

Review of “FGD in Agriculture” Network Activities

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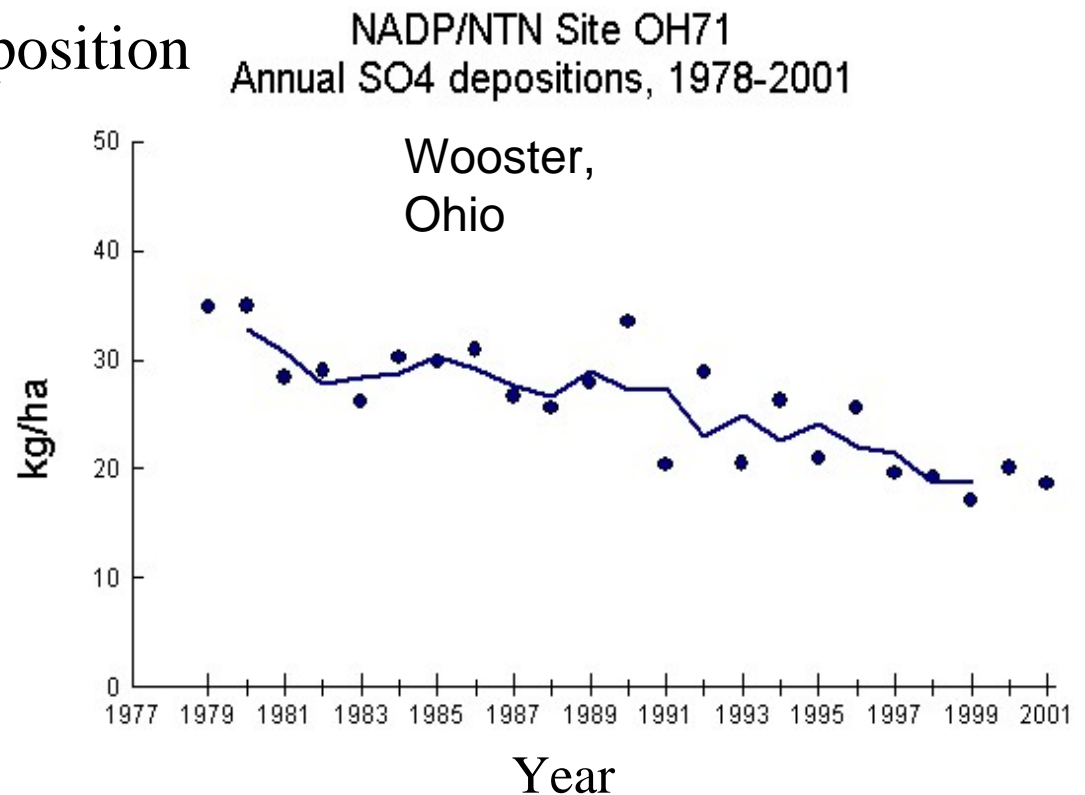
Summary of Gypsum Benefits in Agriculture

- ❑ Ca and S source for plant nutrition
- ❑ Source of S and exchangeable Ca to ameliorate subsoil acidity and Al^{3+} toxicity
- ❑ Flocculate clays to improve soil structure and reclaim sodic and high magnesium soils

