Kansas Department of Health and Environment

2013 works!

Recycling FGD Gypsum for Agricultural Use

GYPSOIL™ BRAND GYPSUM

Beneficial Reuse Management

Beneficial Reuse Management

GYPSOIL™
BRAND GYPSUM

Beneficial Reuse Management

- Founded in 1999, headquartered in Chicago
- Develops markets for non-hazardous, reusable waste steams from industrial companies and utilities
- Two divisions:
  - BRM Division uses byproducts as geotechnical fill for construction projects
  - Gypsoil Division markets byproduct gypsum to the farming community as a crop nutrient and soil amendment

Environmentally Friendly Reuse Solutions

Reusable Waste Streams

- Foundry Sand
- Coal Combustion By-Products
- Paper Mill Residuals
- FGD Gypsum
- Construction & Demolition Waste
- Bio-Solids
- Dredged Materials
- Other Manufacturing By-Products

Beneficial Reuse Management

Capabilities:

- Materials Technology
- Regulatory Expertise
- Project Management
- Market Knowledge & Insight

Process:

- Opportunity Assessment
- Reuse Program Design
- Program Management
- Materials Marketing
- Materials Transformation

User Markets

Construction

- Geotechnical Fills
- Building Materials

Agriculture

- Soil Amendment
- Soil Nutrients

Materials Supply

- Manufactured Soils

Consumer

- Lawn & Garden

Renewable Energy

- BioEnergy

Since 1999, Beneficial Reuse Management has implemented new programs and projects that have diverted more than 5 million tons of industrial byproducts from landfills.

Beneficial Use Partners

waupaca

we

Duke Energy

VECTREN

JEA Building Community

City Water Light and Power Springfield, IL

International

ipl an AES company

Public Service A WPS Resources Company

FirstEnergy

Westar Energy

Xcel Energy

Citation Innovative Metal Components

Brillion Iron Works

Southern Illinois Power Cooperative

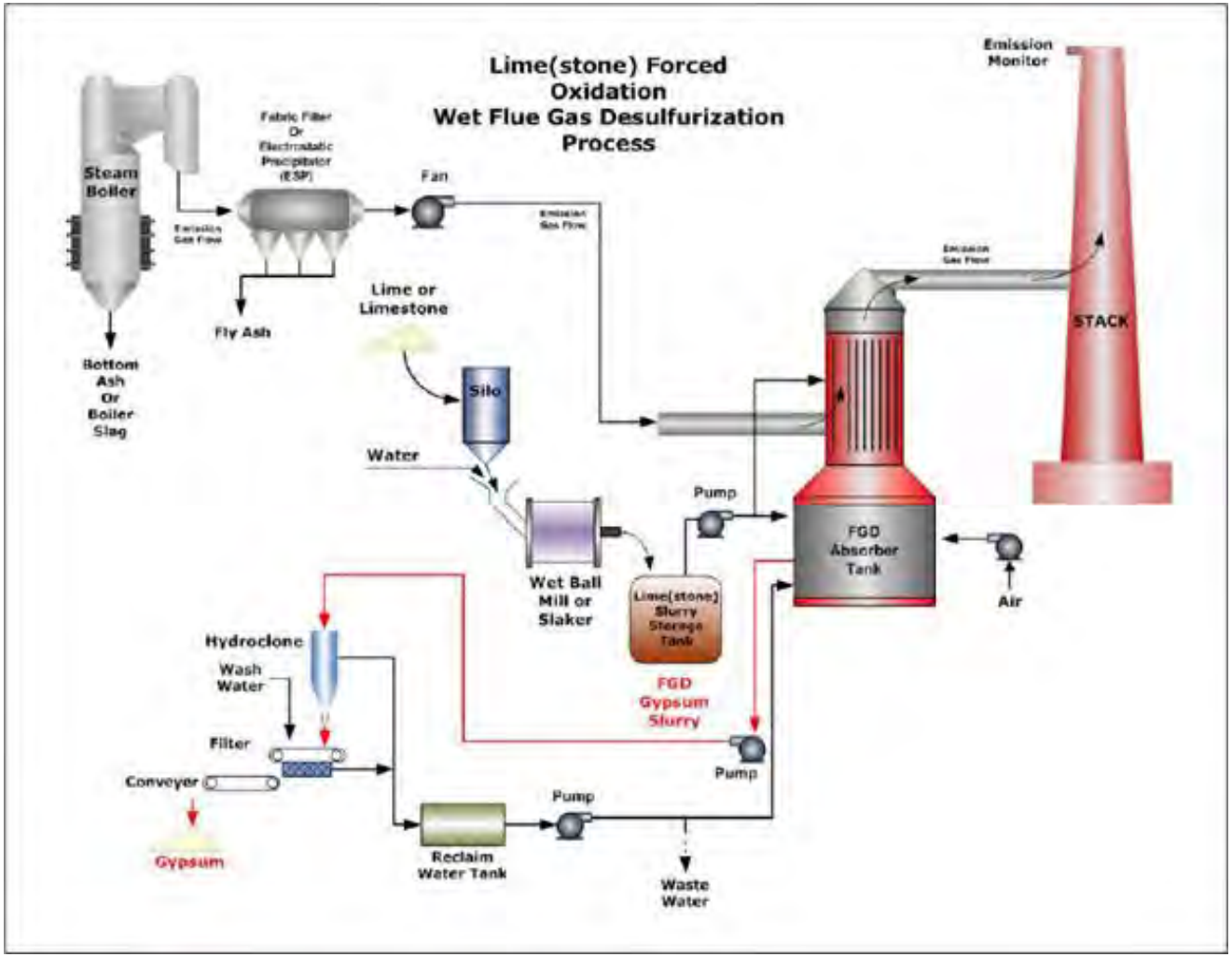
Temple-Inland

ADM

Flue Gas Desulfurization and the Creation of FGD Gypsum

GYPSOIL
BRAND GYPSUM

FGD Gypsum Process



Jeffrey Energy Center– St. Marys Kansas

Westar-Jeffrey Energy Center Gypsum Stackout Pile

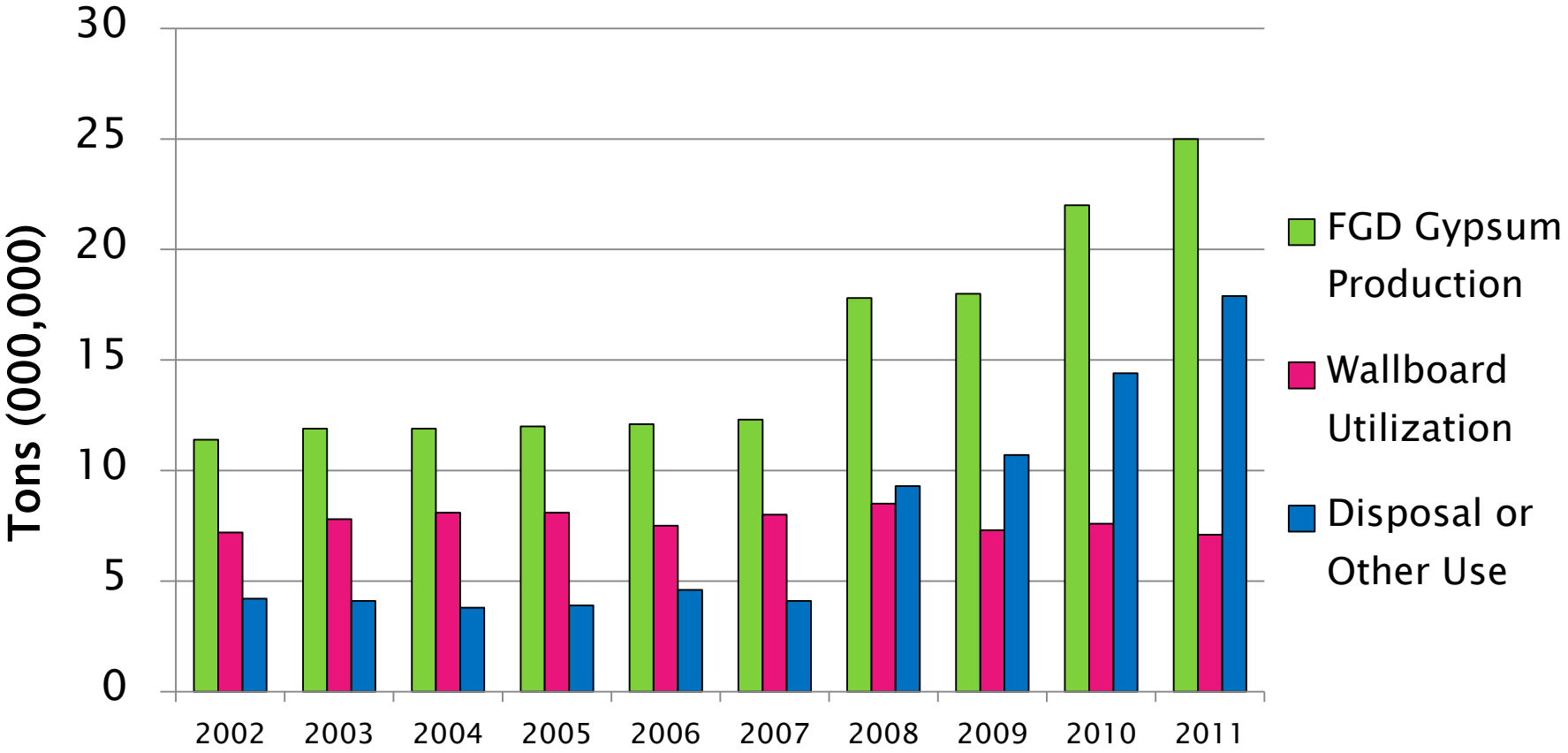
Power Plants with Existing or Planned FGD Gypsum Scrubbers

Opportunities for Gypsum in Agriculture

Agricultural Gypsum Opportunity

- Rising volumes of FGD Gypsum byproduct is being produced as utilities bring new emissions scrubbers on line.
- Primary reuse market is wallboard production which is limited by geography and subject to construction market volatility
- With new regulatory standards, disposal options will be increasingly expensive for utilities.

