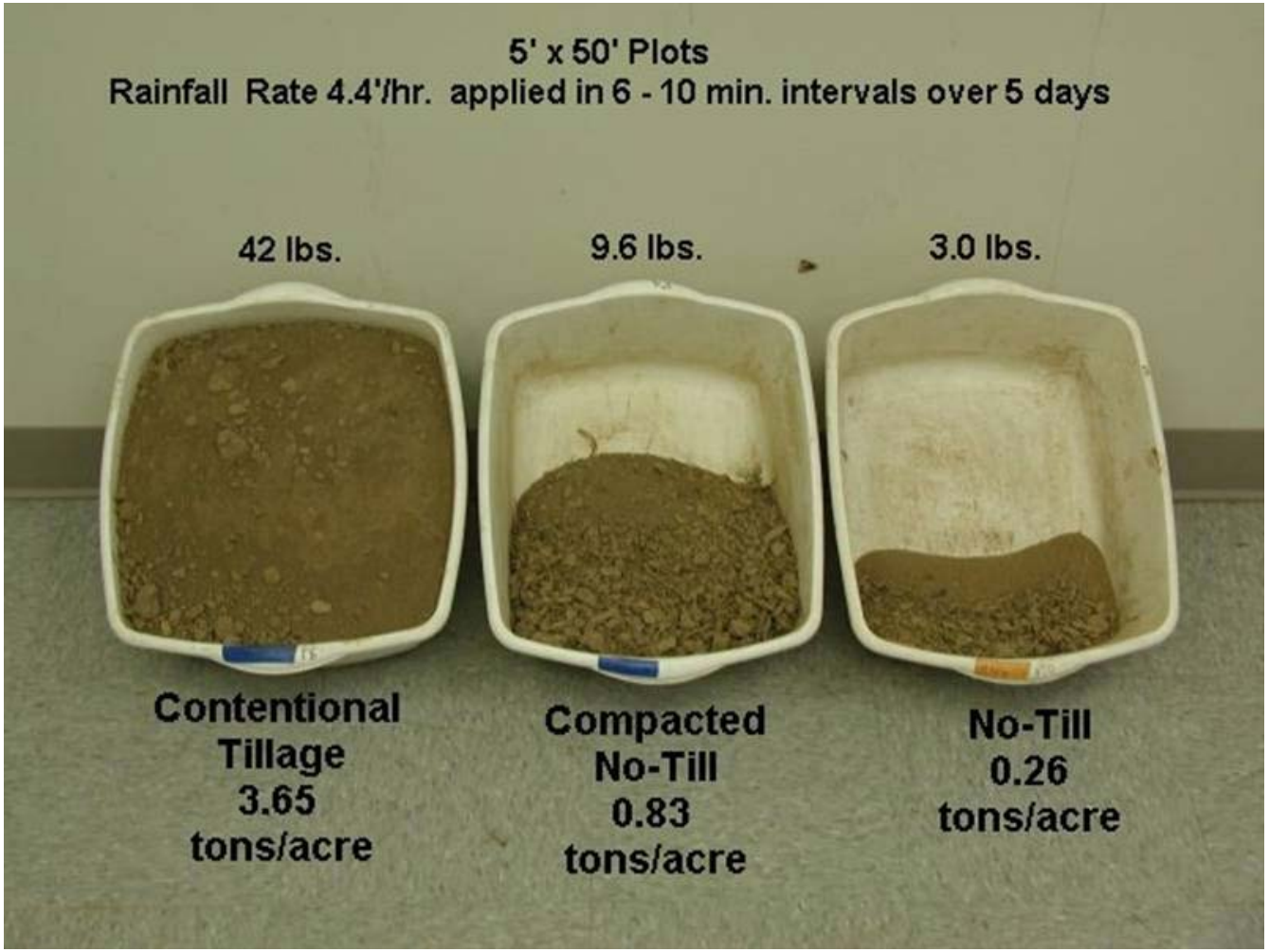


2005 Bradford runoff experiment

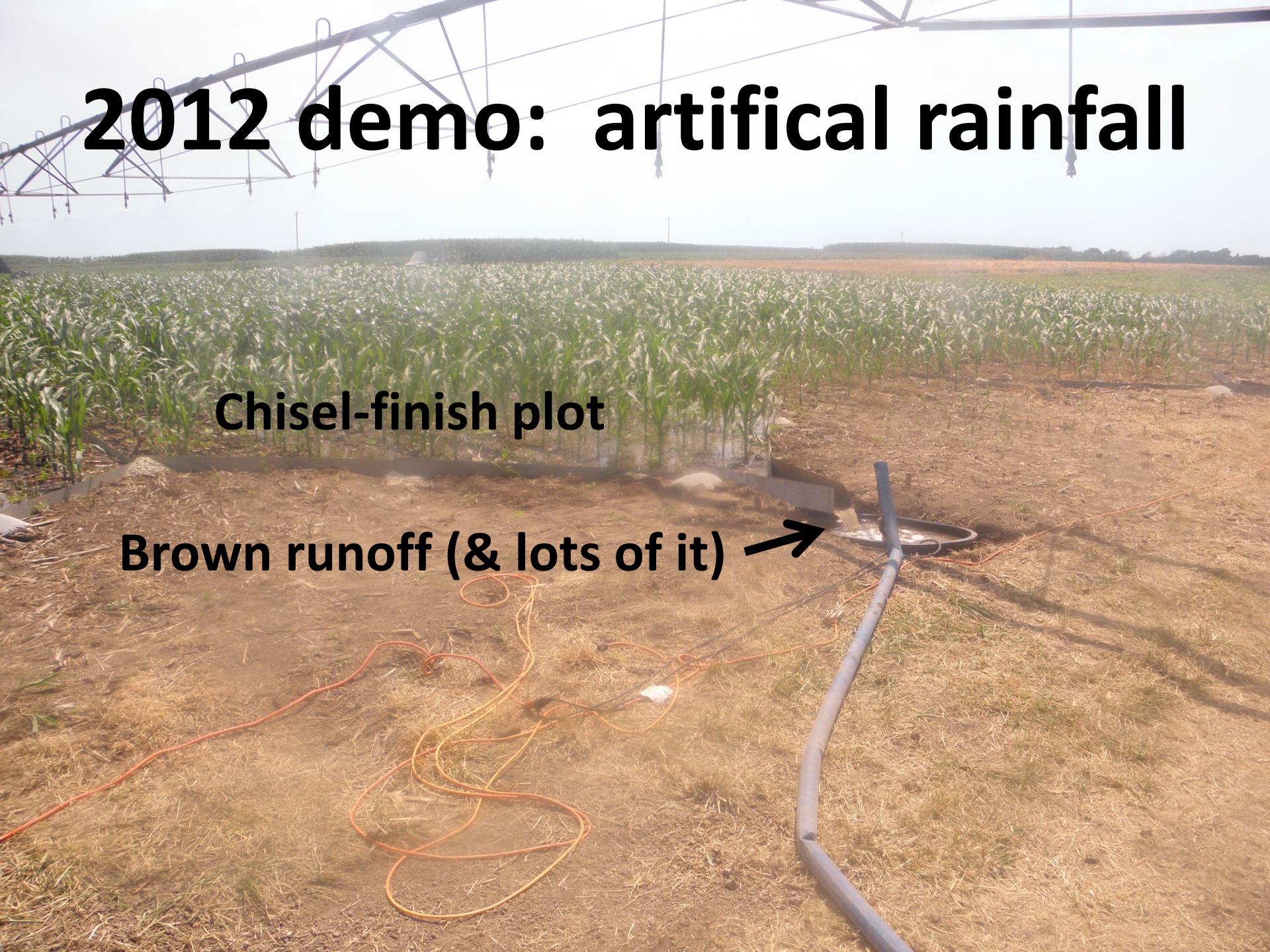


Effect of tillage (& compaction) on erosion

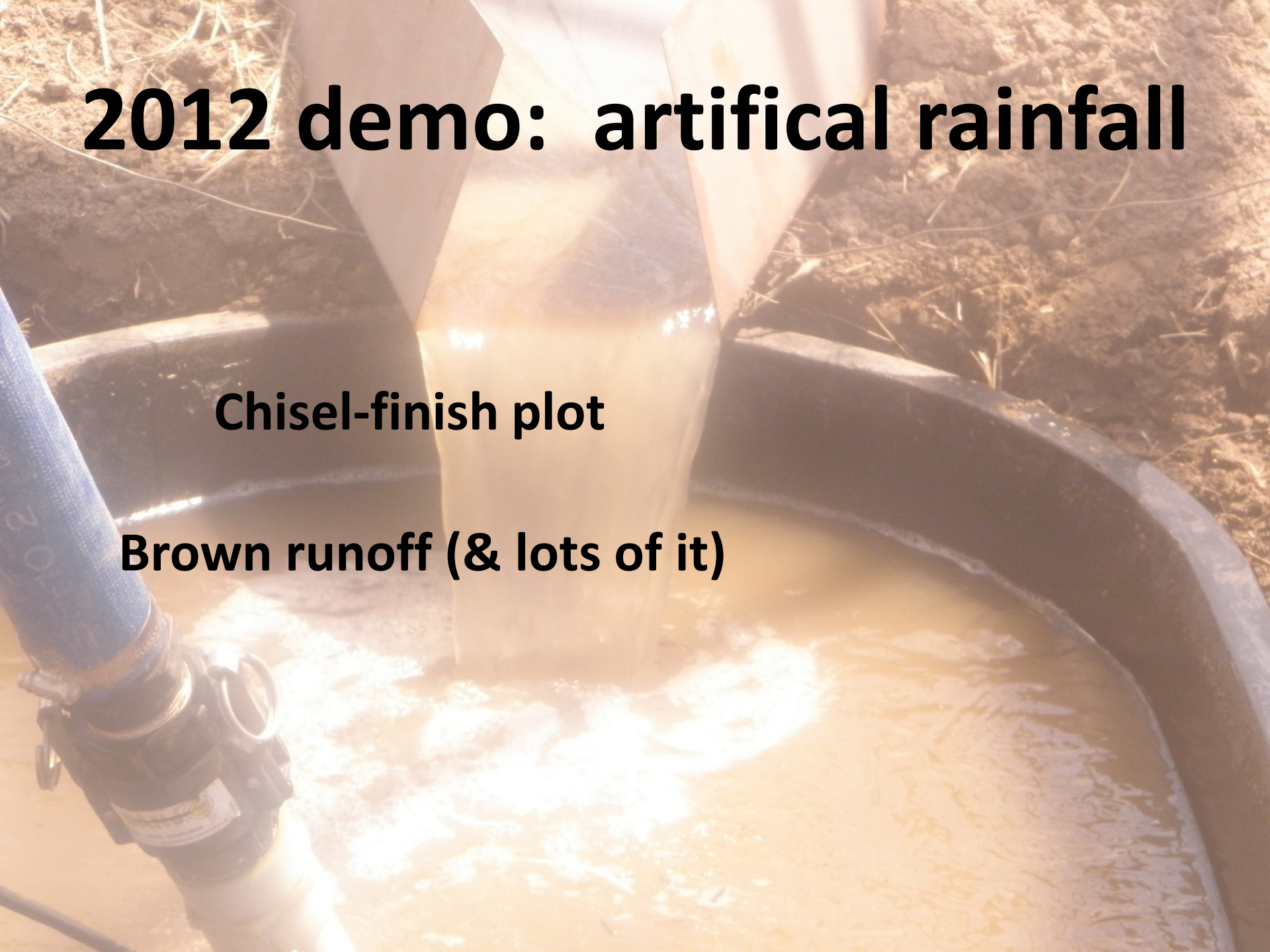
- From 2006 demo plots near Columbia



2012 demo: artifical rainfall



2012 demo: artifical rainfall



Chisel-finish plot

Brown runoff (& lots of it)

2012 demo: artifical rainfall

2012 demo: artifical rainfall

I’m convinced that a cover crop with no-till would have protected this field

Cover crop: cost vs benefit

- Seeding rye: $20/acre/year
- Killing: You'd burn down anyway
- Equals income loss in corn-soybean rotation from losing 1.4" of topsoil in central Missouri
- Long-term economics:
  - Ahead without cover crop until 1.4" of soil is lost
  - How long will that take?
  - After that, the person who cover-cropped makes more money **FOREVER**
- EQIP can provide some subsidy: $38/ac, max $25,000 (650 ac)
- Other benefits: water infiltration, weed suppression


Cereal rye, December 13, 2012

Erosion and the value of topsoil: Summary

- Missouri's soils are naturally erosive
- Soybean residue doesn't give much protection
- We reduced erosion from 1982 to 1992 (terraces, reduced tillage) but not much since then
- Erosion rates in Missouri are still unsustainable—agriculture here will die if we don't improve
- We're contending with more big rains (3+")

Erosion and the value of topsoil: Summary

- Many civilizations have perished because they couldn't feed themselves due to topsoil loss
- Takes a long time
- We've only been farming here for about 150 years
- Farming on the east coast for much longer, and erosion has ruined many areas for farming (or anything else)

Erosion and the value of topsoil: Summary

- Crop residue provides good protection from erosion
- Cover crops provide even better protection
  - I vote for what's cheap, and getting it planted on time
- Topsoil is worth $14/acre/inch **EVERY YEAR**
- It's not that expensive or hard to protect our topsoil so that we can farm forever
- A rye cover crop can be paid for forever by the value of topsoil that can be lost in a single gully-washer