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Gypsum Use in Agriculture: Impact on the Environment

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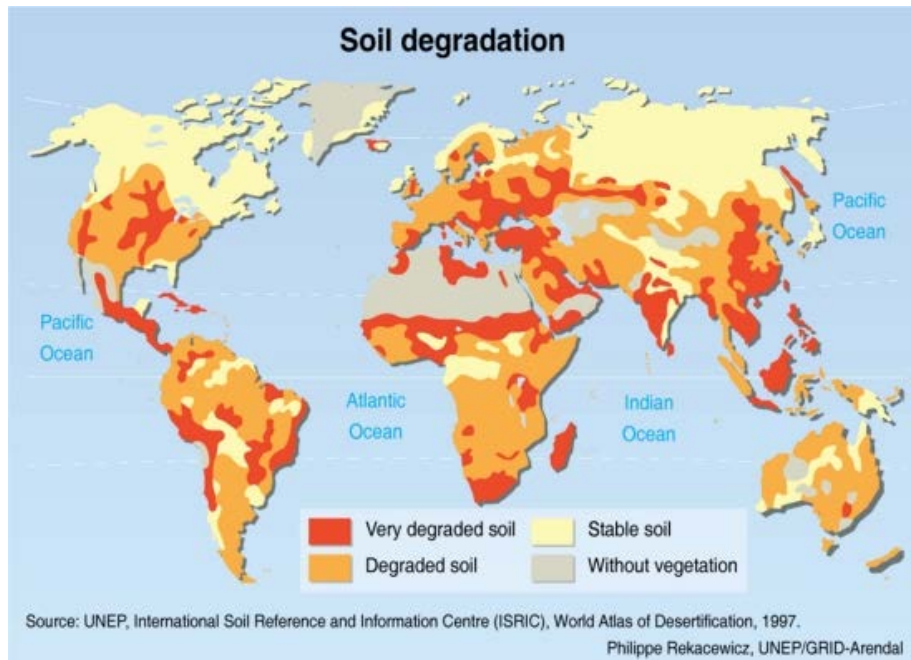
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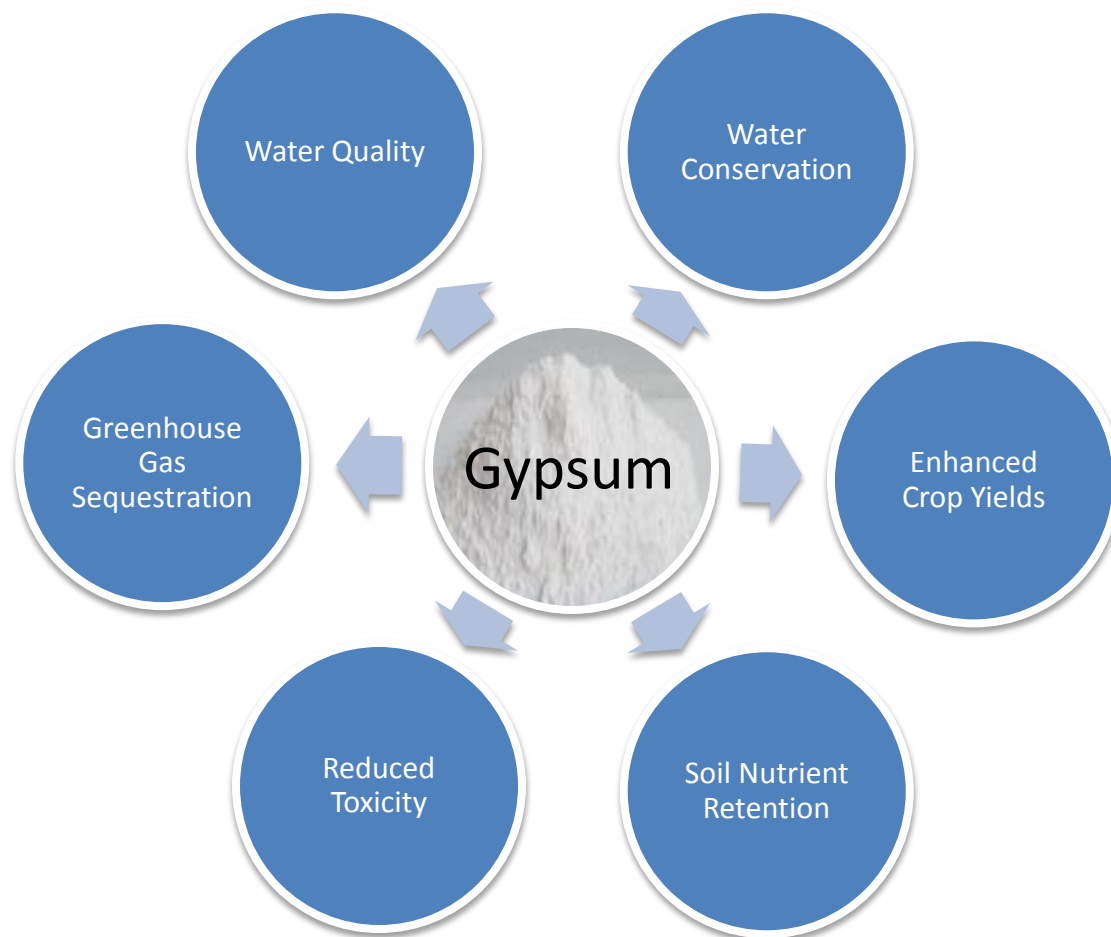
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Global Environmental Stresses: Soil Degradation

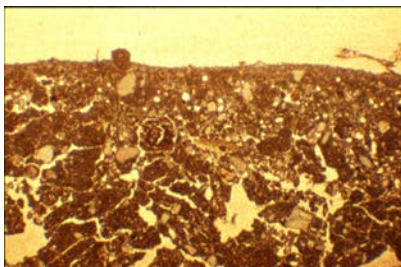


- Depleted soils threaten economies and human health
- Water and food security issues
- 23% of global disease attributable to environment
- 13 million annual deaths from environmental causes can be prevented (WHO)

Environmental Benefits of Gypsum

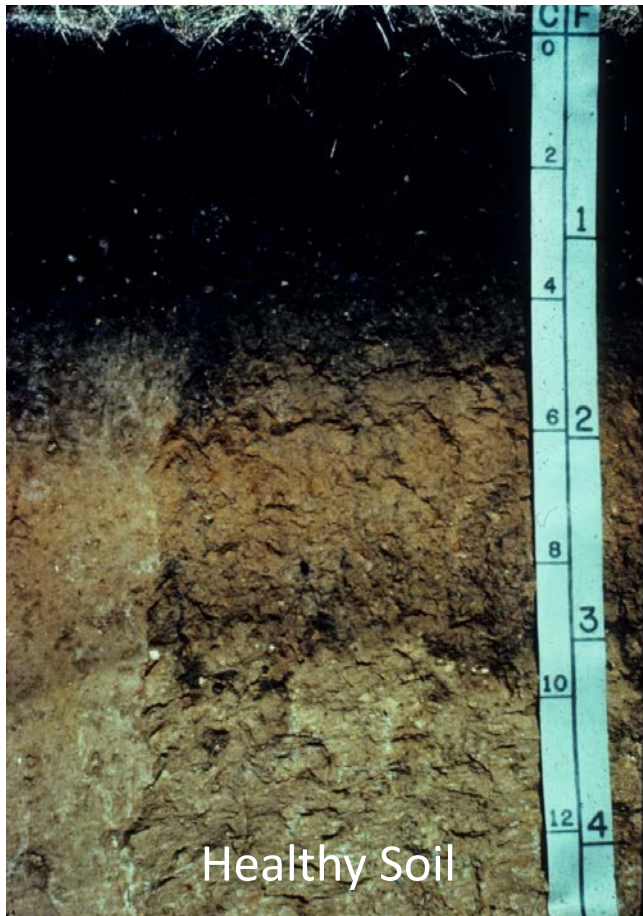


Surface Sealing inhibits penetration of water and oxygen into soils



- Rainwater: Naturally distilled and low in electrolytes
- Physical and chemical processes occur at raindrop impact
- These processes lead to surface sealing