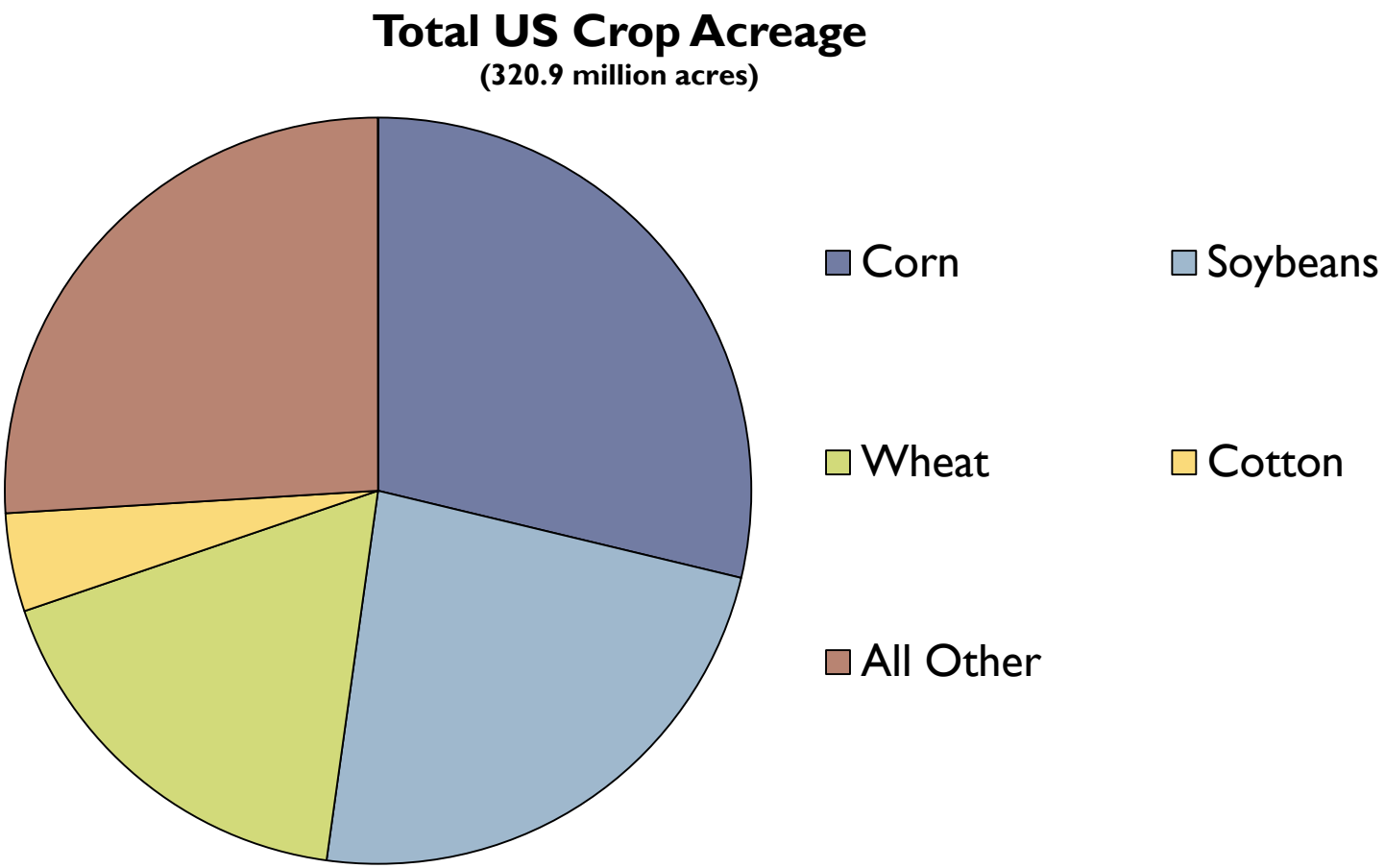
FGD Gypsum – Supply & Use



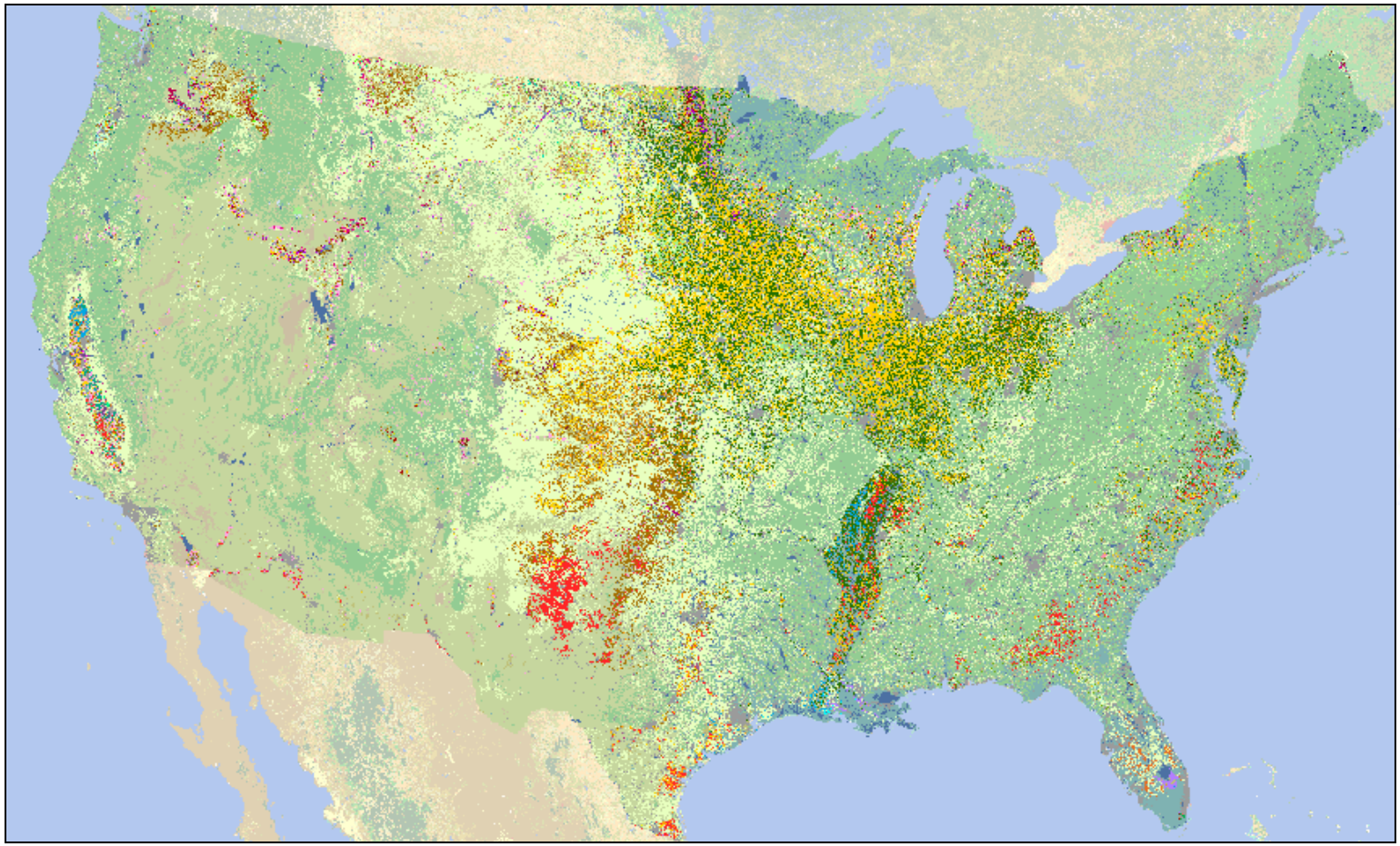
Agricultural Gypsum Opportunity

- The potential market for agricultural gypsum is enormous and has high potential to be a large volume reuse alternative.
- Gypsum demand from farmers for use as a soil amendment and micro-nutrient is growing.
- Gypsum has not been effectively marketed for agriculture and has lacked an organized distribution system.

Total Crop Acreage – U.S.



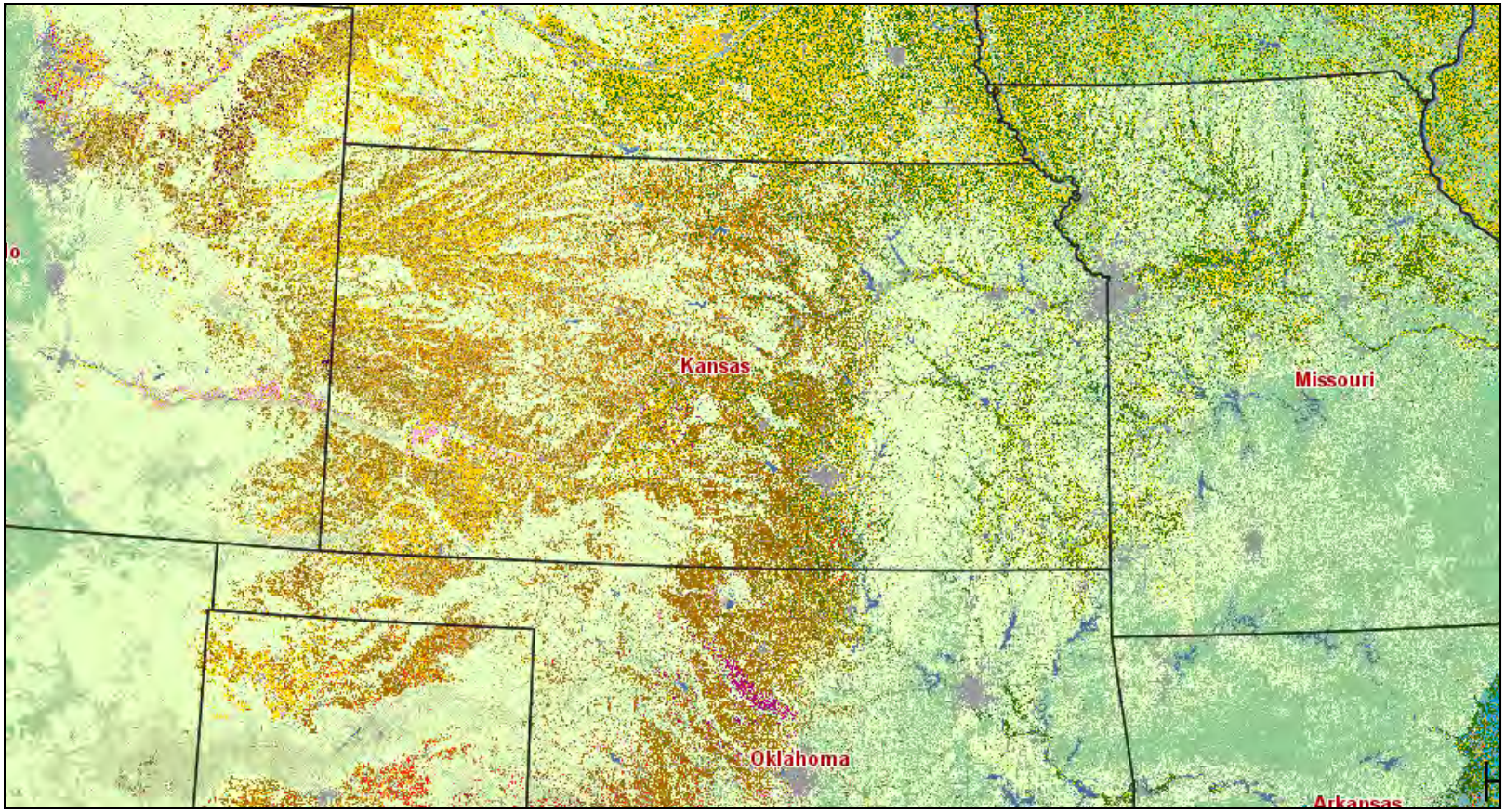
U.S. Cropland Data



- Corn
- Soybeans
- Winter Wheat
- Fallow/Idle Cropland
- Other Hay
- Alfalfa
- Cotton
- Spring Wheat
- Sorghum
- Dbl Crop WinWht/Soy
- Rice
- Peanuts
- Potatoes
- Rye
- Durum Wheat