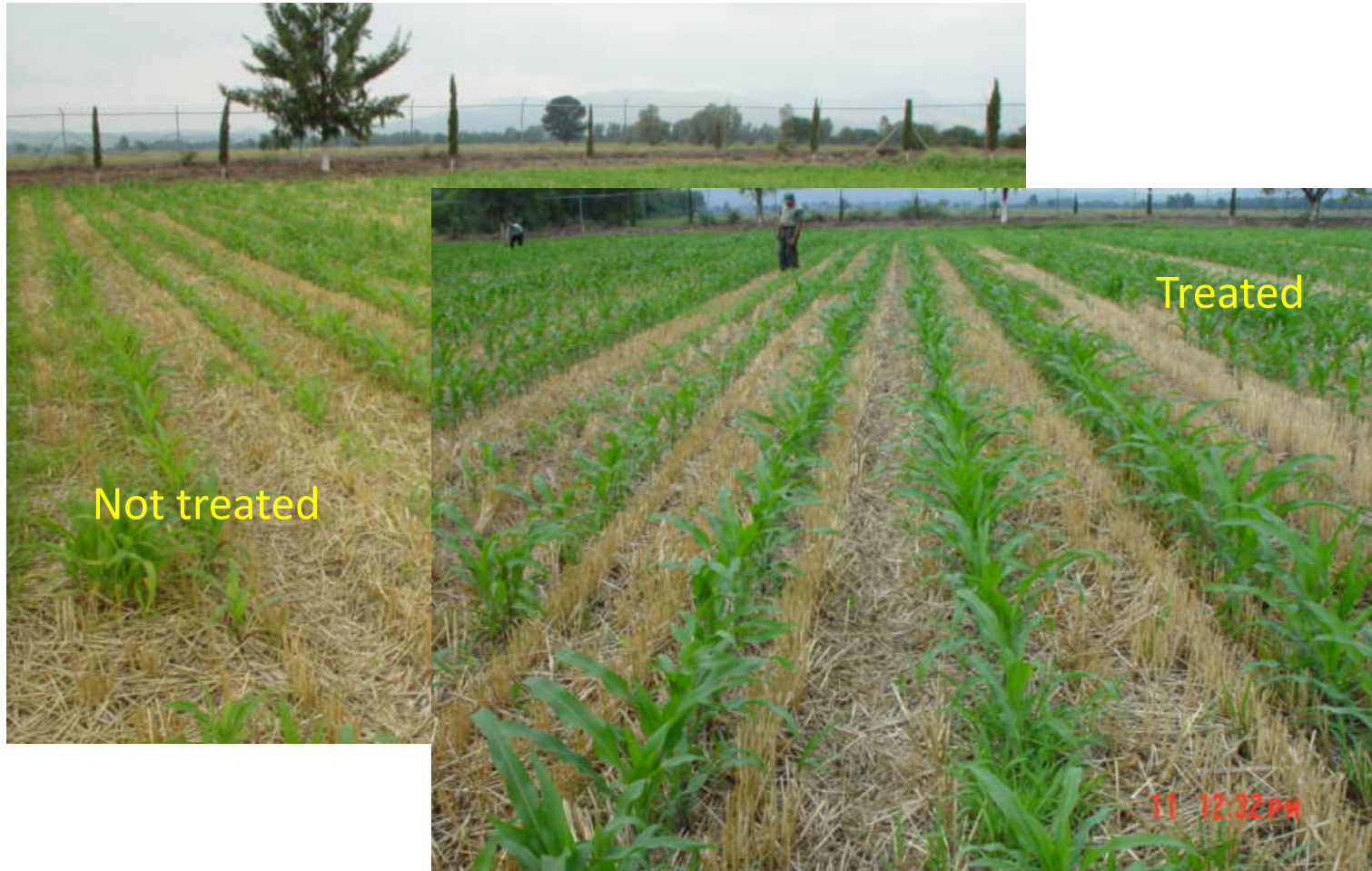
Many Soils Are Degraded



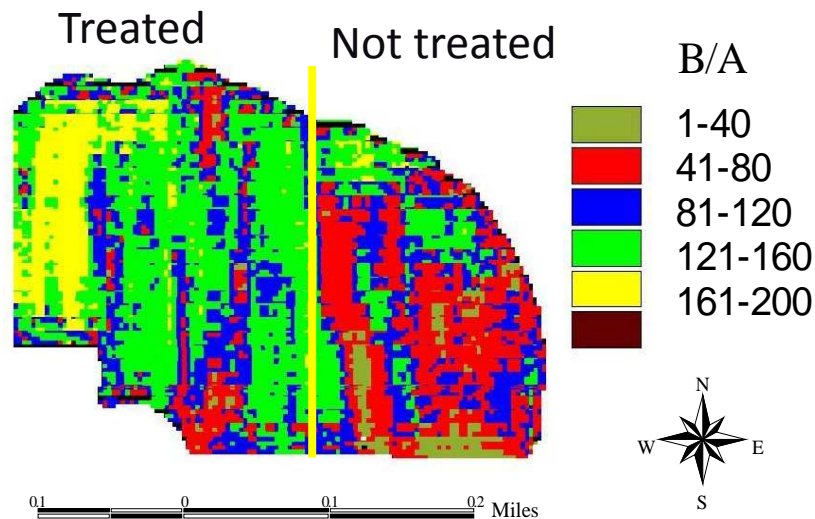
Effect of Degradation by Erosion on Crop Productivity



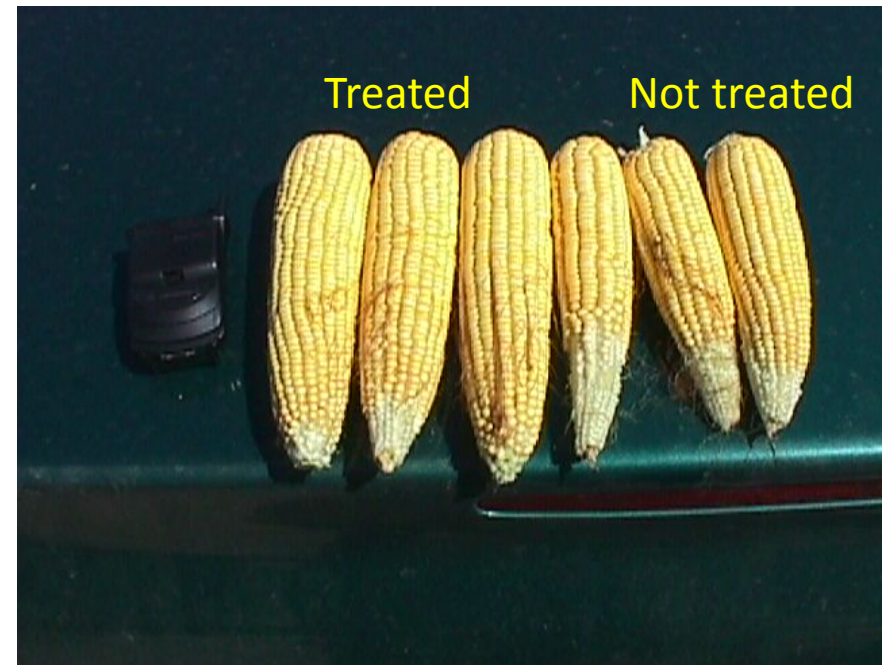
Soil Nutrient Retention: Seedling Emergence Improves With Gypsum



Soil Nutrient Retention: Agricultural Yields Increased with Gypsum Treatment



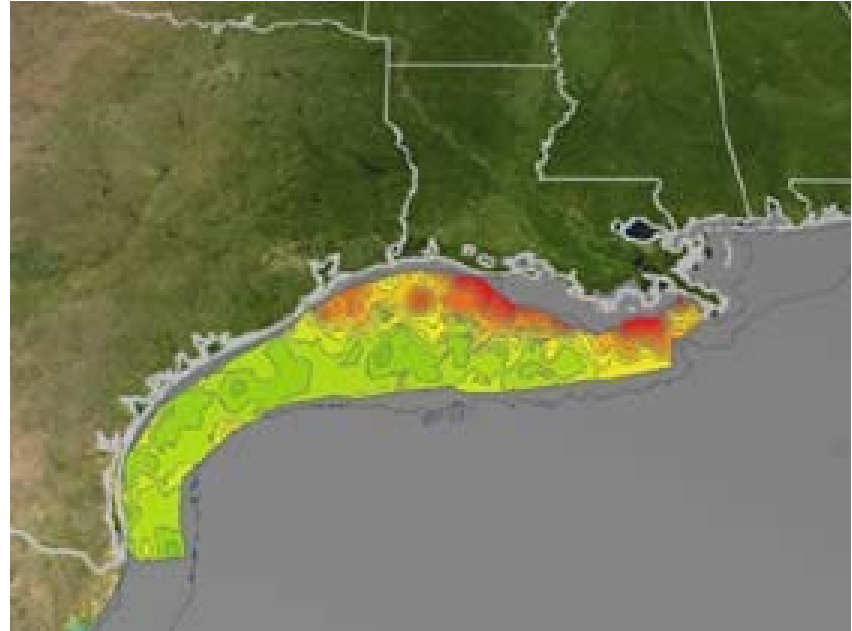
Corn Yields, 1 T/A Gypsum (1997)



Nutrient Loading Contributes to Hypoxic And Anoxic Zones



Hypoxic zones in the Great Lakes



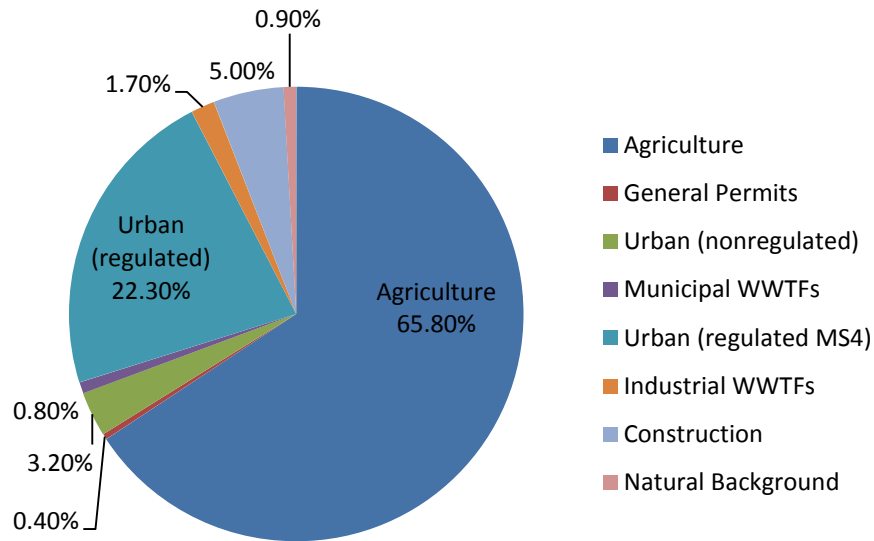
Dead zone: Gulf of Mexico
(Approximately the size of New Jersey)

Sediment Loading from Maumee River Basin to Western Lake Erie

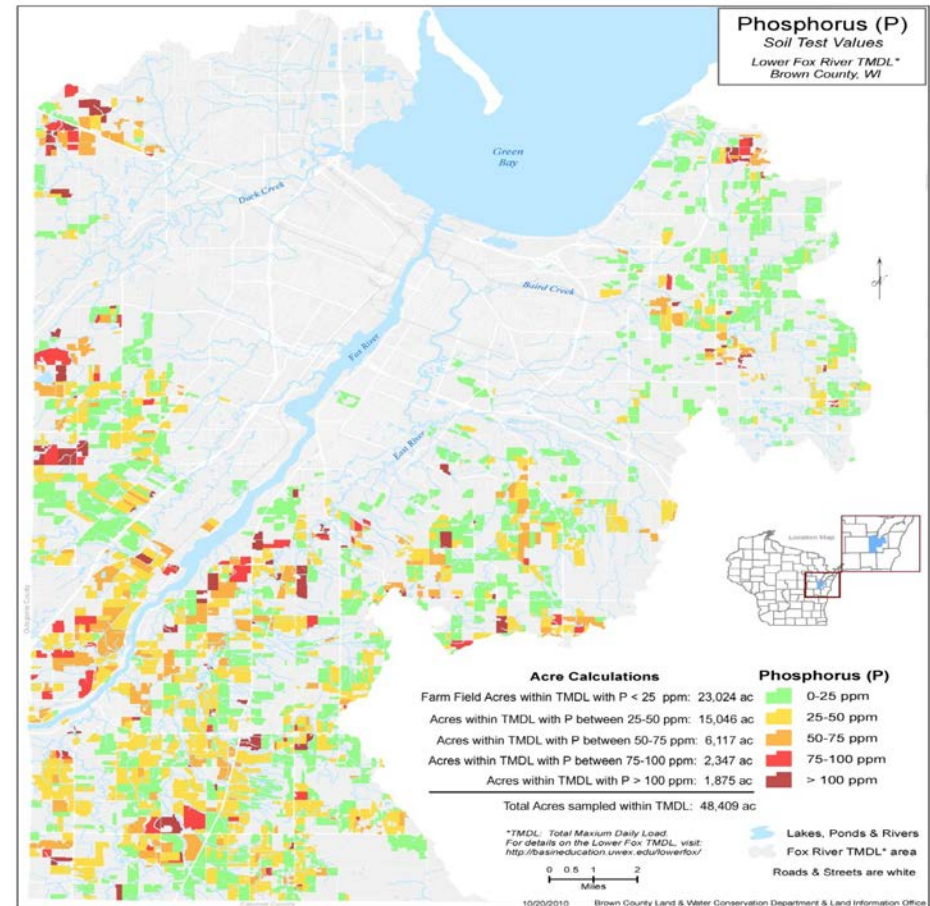


Friday, March
13, 2009
3 Days After
Storm

Sediment Loading from Lower Fox River Watershed into Green Bay



Sources of baseline TSS loading in the LFR Basin. *The Cadmus Group*



Nutrient Runoff Causes Algae Blooms



Don't Be Depressed

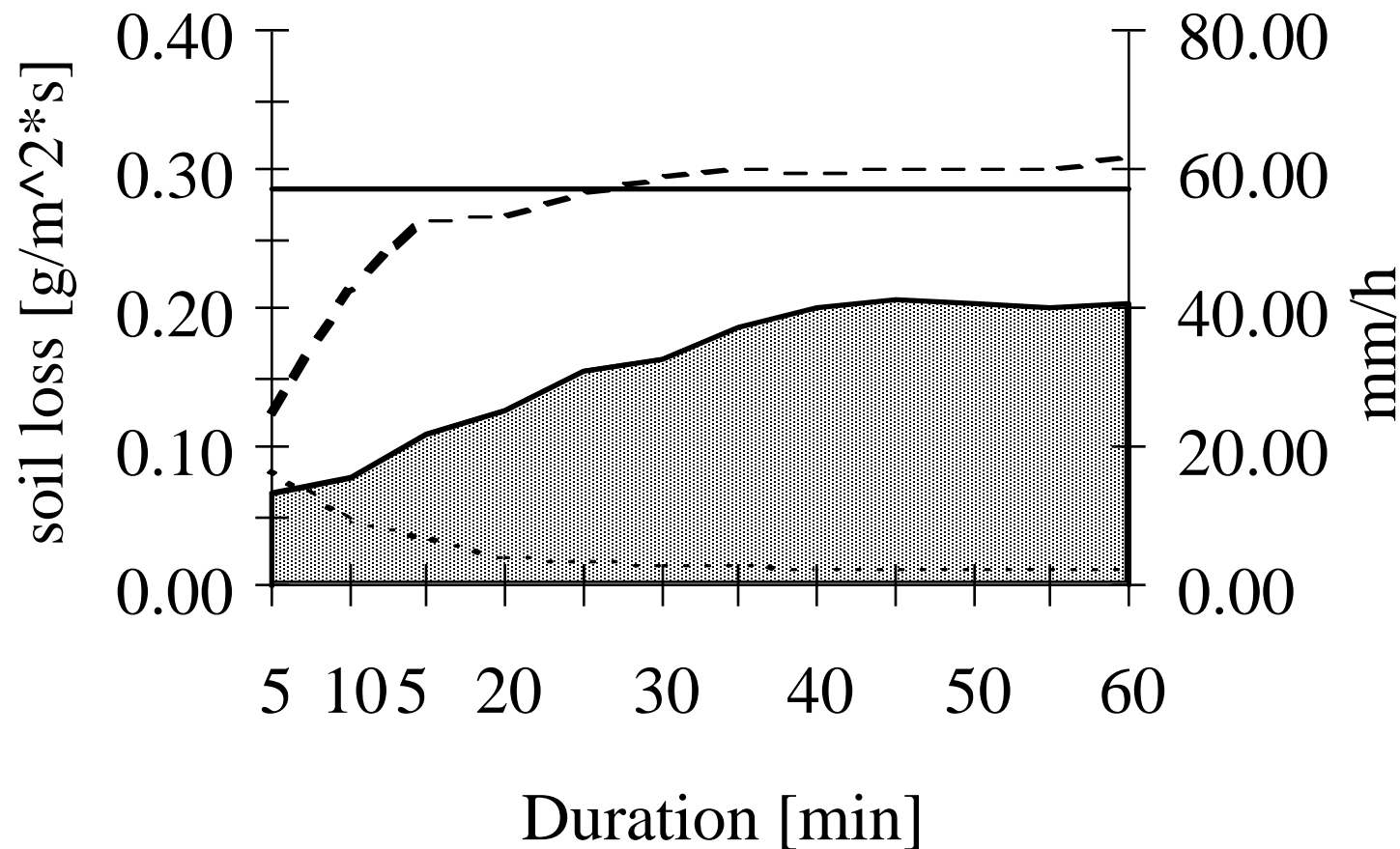
We Can Do Something About Erosion And Runoff