Source: USDA- National Agricultural Statistics Service

Kansas Relevant Crop Acreage



- Durum Wheat
- Spring Wheat
- Winter Wheat
- Alfalfa
- Other Hay/Non Alfalfa
- Soybeans
- Corn

Crops	Acreage
Corn	3,750,000
Soy	3,750,000
Wheat	7,900,000
Forage	2,400,000
Total	17,800,000

FGD Gypsum for Agriculture in the News

PRODUCTION

Gypsum Gains Ground

This mineral improves soil tilth, water permeability and nitrogen uptake BY RHONDA BROOKS

PHOTO: RHONDA BROOKS

Effingham Equity, a large independent cooperative, spreads gypsum on the Howard Buffet Foundation farm near Decatur, Ill.

What do coal-fired power plants that generate electricity have in common with an increasing number of U.S. corn and soybean farms? They both benefit from the use of gypsum.

Farmers use the naturally occurring mineral to improve soil tilth, water infiltration and nitrogen uptake in their fields. According to the American Coal Ash Association, a utility industry group, farmers used 279,000 tons of gypsum in 2008. That's more than three times the amount they used in 2002.

"With gypsum, the soil structure becomes more spongelike, so even tight clay soils readily absorb water and move it down through the soil profile, rather than allowing it to pond or run off," says Ron Chamberlain, director of gypsum programs for Beneficial Reuse Management. The company sells a synthetic gypsum product, Gypsoil, for agricultural use.

Synthetic gypsum is a byproduct of fossil-fueled power plants that work to remove sulfur dioxide from flue gases in an effort to curb pollution and comply with clean air regulations. In recent years, synthetic gypsum has gained ground with farmers because of its availability and lower price.

"Gypsum is a big benefit to corn as the plants' roots are able to work their way deeper into the ground," says Brad Brown, a Center Point, Ind., farmer who uses synthetic gypsum.

Brown says his soybean crops also benefit from gypsum.

"We are seeing a reduction in mold problems because the water is able to move into the soil," he says.

Purdue University research indicates that gypsum also offsets the impact of aluminum toxicity in low pH soils, helps curb phosphorus runoff and increases iron uptake by reducing the effects of bicarbonates.

Some seed companies are conducting field research to determine whether the soil benefits from gypsum also support increased crop yields. To date, the data shows mixed results.

Brown has used gypsum for eight years, and the soil quality benefits have steadily improved over time. A side payoff, he notes, is that his fields containing gypsum are easier to harvest in wet conditions.

Using a lime spreader, Brown applies 1 ton of gypsum per acre to select fields postharvest. The gypsum he purchases from a local power plant contains 16% sulfur and 22% calcium. The moisture content is 6%.

"It has the consistency of baking soda," he says.

Cost and availability. Brown pays between $9 and $14 per ton. To keep costs down, he loads and transports the gypsum to his farm, using a polyurethane liner in the semi to help contain the product.

Because the country remains reliant on coal-fired plants, farmers can expect to have access to a steady supply of gypsum in the years ahead. The federal government encourages farmers' use of synthetic gypsum to minimize build-up of the product around plants. Several environmental groups are at odds with this decision.

"The power plants used to just throw away the gypsum," Brown says. "Now that we know it's useful to our soils, it can be a good deal for everyone."

You can e-mail Rhonda Brooks at rbrooks@farmjournal.com.

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Production

Miracle Sulfur Source?

Gypsoil shows promising benefits

BY JIM DICKRELL

Anecdotal evidence from farmers and claims by the marketers of Gypsoil—the commercial name for flue gas desulfurization (FGD) gypsum—suggest this relatively new source of sulfur fertilizer also improves soil tilth, nitrogen utilization and crop yields while reducing runoff and dissolved phosphorus losses.

University research results vary by state. In Ohio, dry matter yields of new seeding alfalfa were up as much as 40% and established stand yields up 5% to 6%, says Warren Dick, an Ohio State University agronomist. Results in Wisconsin, however, are inconclusive, says University of Wisconsin Extension soils specialist Dick Wolkowski.

What is being confirmed is that FGD gypsum is a bona fide replacement for mined gypsum that is used to provide sulfur and calcium. It also could prove to be cheaper, with FGD available at its source for less than $20 per ton.

A new source of fertilizer provides the sulfur and calcium of mined gypsum and may have other benefits as well.

PHOTO: RHONDA BROOKS

One of the challenges is that there are no good soil tests for sulfur. The best you can do for alfalfa is a leaf tissue test to see if concentrations meet the goal of 0.25%, says Ohio's Dick. Such data reflects what has already happened, but it can then be used to correct sulfur deficiencies. To meet alfalfa sulfur requirements, he recommends, use about 100 lb. to 200 lb. per acre of gypsum.

"Since sulfur is leached from soil as sulfate, slightly higher rates can sometimes be applied in sandy soils and in more humid climates," Dick says. He usually sees the greatest response on alfalfa. Corn, a high user of sulfur, sometimes responds.

DAIRYTODAY.COM
Bonus content:
More on Gypsoil

Improvement in soil porosity and tilth is a more controversial claim. "We have seen improvement in soil quality due to gypsum additions, although this work is not yet published," Dick says.

For those unsure whether to apply gypsum to improve overall soil quality, Dick recommends treating several small areas with 1,000 lb. to 2,000 lb. per acre every year or every other year for two or three years. "If benefits are not obvious, I would no longer use these higher rates, at least until we have more data," he says.

In Wisconsin trials, FGD gypsum produced an 18% yield bump in first-cutting alfalfa in the seeding year. But this difference was not repeated at second cutting, and total tonnage for the year was not statistically different, Wolkowski says.

The research raises an intriguing possibility. Two tons per acre of FGD reduced dissolved reactive phosphorus from the surface of soils 30 days after application. The reduction was highly significant at one site and nearing significance at a second site. That suggests FGD could be used to reduce phosphorus runoff on fields.

"While these data are promising, no recommendation for FGD gypsum can be made beyond its proven benefit as a calcium and sulfur source for plants," Wolkowski says.

A note of caution: Due to sulfate toxicity, gypsum can be harmful to ruminants if they consume a kilogram (2.2 lb.) per day for a week or more. Do not allow cattle access to stockpiles of gypsum, and manage loading and spreading equipment to avoid small piles from accumulating in fields where cattle graze.

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Calcium Is King

Timely application of calcium is critical for large-seeded peanuts.

For as long as Clarkton, N.C., peanut grower Dan Ward can remember, timely application of land plaster has been a family tradition that is key to profitability.

"We apply a ton to the acre before the plants get too big, which could damage them," says Ward, who grows large-seeded Virginia peanuts and also serves on the National Peanut Board. "You don't want to apply land plaster too early, because it could move out of the pegging zone in the sandy soil.

"If there's a lack of calcium, it results in pops. For best results, we spread the land plaster in late June or early July."

Calcium Is Critical

Having enough calcium present in the pegging zone is essential for large-seeded runners, says University of Georgia Extension specialist Glenn Harris, who specializes in soil fertility.

"In Georgia, we have shifted from small-seeded runner cultivars to large-seeded runners, where calcium nutrition is even more critical," Harris says.

The university currently suggests two options for supplying calcium. If soil pH is low, liming is an option provided that at least half is applied at planting time and on the surface without turning. The other, more common method to provide calcium is to apply 1,000 pounds per acre of gypsum at bloomtime if pegging zone soil samples taken soon after emergence are 500 pounds per acre calcium or less, or if the calcium-to-potassium ratio is less than three-to-one.

"Calcium is critical for proper seed development and to avoid pops, pod rot, black heart and, if peanuts are produced for seed, poor germination. A good supply of soluble calcium needs to be present in the top three to four inches of soil so it can be absorbed directly through the hull and into the developing seed," Harris explains.

Dan Ward, of Clarkton, N.C., knows that calcium is a critical input for peanuts.

Better Early Than Late

Timely application is precisely the recommendation of Jay Chapin, Clemson University Extension peanut specialist. Timely management is one of Chapin's five keys to successfully growing peanuts, and using land plaster is one of his top ten production principles.

"Ideally, you want to apply the calcium at first bloom, which is typically about 30 to 35 days after planting," Chapin says. "For growers who have a spread of planting dates and need to manage their work to get all the calcium applied, it is okay to be two weeks early, but they don't want to be two weeks late, which can be 50 days after planting.

"The consequence of being late is the

Reprinted from the April 2011 issue of Peanut Grower Magazine

FGD Gypsum for Agriculture in the News

Feature

Amending soils with Gypsum

By Madeline Fisher
Lead Writer
Crops & Soils magazine
mfisher@sciencesocieties.org

Photo courtesy of GYPSOIL/Ron Chamberlain.

Gypsum has received renewed attention in recent years as a potential soil amendment. Some farmers who've adopted it are finding that its effects on soil physical properties can lead to higher yields and profits, and data are mounting on the mineral's capacity to reduce nonpoint source pollution contributed by agriculture. But is there enough information out there to justify applying it on any one farm? A group of industry representatives, scientists, and growers addressed this question at the Midwest Soil Improvement Symposium this past August.

Gypsum, or calcium sulfate dihydrate, has been used by farmers for a very long time. It was applied extensively as a fertilizer in 18th century Europe, U.S. founding father Ben Franklin touted its benefits—even the Greeks and Romans reportedly used it. More recently, it has become a proven soil amendment to reclaim sodic and other degraded soils. And its use as an economical fertilizer continues to this day.