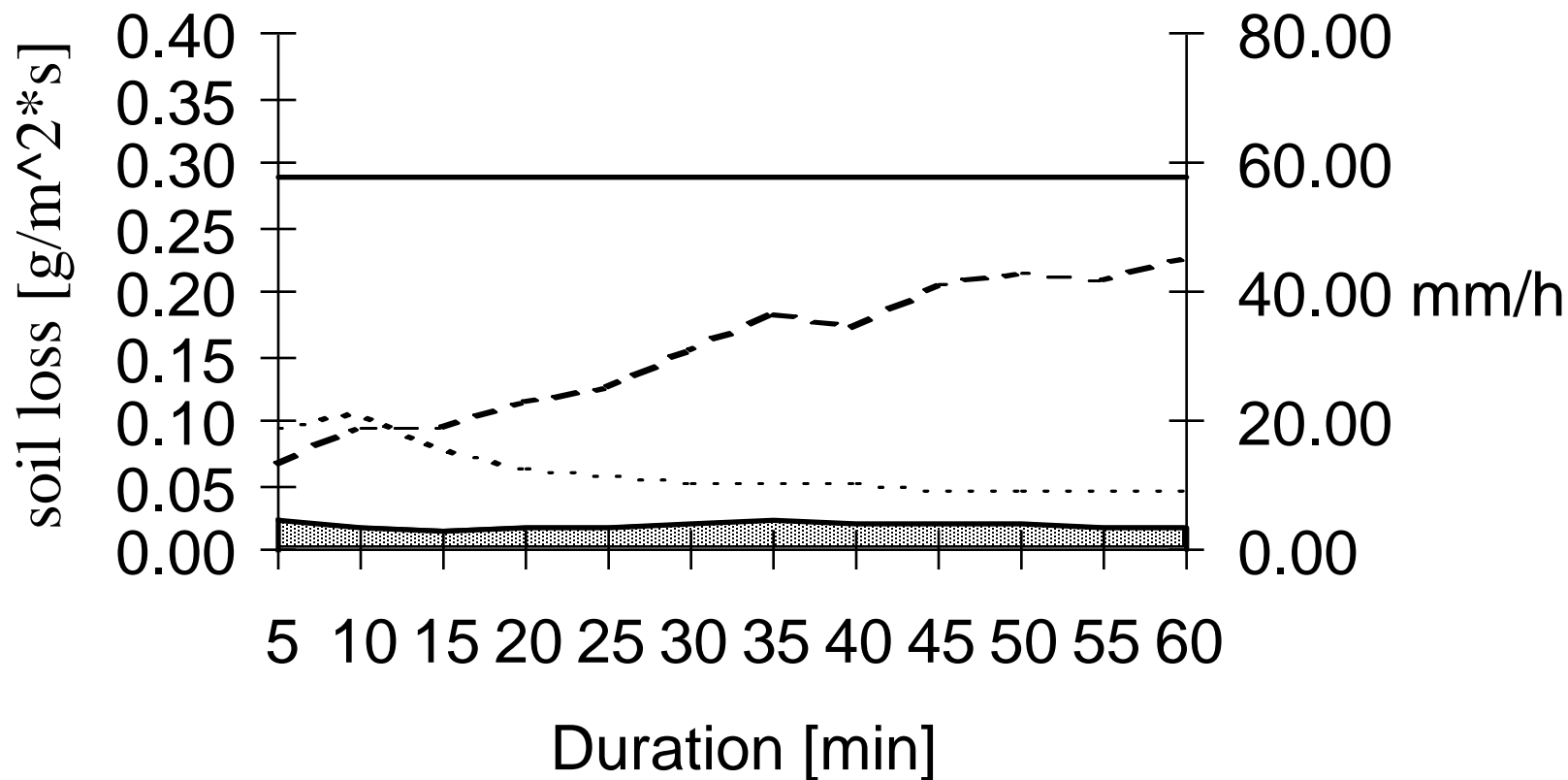
Gypsum Reduces Detachment of Sediment and Loss to Runoff



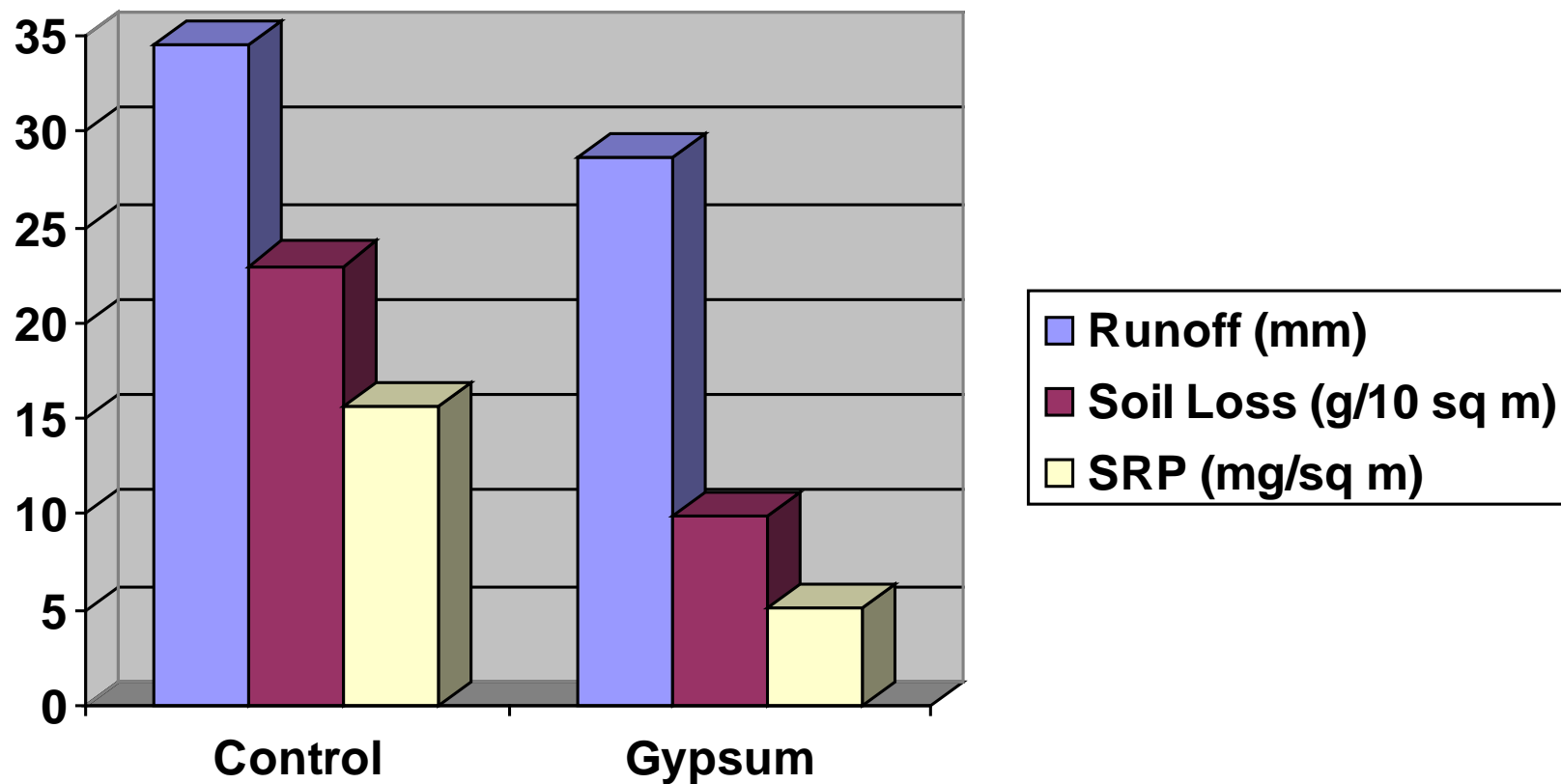
Runoff Pace without treatment



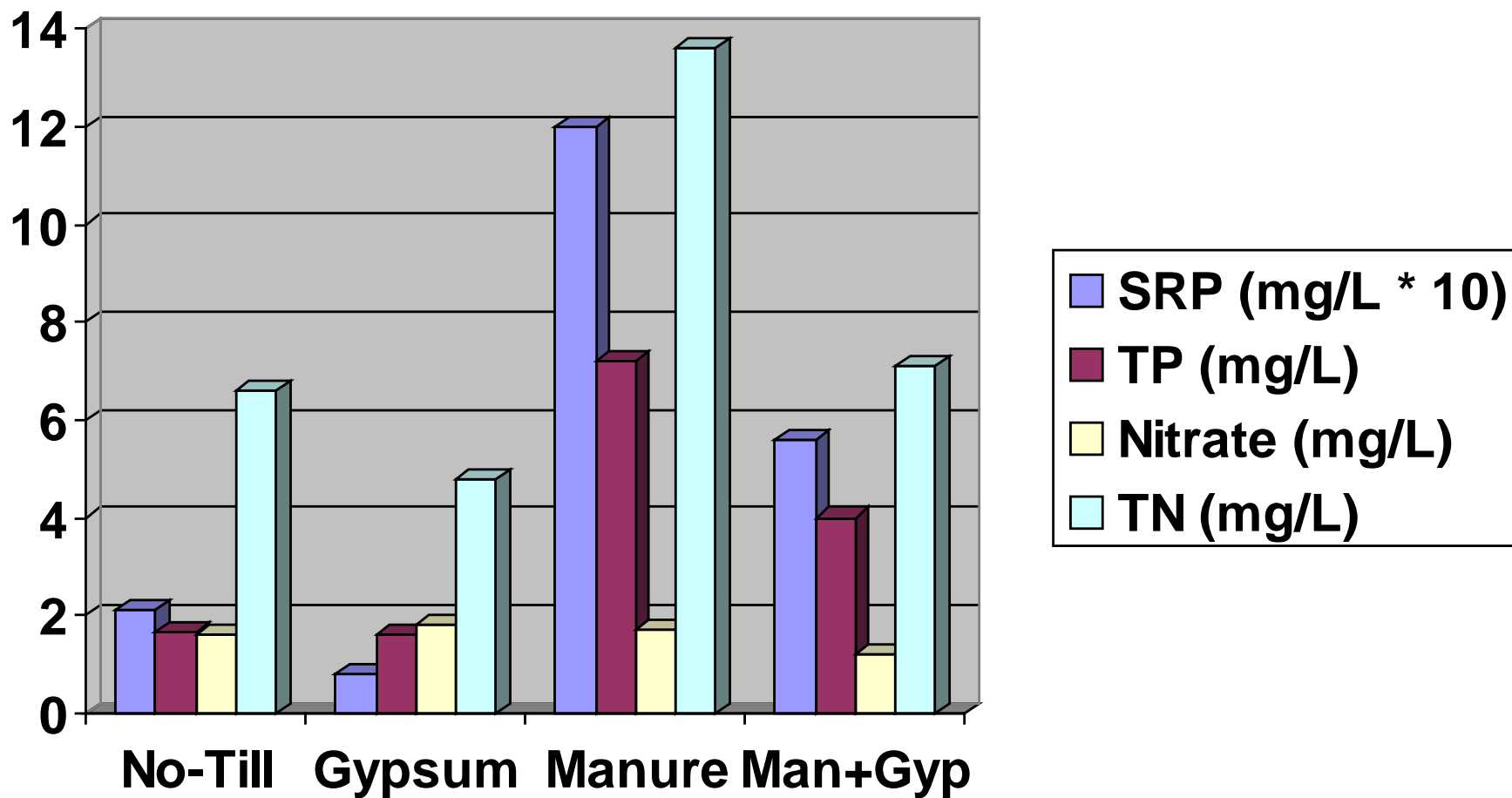
Runoff Pace with treatment (PAM+FBCBA)



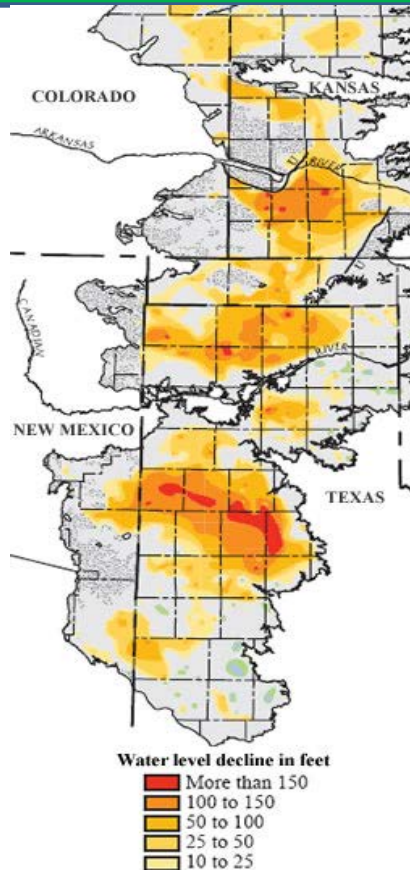
Effect of Gypsum on Runoff and Soil Loss



Gypsum Effect On N And P In Manure Rich Soils



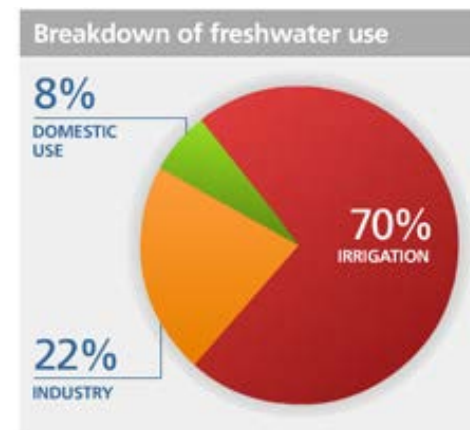
Water Quantity Depletion



Water Level Decline in
The Ogallala Aquifer

“Water is the oil of the 21st century”