However, gypsum can seem like a brand new product these days, thanks to the renewed attention it's receiving for several reasons. Gypsum is more plentiful now, for one. It was mostly mined in the past, but today a "synthetic" form is surpassing natural sources: Flue gas desulfurization (FGD) gypsum, a by-product of scrubbing sulfur dioxide gases from the emissions of coal-fired power plants. Production of FGD gypsum doubled from 12 to 25 million tons between 2004 and 2010, according to the U.S. Geological Survey, and it's projected to reach 40 million tons by 2020. Meanwhile, manufacturing markets for gypsum have steadily declined, and the combination of increased supply and reduced demand has sparked efforts to find new applications and expand old ones—including agricultural uses.

Another factor in gypsum's resurgence is its potential to reduce nonpoint source pollution contributed by agriculture. Through the work of scientists like Darrell Norton, a long-time gypsum researcher with USDA-ARS, data are mounting on the mineral's capacity to curb erosion, improve infil-

Loading gypsum on a truck. Photo courtesy of GYPSOIL/Ron Chamberlain.

FGD Gypsum for Agriculture in the News

Metro&State
Section B • The Columbus Dispatch • Sunday, Feb. 3, 2013

OHIO STATE UNIVERSITY

Earl Duck, an AEP supervisor, left, and Warren Dick, an Ohio State University soil scientist, with gypsum.

Gypsum on fields may cut runoff of phosphorus

By Spencer Hunt
THE COLUMBUS DISPATCH

Coal-fired power plants use massive scrubbers to remove sulfur and other pollutants from smoke, creating millions of tons of gypsum sludge every year.

Some of the dried sludge is used to make drywall for construction projects, but most of it gets dumped into landfills.

Gypsum is a mineral commonly used in plaster of Paris.

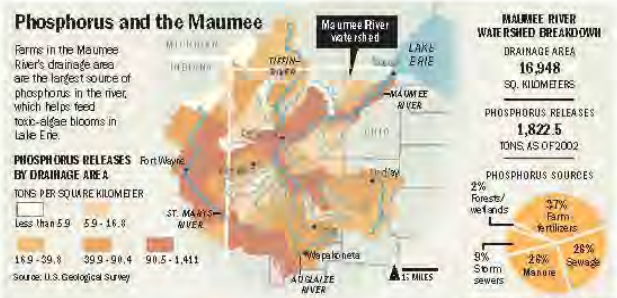
Warren Dick, an Ohio State University soil scientist, says he has found another use for the gypsum — spreading it on farm fields to reduce the phosphorus that washes into waterways and feeds toxic algae.

"(Gypsum) binds with the phosphate in the soil," Dick said. "It keeps phosphorus where you want it — in the field, where the plants can take it up and use it."

It seems an unlikely solution. Power-plant emissions include arsenic, cadmium and other toxic metals. But power-plant officials say nearly all of those poisons are removed from smoke before scrubbers kick in.

"The gypsum is 98 percent pure," said Mark Durbin, a spokesman for Akron-based FirstEnergy, which uses scrubbers at its W.H. Sammis plant along the Ohio River.

See Runoff Page B3



TOM BAKER, MARY NGUYEN | DISPATCH

Runoff

FROM PAGE B1

Dick said he plans to test gypsum this year on about 80 farms in areas that drain into the Maumee River, the main conduit for phosphorus to reach Lake Erie. Penn State University researchers found in 1999 that gypsum could cut farm-field phosphorus runoff in half.

Eric Schaeffer of the Environmental Integrity Project, a group critical of power plants that is based in Washington, D.C., gave the process a conditional OK.

"The test data on gypsum is pretty good in terms of its being something that would have a low probability of harm," said Schaeffer, who added that tests should be performed routinely to make sure toxin levels in gypsum remain low.

Lake Erie researchers say steep reductions in farm-field phosphorus runoff are needed to reduce toxic algae blooms and ensure the lake's survival.

State officials now promote voluntary measures to reduce farm runoff, but the Ohio Farm Bureau Federation recently sent Ohio farmers a letter warning them that state and federal regulations might come if voluntary measures aren't embraced.

Also called cyanobacteria, the algae produce liver and nerve toxins that can sicken people and kill pets. The algae also create an oxygen-depleted dead zone near the center of the lake where fish cannot survive.

▶ To read about algae research going on throughout Ohio, turn to the Science pages, E4-5.

In 2011, the algae spread from Toledo to Cleveland, threatening the lake's $10 billion-a-year tourism industry. Drought conditions kept last year's bloom much smaller.

Melissa McHenry, spokeswoman for Columbus-based American Electric Power, said spreading gypsum on farm fields sounds intriguing.

> "The test data on gypsum is pretty good in terms of its being something that would have a low probability of harm." — Eric Schaeffer of the Environmental Integrity Project

About 80 percent of the gypsum from AEP's Cardinal plant on the Ohio River is shipped downriver to a West Virginia wallboard plant, she said. The rest goes to a company-owned landfill. The plant produced nearly 360,000 tons of the stuff in 2011.

One company, Chicago-based Gypsoil, already sells gypsum to western Ohio farms. The gypsum, trucked from Indiana power plants, contains sulfur and calcium, nutrients that can help grow crops and also encourage root growth, said Dave Schuurman, the chairman of Gypsoil's parent company, Beneficial Reuse Management.

Dick said he hopes this year's tests will show that gypsum can help Lake Erie.

shunt@dispatch.com
@CDEnvironment

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Grower Education

3rd Annual

Midwest Soil Improvement Symposium: 2013

Research and Practical Insights into Using Gypsum

Thursday, March 7, 2013
McIntosh Center at
OHIO NORTHERN UNIVERSITY
Ada, Ohio

The third annual Midwest Soil Improvement Symposium will be held in conjunction with The Ohio State University's Conservation Tillage and Technology Conference.

The one-day symposium will feature leading experts on the use of gypsum to improve soil structure, reduce runoff and add important nutrients to the soil.

Confirmed speakers:

JUST ANNOUNCED! **Dr. David R. Montgomery**, professor, University of Washington, and author of DIRT: THE EROSION OF CIVILIZATIONS;

Dr. Warren Dick, professor, Environmental and Natural Resources, The Ohio State University, Wooster, OH;

Dr. Jerry Bigham, professor (retired), Environmental and Natural Resources, The Ohio State University, Wooster, OH;

Dr. Darrell Norton, soil scientist (retired), National Soil Erosion Research Lab, USDA-Agricultural Research Service, West Lafayette, IN;

Dr. Allen Torbert, research leader, National Soil Dynamics Laboratory, USDA-Agricultural Research Service, Auburn, AL;

Dr. Ray Bryant, research soil scientist, Pasture Management and Watershed Management Research Unit, USDA-Agricultural Research Service, University Park, PA;

Ron Chamberlain, agronomist and director of gypsum programs for Beneficial Reuse Management, marketer of GYPSOIL™ brand gypsum.

Moderator: **Randall Reeder**, (retired) extension agricultural engineer, The Ohio State University.

Panel discussions featuring growers and consultants who use or recommend gypsum.

Approximately 7.0 CCA CEU credits available.
$15 for advance registration or $20 at door.
On-site registration 7:00 AM • Program 8 to 5:00 PM

Hosts and sponsors:

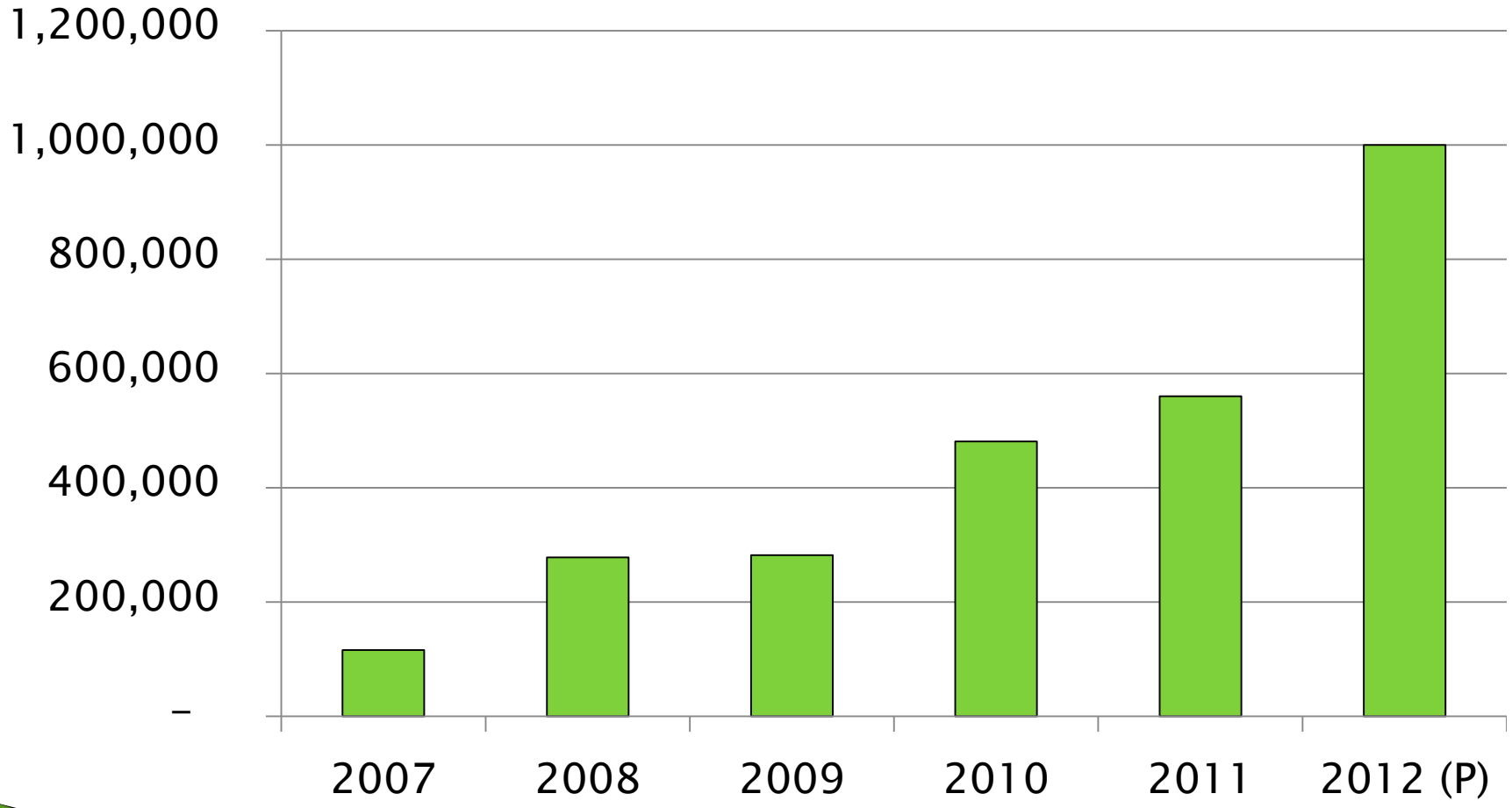
GYPSOIL™ BRAND GYPSUM · THE OHIO STATE UNIVERSITY · CTIC

ADVANCE REGISTRATION CLOSES MARCH 1

Visit: www.gypsoil.com/symposium or call (563) 320-2247 to register.

Midwest Soil Improvement Symposium– 2013

Growth in Agricultural Use of FGD Gypsum (tons)



Source: ACAA CCP Production and Use Survey Reports

Gypsum's Benefits for Agriculture and the Environment

Why do farmers use gypsum?

Gypsum offers:

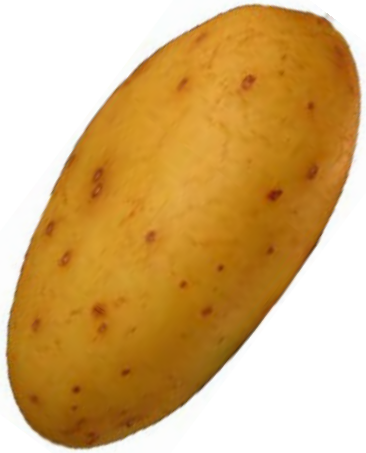
- Soil amendment

  and

- Nutrients

Gypsum as a Source of Calcium

- 20% calcium for peanuts, potatoes, tomatoes etc.



Gypsum as a Source of Sulfur

- Sulfur – deficiency is on rise
- With 16% Sulfate Sulfur, gypsum is an economical source of sulfur

AG PROFESSIONAL

Sulfur deficiency, a developing issue

Gypsoil | June 8, 2012

K-STATE RESEARCH AND EXTENSION

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Sulfur (S) Fertility Management

considerable research with sulfur fertilization has been conducted in Kansas.
Positive yield responses have been noted on wheat

Purdue University Department of Agronomy

Soil Fertility Update

May 2012

Sulfur deficiency in corn

Jim Camberato, Stephen Maloney, and Shaun Casteel[1]

Agronomy Department, Purdue University, West Lafayette, IN

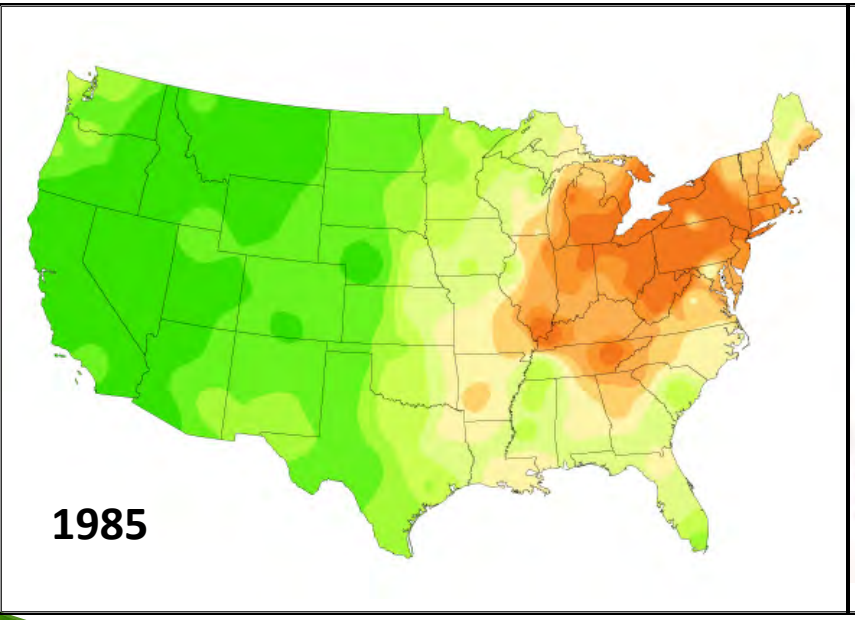
the Bulletin

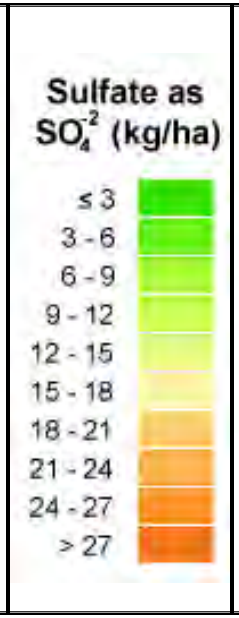
June 8, 2012

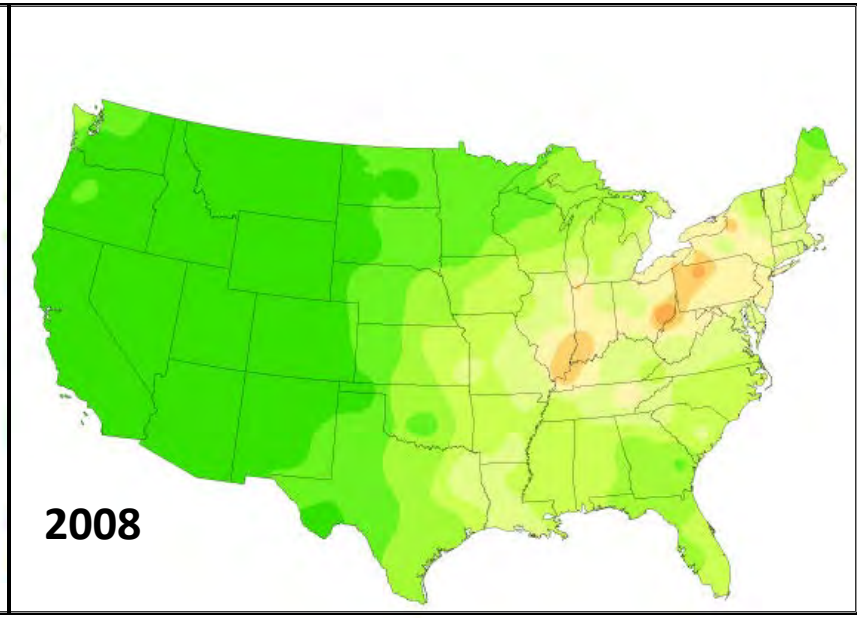
Corn Crop Appears Sulfur-Deficient in Western Illinois

Sulfur Depletion

National Atmospheric Deposition Program Maps
Sulfate Ion Wet Deposition
1985-2008

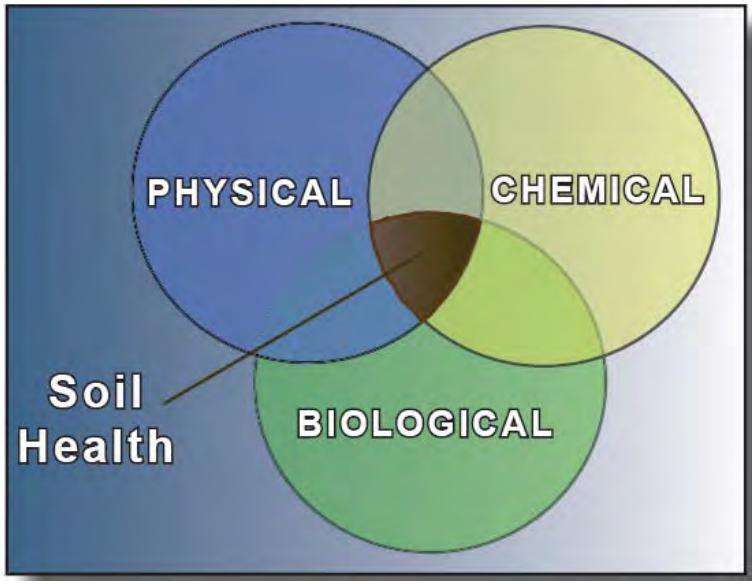






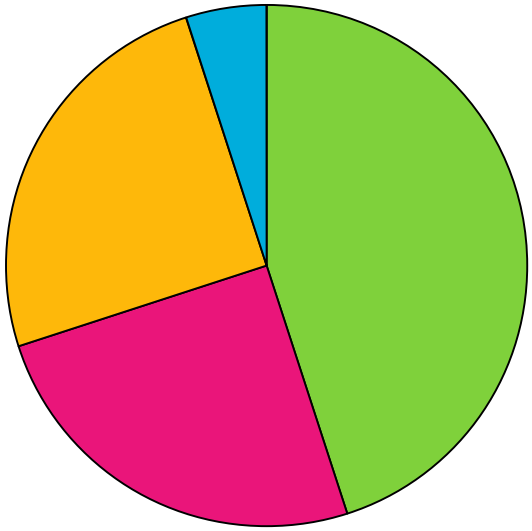
National Atmospheric Deposition Program (NSRP-3). 2007. NADP Program Office, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820

Gypsum as a Soil Amendment



Soil Constituents

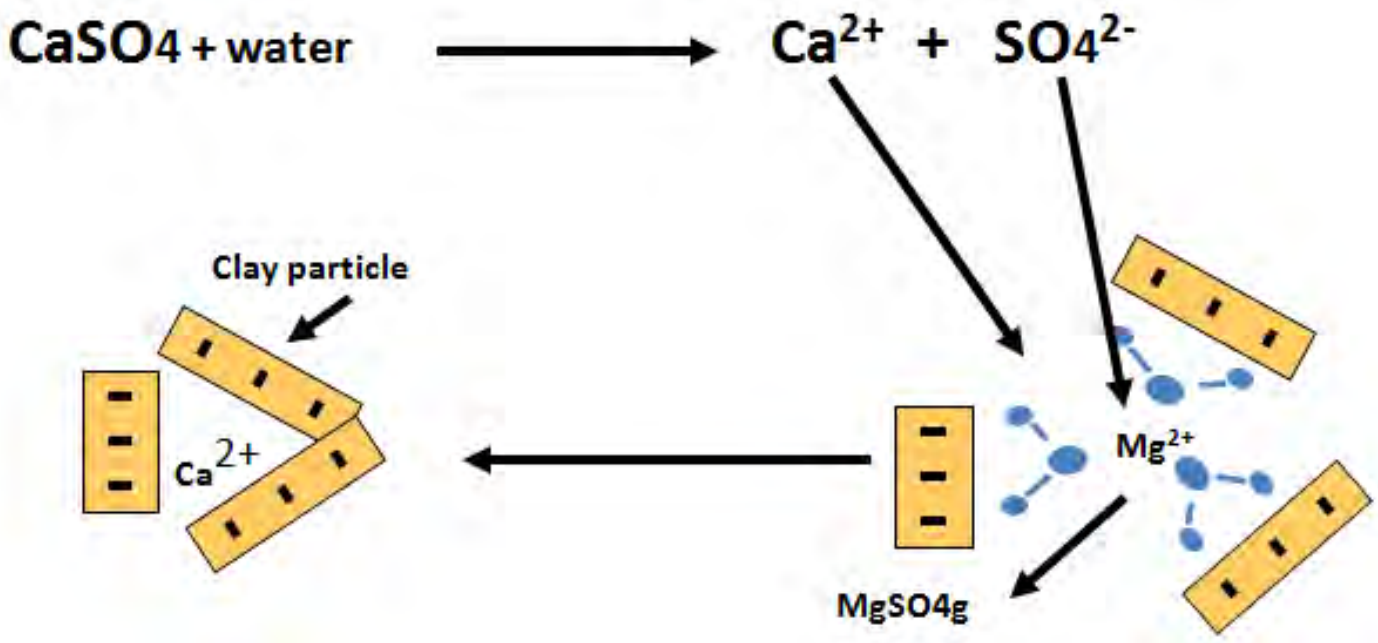
- Mineral Matter
- Air
- Water
- Organic Matter