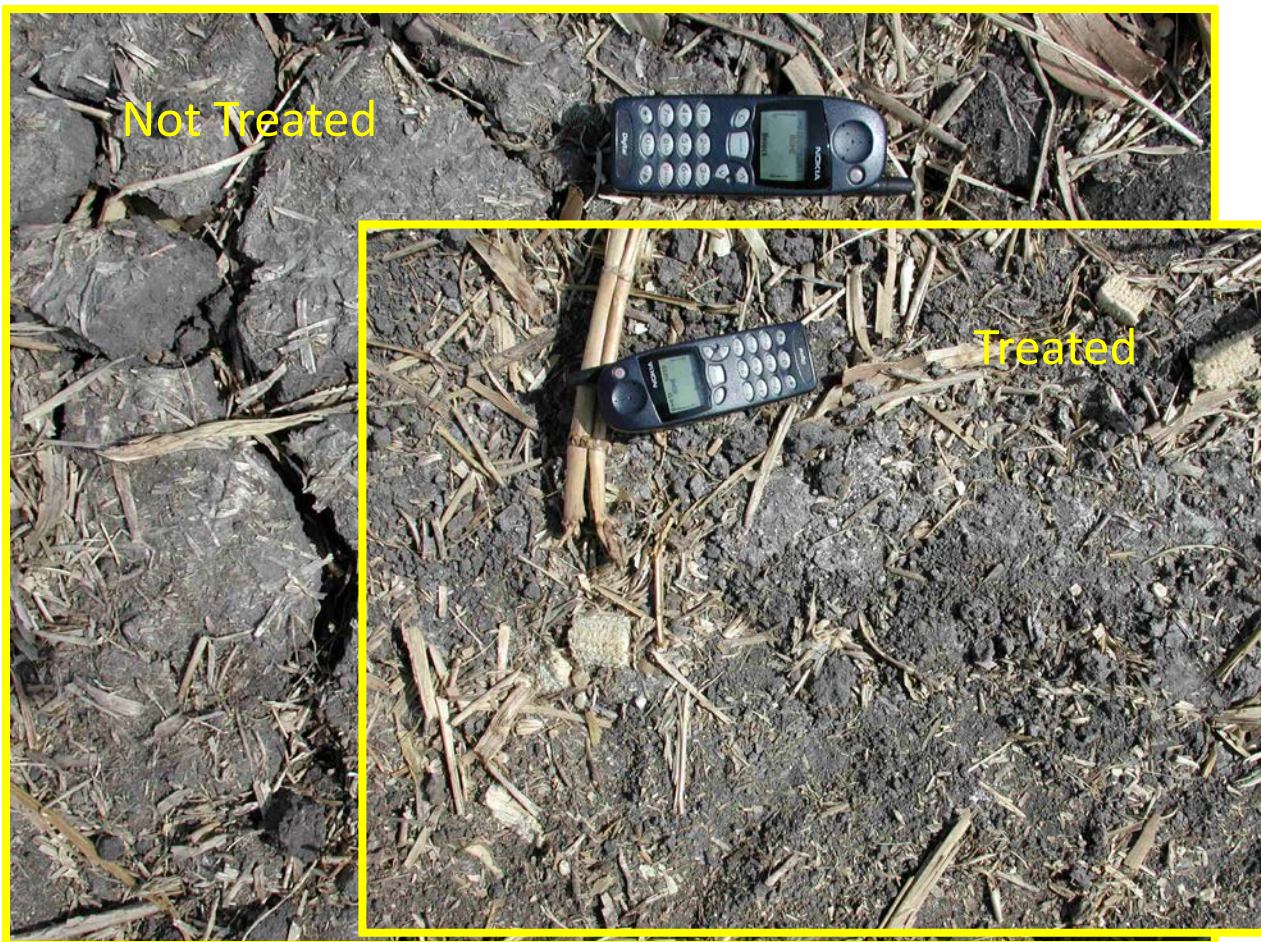
–Andrew Liveris, CEO Dow Chemical



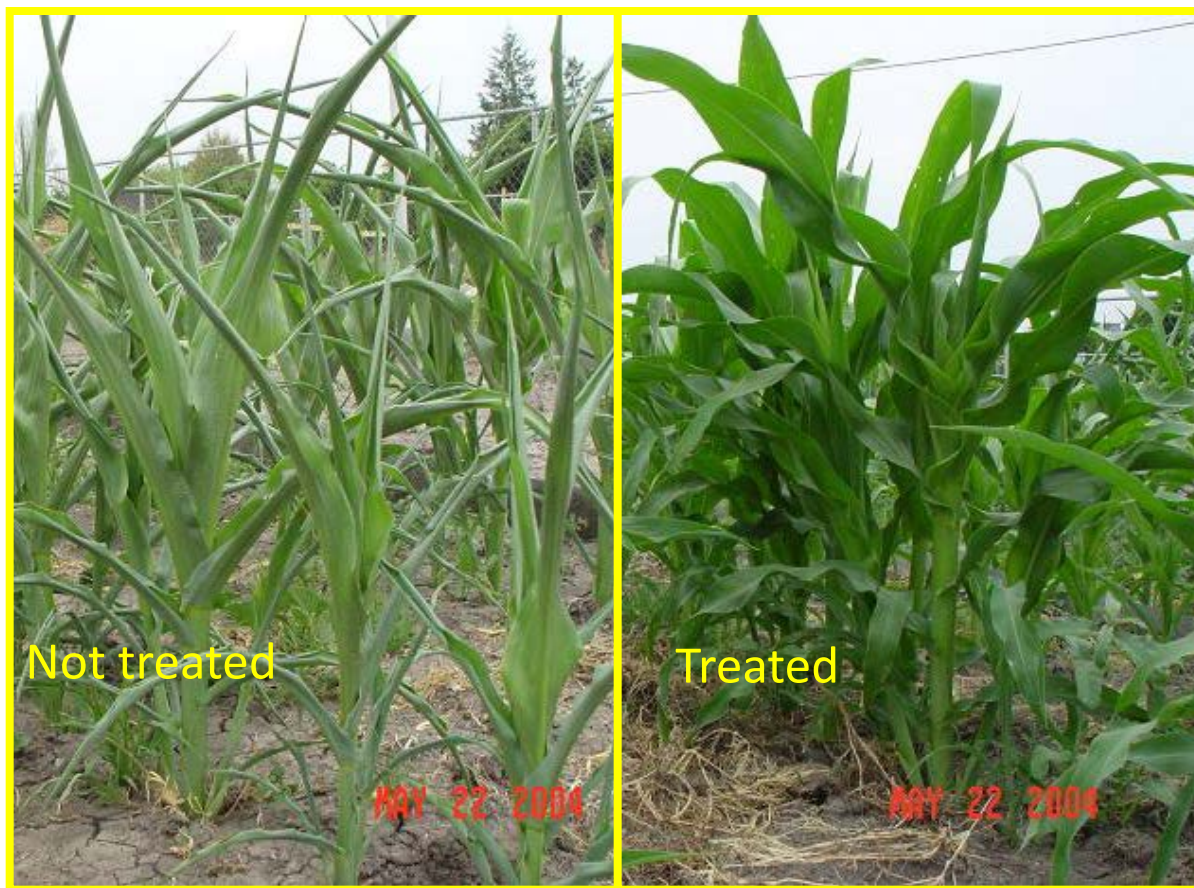
- ◆ Water use of agriculture
 - ~ 70% of water use is for agriculture
- ◆ Water levels are falling worldwide
 - Ogallala Aquifer water levels drop 150 feet
 - Waukesha Aquifer is 600 feet below original level

Severe Cracking Wastes Water

Gypsum Reduces Cracking



Water Stress Reduced with Gypsum and PAM

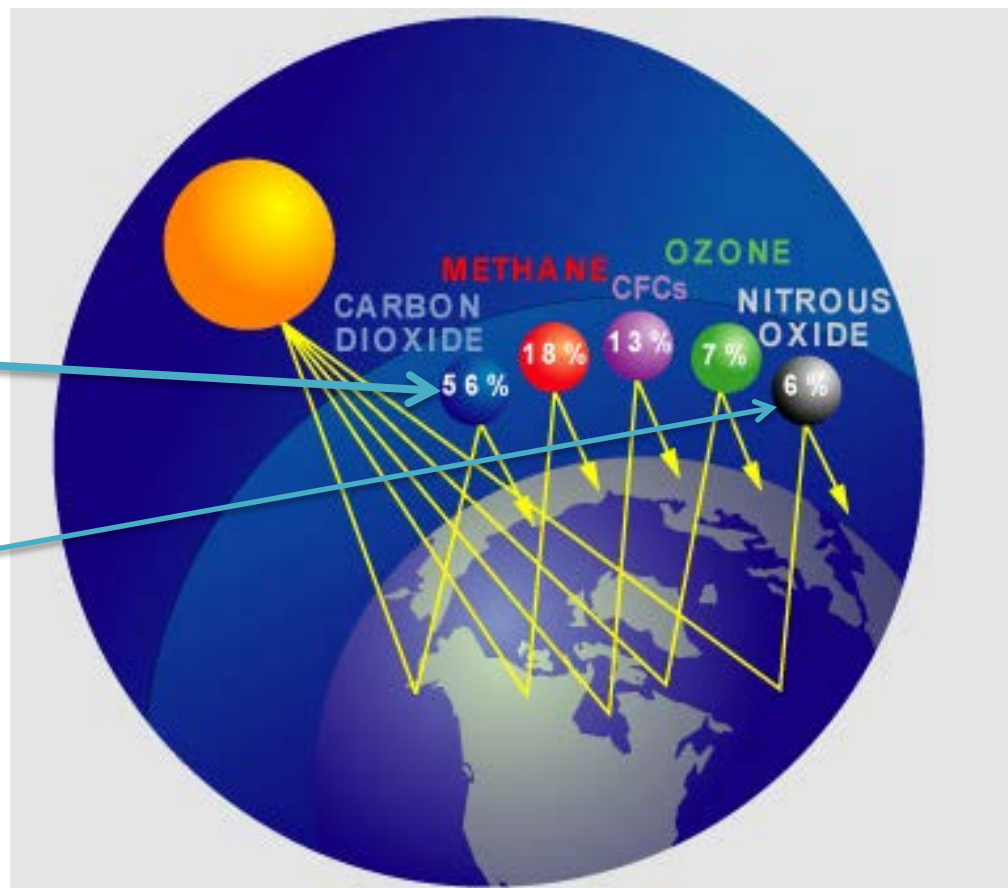


Improved Infiltration/Drainage By Amending Soil with Gypsum



Degraded Soils Increase Greenhouse Gases

- Greenhouse gases contribute to climate change
- Nitrogen-based fertilizers are energy intensive
- Damaged soils process less nitrous oxide - (NO₂ traps 310 times more heat than CO₂)



Marian Koshland Science Museum of the Natural Academy of Sciences

Improved Nitrogen Efficiency

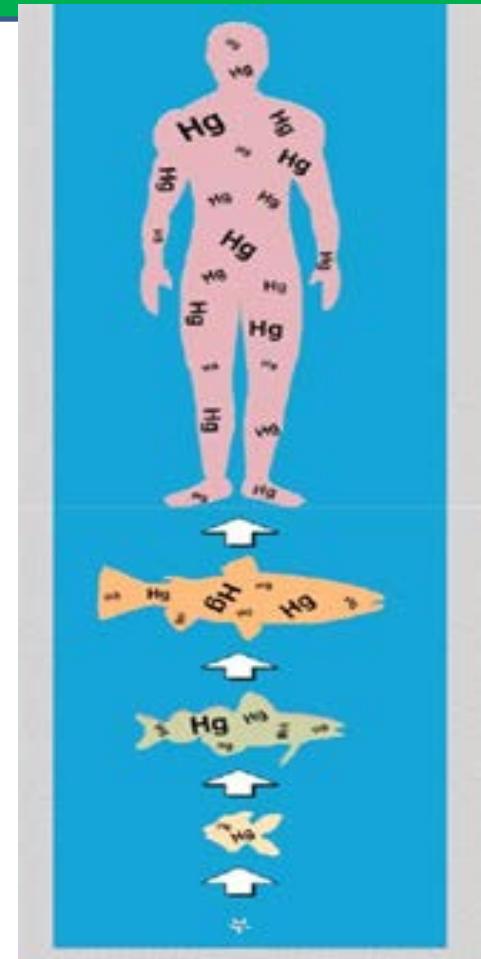
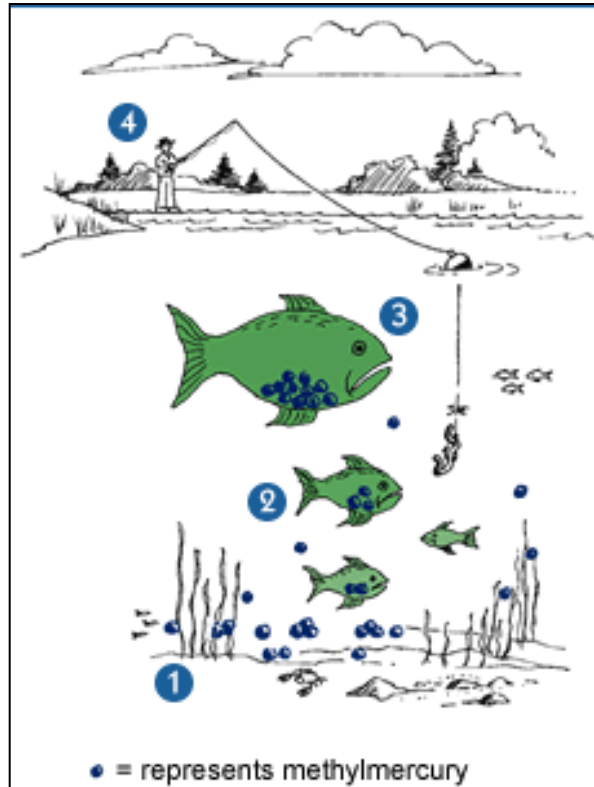