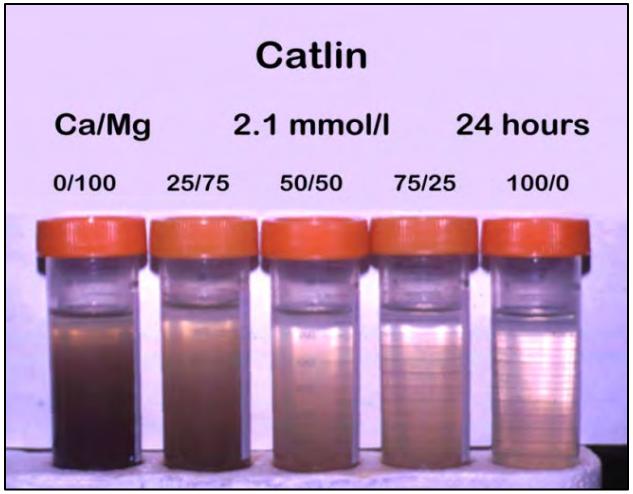
Increased Soil Permeability

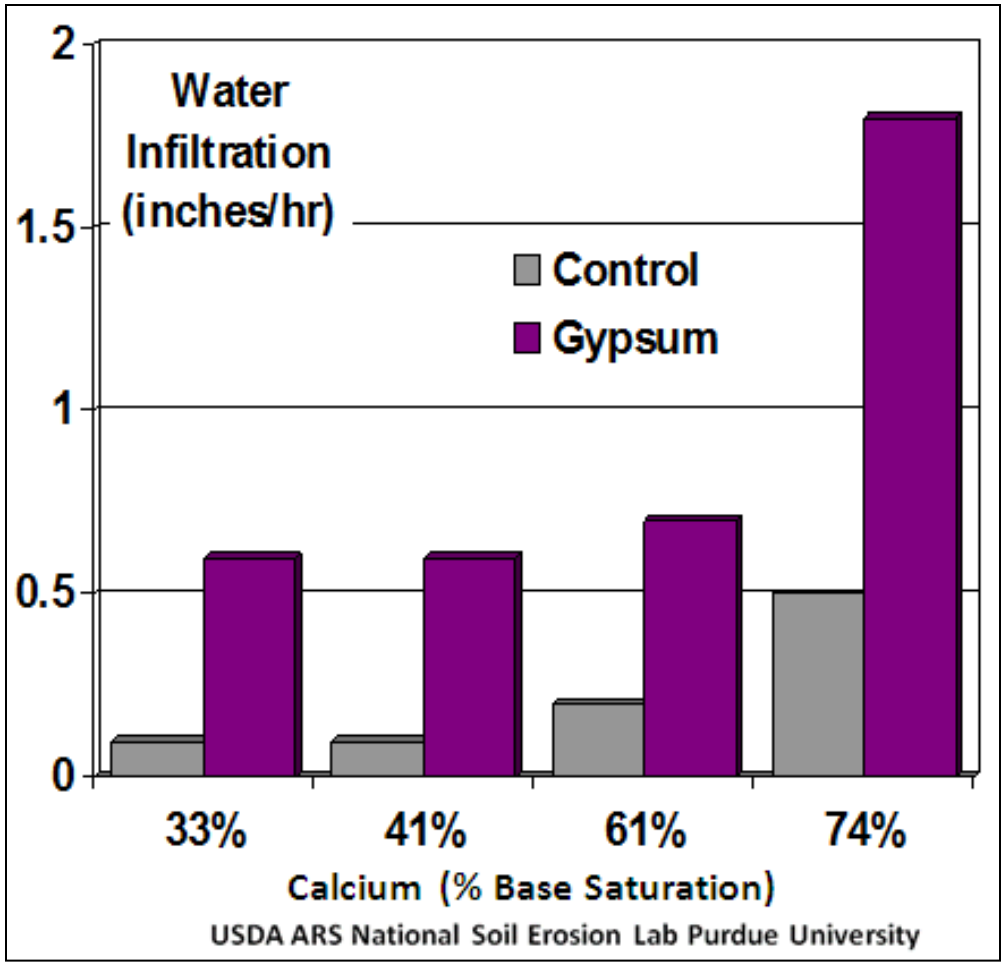
What Gypsum Does for Soils

Gypsum Flocculates Dispersible Soils

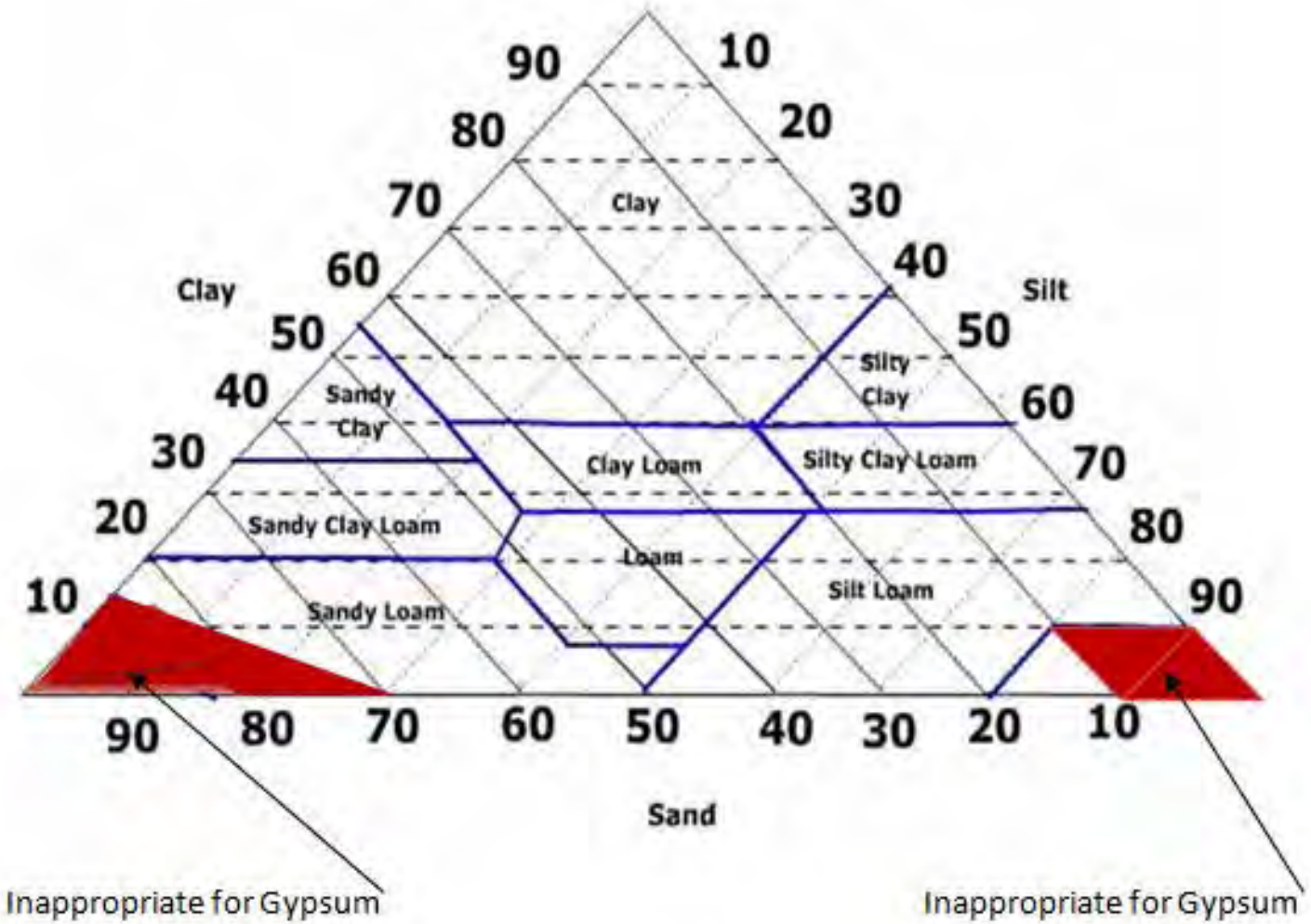


Research

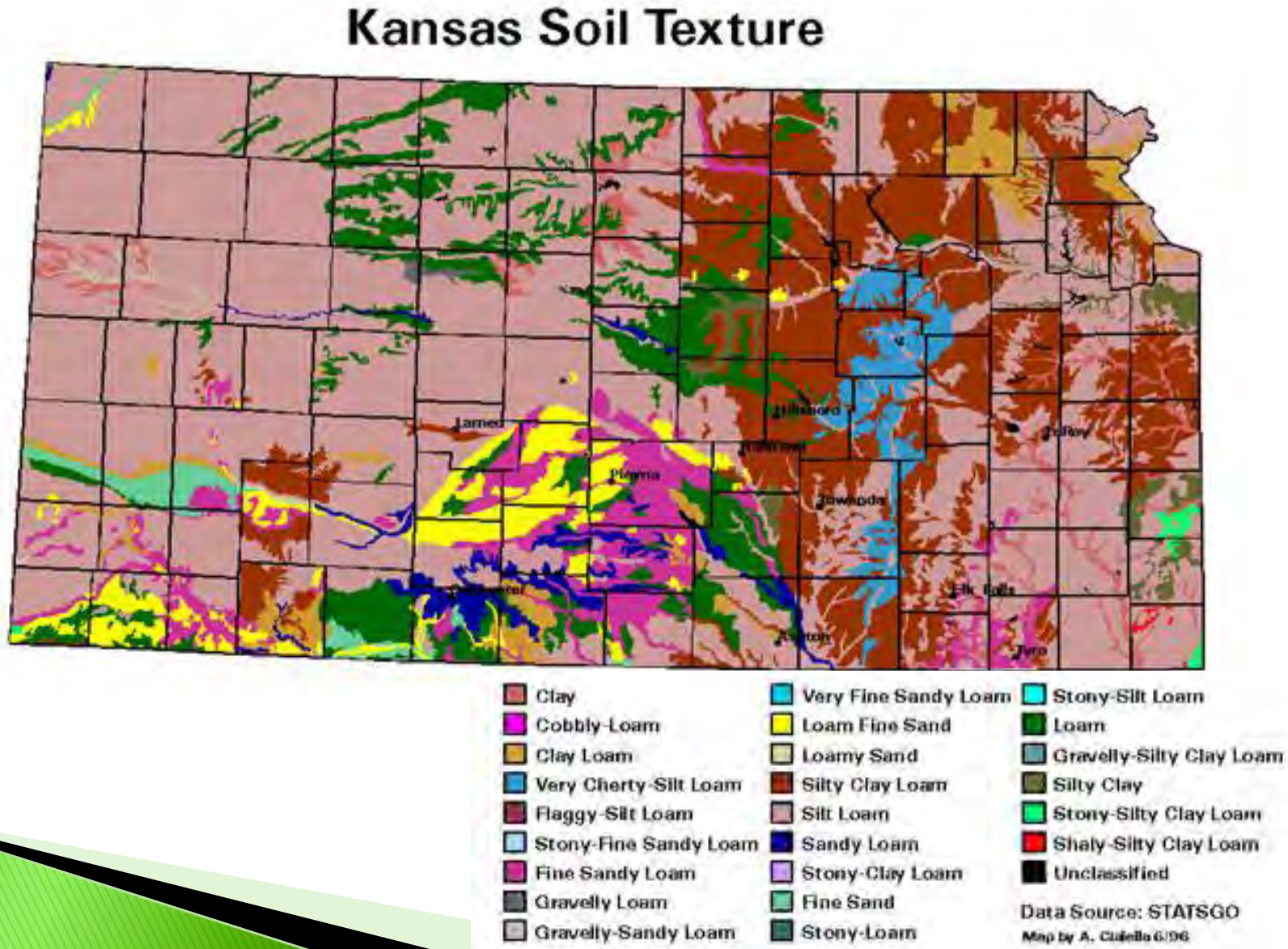

Catlin
Ca/Mg
2.1 mmol/l
24 hours
0/100
25/75
50/50
75/25
100/0


Water Infiltration (inches/hr)
2
1.5
1
0.5
0
Control
Gypsum
33%
41%
61%
74%
Calcium (% Base Saturation)
USDA ARS National Soil Erosion Lab Purdue University

Gypsum Qualified Soils



Kansas Soil Profile



What Gypsum Does for Soils

What Gypsum Does for Soils

- Balances soil chemistry
- Flocculates soil clays
  - Improved soil structure
- Increased soil biological activity
- Increased water infiltration/ conductivity
- Deepened rooting zone
- Improved, sustainable soil quality

What Gypsum Does for Crops

What Gypsum Does for Crops

What Gypsum Does for Crops

- Higher quality rooting environment
  - Balanced nutrients, moisture, & oxygen
- More usable soil
  - Greater root volume into the subsoil
- Reduced stress season-long
  - Greater vigor during extreme weather events
  - Higher yield vs. genetic potential
- Increase crop production efficiency

What Gypsum Does for the Environment

What Gypsum Does for the Environment

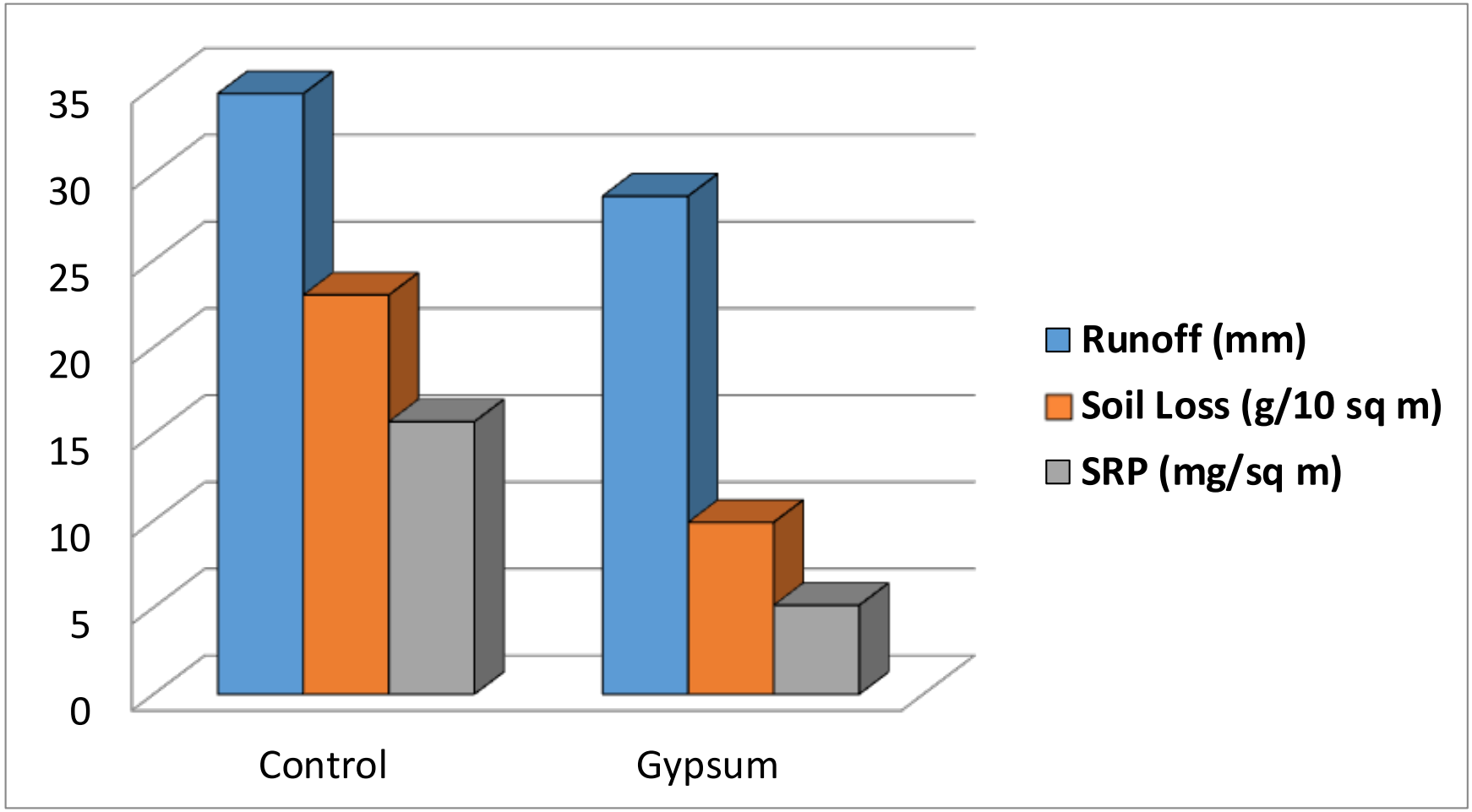
- Reduced runoff/ erosion
- Reduced nutrient loading
- Increased efficiency of mineral fertilizer
  - Reduced application
- Improved soil quality – long term
- Sustainable crop production

What Gypsum does for the Environment

Hypoxia Zone

GYPSOIL
BRAND GYPSUM

Effect on Erosion in No-Till



Continuing Research

- Universities in many States have initiated or are considering additional research on gypsum's ability to improve soils, add nutrients, and improve yields
  - KS, IA, WI, IL, IN, MO, AL, MS, AR, OH, NC

- New research has been initiated specifically on gypsum's ability to mitigate nutrient run off to help improve water quality
  - EPRI/OSU/Gypsoil –Maumee River Watershed, OH
  - EPRI/UW/Gypsoil – Fox River Watershed, WI