Increased Root Mass

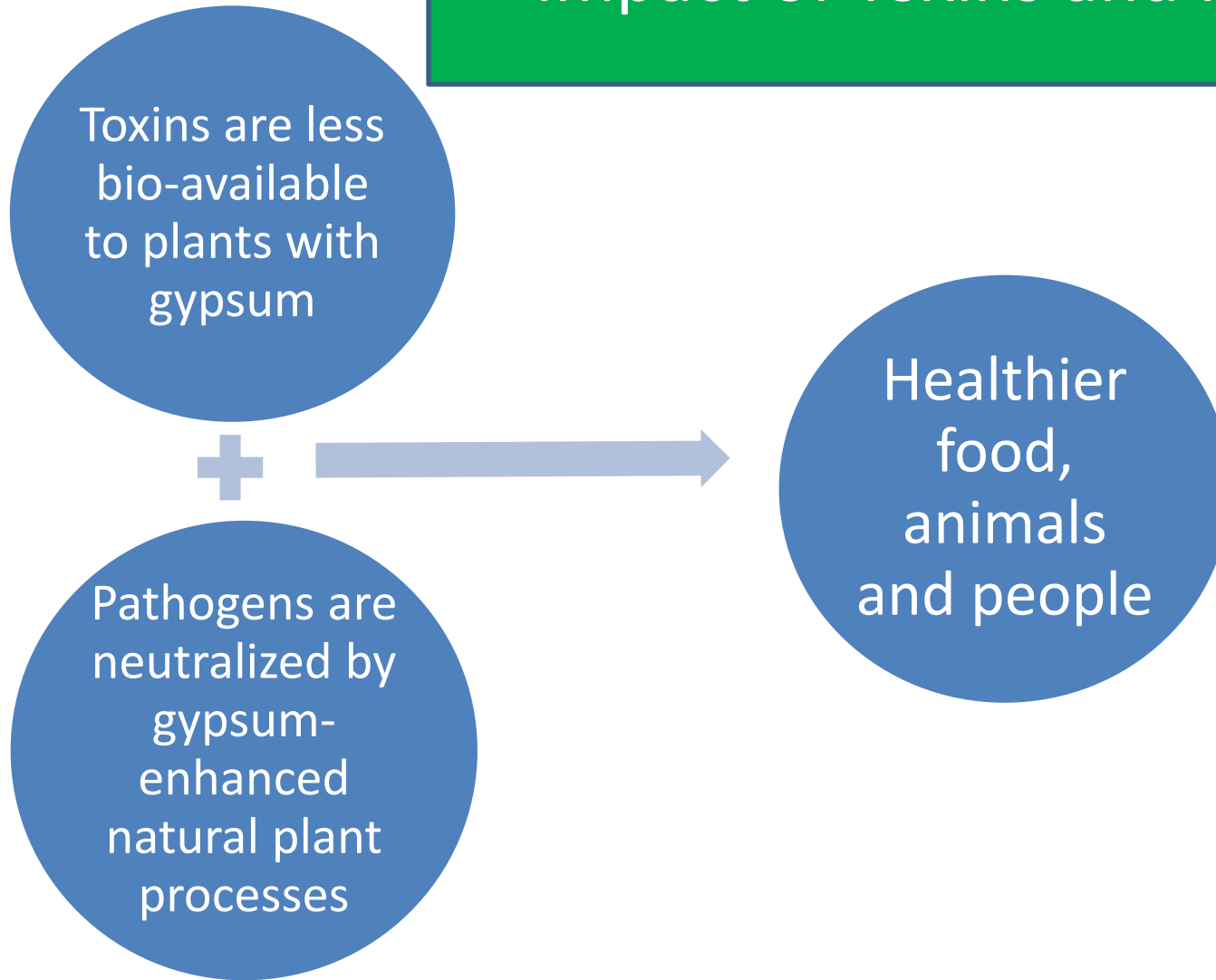


Natural Toxins and Pathogens Are Present in Soil

- Natural toxins and pathogens occur in geology and soils
 - Mercury
 - Arsenic
- Bioaccumulation threatens humans



Gypsum Treatment Reduces the Impact of Toxins and Pathogens



RCRA Total Elements in Materials Added (USEPA 3051)

Material	As	Ba	Cd	Cr	Hg	Pb	Se
	ppm	ppm	ppm	ppm	ppm	ppm	ppm
FGD #1	<1.3	22.2	0.39	7.2	0.1635	<0.77	3.5
FGD #3	1.4	20.4	0.55	6.8	0.2320	<0.77	<2.3
Mined Gypsum	<1.3	46.6	0.11	2.2	0.0001	<0.77	<2.3
Soil	9.4	170.8	1.47	30.3	0.0261	16.06	3.5

Gypsum Does Not Increase Mercury Levels in Shallow Groundwater

Date	Rate (lbs)	Product	ppt
			Hg
7/18/2008	2000	FGD	17.09
7/23/2008	2000	FGD	19.54
7/18/2008	0	None	28.37
7/23/2008	0	None	67.98
7/18/2008	2000	Mined	65.32
7/23/2008	2000	Mined	18.96

Mercury Uptake in Corn Shoots After Six Weeks with and without a Perched Water Table

Drainage	Treatment	Hg ppb	
Freely Drained	Control	4.57	a
	FGD Gypsum	3.75	a
	Glyphosate	6.43	a
	FGD Gyp.+Glyph.	4.13	a
Perched water table (- 5cm)	Control	55.92	b
	FGD Gypsum	61.88	b
	Glyphosate	61.98	b
	FGD Gyp.+Glyph.	64.54	b

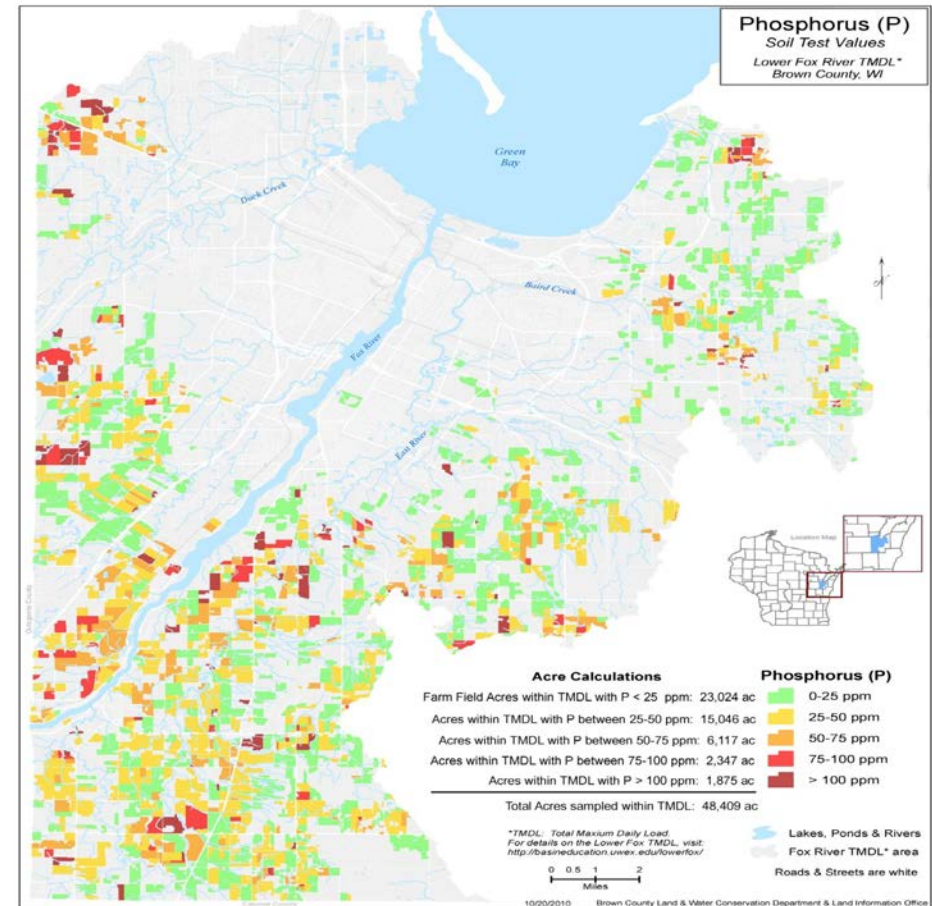
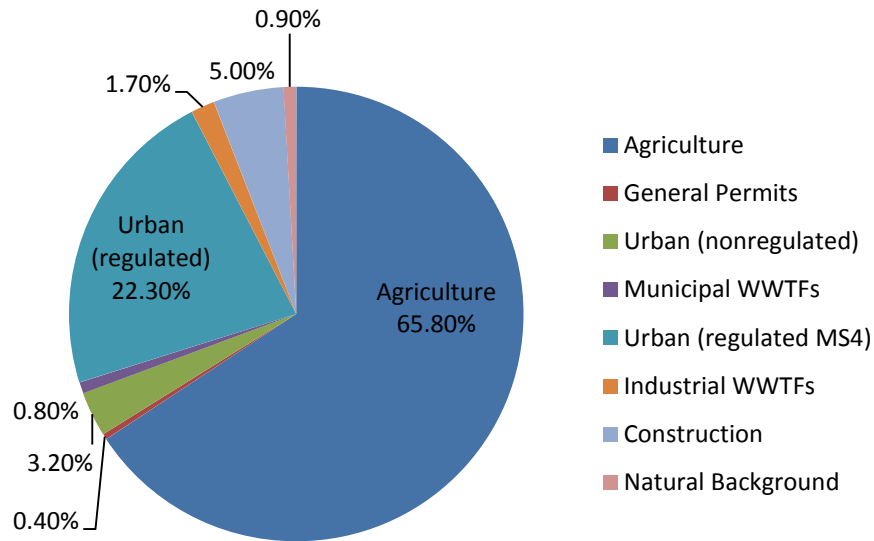
Ecosystem Markets can provide Monetary Incentives for Farmers

- Markets support improved agricultural land management
 - Water quality (nutrient trading e.g. Chesapeake's Bay Bank)
 - Watershed conservation
Williamette Partnership -
Ecosystem Credit A/C Systems
 - Climate change mitigation (carbon offsets)
 - Food safety and nutrition



Some landowners in Oregon are paid to enhance salmon habitat

Can a Nutrient Trading Scheme help reduce Sediment Loading from Lower Fox into Green Bay ?



Conclusion

Gypsum's Environment Contributions are many

Greater
agricultural
yields and
healthier
soils

Healthier
food

Reduced
greenhouse
gas
emissions

Use of less
water and
fertilizers

Cleaner
water

The Presenters Thank You for Listening Questions?