  - USDA-ARS/UMES/Raven Energy-Chesapeake Bay, MD
  - IUPUI/IPL/Gypsoil – Eagle Creek Watershed, IN

Gypsoil Case Study

Jack Maloney, Brownsburg, IN

2,600-acre corn and soybean no-till operation
Started applying gypsum in 2001
Improved soil structure, water infiltration
Better soil and water quality
Improved yields, lower production costs

Gypsoil Case Study

- 320 acre field
- 5th year gypsum
- Corn

Financial Benefits to Growers

	Gypsoil Program		Conventional Program
Yield Improvement			
Yield Check	150 bu/acre		123 bu/acre
Yield Difference		27 bu/acre	
Bushel Value		@ $6.00	
Yield Value Improvement		***$162 / acre***	

Input Cost differential ($/acre)

- Phosphate	$	7.00	$	48.00
- Potassium	$	9.00	$	63.00
- Lime	$	24.00	$	30.00
- Gypsum	$	50.00	$	-
Total Inputs	$	90.00	$	141.00

Input Cost Savings ***$51 / acre***

Combined Benefits	
Higher Yield	$162 / acre
Lower Costs	$51 / acre
Total Gypsoil Benefit	$213 / acre

Risk Assessment of FGD Gypsum for Agriculture

USDA/EPA Risk Assessment of FGD Gypsum use in Agriculture

- EPA contracted with USDA to complete a 3 year risk assessment program beginning in 2009
  - Directed by Dr. Rufus Chaney at USDA-ARS Laboratory at Beltsville, Maryland
- Comprehensive review of all prior field research on FGD gypsum used in agriculture including data collected from multiple EPRI test plots in six states
- Data analyzed:
  - Crop Yield
  - Soil Quality
  - Meteorological Data
  - Plant Tissue Metals
  - Mercury
- Focus on trace metals in soils and plant tissues
  - Comparisons to natural mined gypsum
  - Comparisons to Background Soils
  - Evaluation of 14 different exposure pathways

Risk Assessment Findings

- FGD gypsum contains very low levels of trace metals relative to both natural mined gypsum and to background soils
- **"It is difficult to identify any adverse effects of use of FGD gypsum in agriculture"**
- Trace metals levels for FGD gypsum are well below standards for land application of Biosolids to farmland
- Maximum lifetime metal loading rates of application of FGD gypsum are well within allowable tolerances

Trace Constituents in FGD Gypsum, Mined Gypsum, and Natural Soils

Trace Constituent	FGD Gypsum (ppm)	Mined Gypsum (ppm)	National Background in Soils, Lower 25th percentile (ppm)
Antimony	2.0–9.1	0.02–0.28	0.3
Arsenic	0.6–4.0	0.19–3.0	4.21
Cadmium	.02–1.2	<2–0.5	0.19
Chromium	1.3–42.0	8.7–30.5	28.6
Lead	0.8–12.0	All<5	14.5
Mercury	0.01–1.4	0.00044–0.025	0.039
Molybdenum	0.5–12.0	All<3	0.44
Nickel	0.73–20.1	<4–11.9	11.8
Selenium	2.0–30.0	11.3–21.1	0.21
Thallium	0.6–2.0	All<15	0.3
Vanadium	<1–73.2	<2–12.7	45.9
Zinc	3.4–47.5	13.1–27.5	36.8

Sources: DOE. 2007. Unpublished data. U.S. Department of Energy; EPA. 2007. Unpublished data. Office of Research and Development, U.S. Environmental Protection Agency; EPRI. 2007. Unpublished data. Electric Power Research Institute; OSU. 2006. *Gypsum for Agricultural Use in Ohio–Sources and Quality of Available Products.* Ohio State University Extension Fact Sheet, ANR–20–05. http://ohioline.osu.edu/anr-fact/0020.html; Shacklette and Boerngen. 1984. *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States.* U.S. Geological Survey Professional Paper 1270. Washington, D.C.; U.S. Government Printing Office; USGS. 2005. *Major-and Trace-Element Concentrations in Soils from Two Continental-Scale Transects of the United States and Canada.* Open-File Report 2005-1253, U.S. Geological Survey. http://pubs.usgs.gov/of/2005/1253

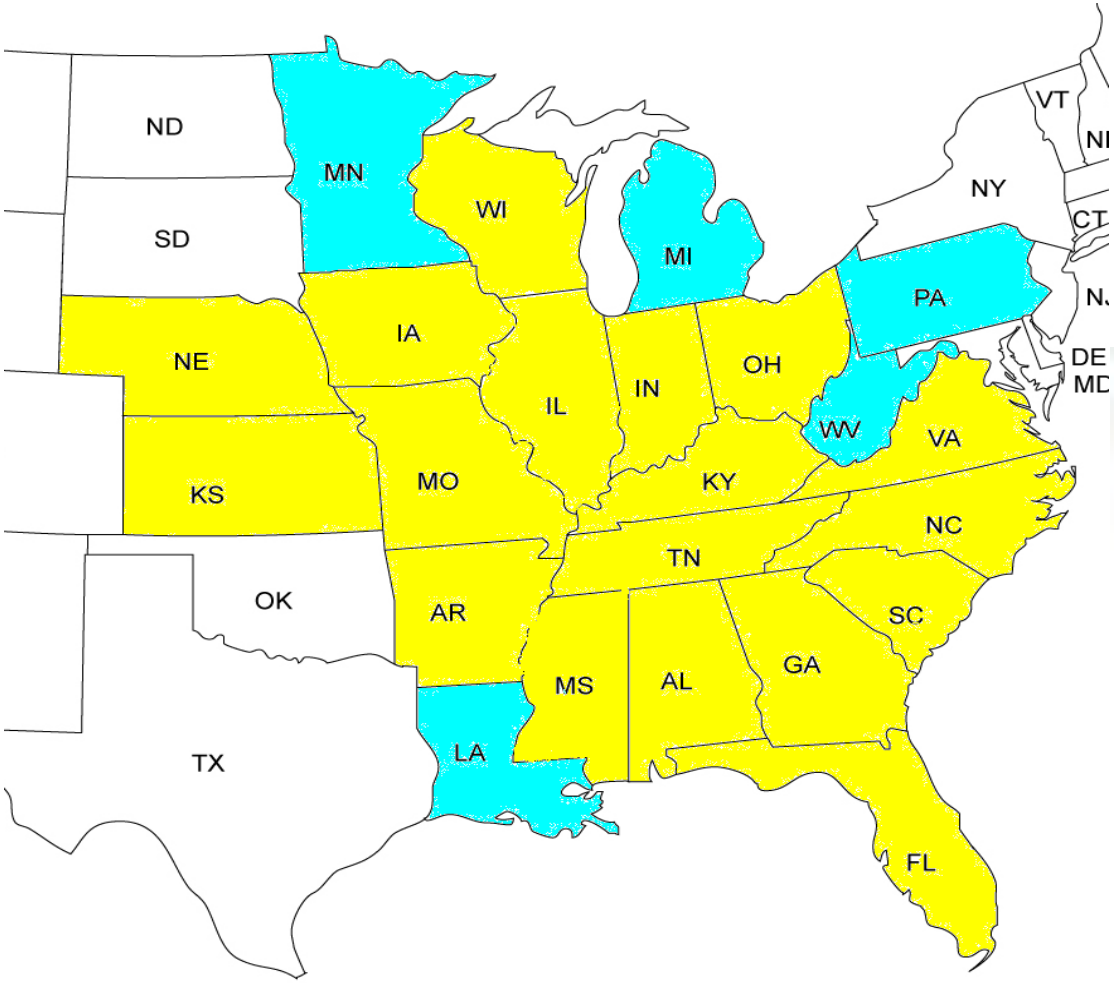
FGD Gypsum– Comparison to Part 503 BioSolids Standards

(mg/kg)	Part 503 Exceptional Quality BioSolid	FGD Gypsum Typical Range per USEPA	BRM Customer Plant A	BRM Customer Plant B
Metal				
Arsenic	41	.6–4.0	<.43	2.4
Cadmium	39	.2–1.2	0.042	n.d.
Copper	1500	1.1–4.7	No data	4.6
Lead	300	.8–12.0	1.5	n.d.
Mercury	17	.01–1.4	0.97	0.08
Molybdenum	75	.5–12.0	0.31	2.89
Nickel	420	.73–20.1	2.6	2.6
Selenium	100	2.0–30.0	12	4.12
Zinc	2800	3.4–47.5	5.5	10

State Level Regulation of FGD Gypsum in Agriculture

- Because it is a byproduct, many States regulate and permit under environmental codes
- In addition State agricultural regulations apply to FGD gypsum
- At least 20 States have approved FGD gypsum for use in agriculture and several more are now considering it
- Permitting requirements differ from State to State and the approval process can be difficult and time consuming

Gypsoil– Current State Permit Status



Permit Pending
Permit Approved

Gypsoil Supply Partners & Distribution Network

River

Truck

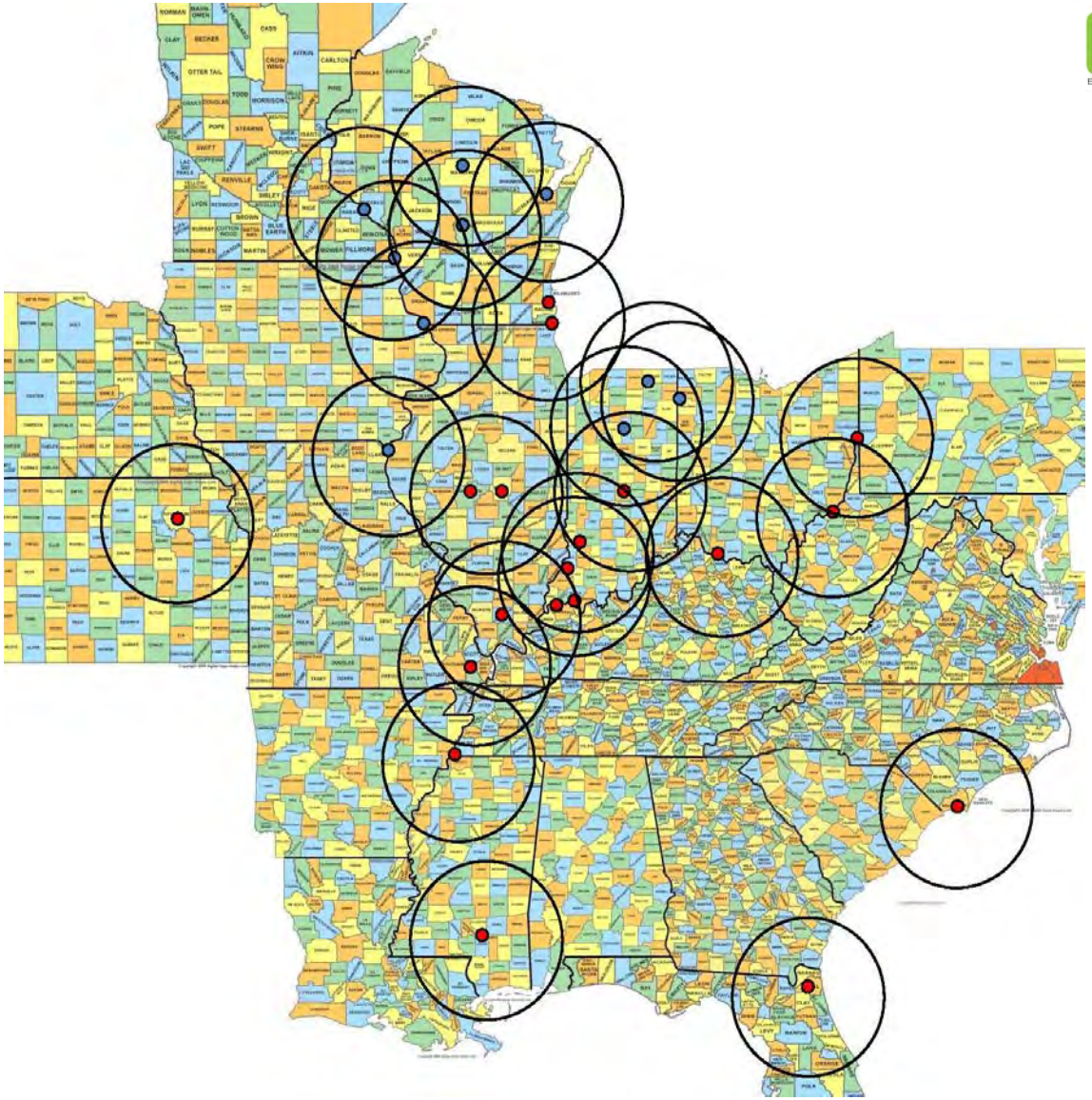
Current Supply Partners

Market Coverage

Advanced Distribution Sites

Supply Partners

100 mile radius



	Corn	Soybean	Alfalfa	Forage	Addtl Crops	Overall Total
Total Harvested Crop Acres	38,792,397	36,536,865	2,737,120	7,007,784	2,453,018	**87,527,7184**

Beneficial Reuse Management

GYPSOIL™

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