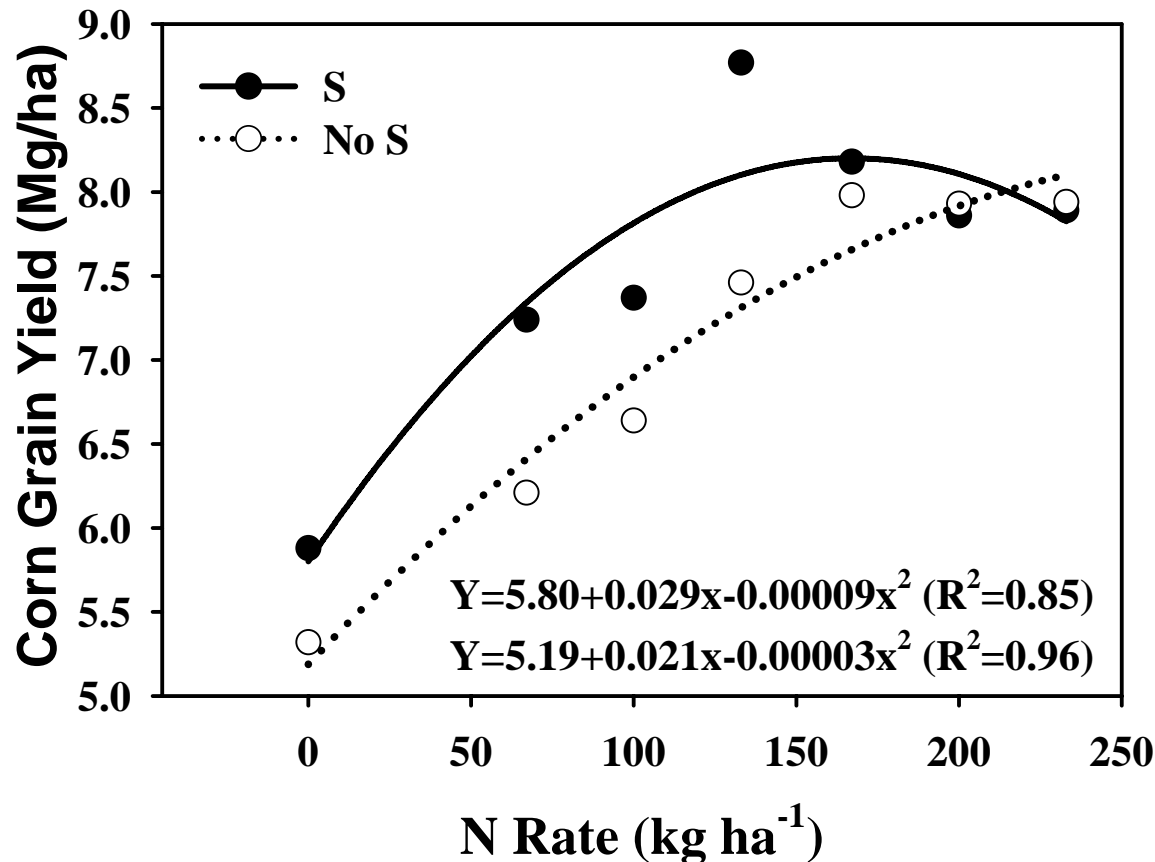
(Also as growth media component for mushroom production - approximately 60 kg/ton compost)

Reduction in Atmospheric S Deposition

- Increasing in importance as cause for crop S deficiencies
- Loss of soil organic matter
- Reduced annual S deposition
 - 34 kg/ha in 1971
 - 19 kg/ha in 2002



Average Corn Yields from 2002 to 2005 (Ohio, USA)



Development of Network for FGD Gypsum Use in Agriculture



Initiated in 2005

Agricultural Uses of Gypsum and Other Products from Flue Gas Desulfurization (FGD) Systems



Many crops can benefit from the addition of gypsum to the soil

- Demonstration of the agronomic value and environmental acceptability of FGD products in each participant's geographic area
- Development of the agricultural market for high volumes of FGD gypsum to complement the wallboard market
- Direct interaction with a wide range of interested parties--researchers, utilities, marketers, regulators, and agricultural specialists

Development of Network for FGD Gypsum Use in Agriculture

Deliverables:

- **On-site Research.** Site-specific research activities and reports. Network members are on the project steering committee.
- **Database.** All of the data collected will be maintained in a central database. Network members will have access to data via an OSU website.
- **Website.** OSU will maintain a website throughout the project to disseminate information to network members in a timely manner, supplemented by webcasts and conference calls.

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Deliverables:

- **Progress Reports.** Annual reports will detail progress and significant results. A comprehensive final report will detail all aspects and results from the project.
- **Specialty Reports.** Various reports on special interest topics (e.g., sulfur deficiency in soils, mined vs. natural gypsum) will be prepared throughout the project at the direction of the steering committee.
- **Workshops.** One workshop will be held each year to discuss project progress and technical topics.

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Workshop

Research and
Demonstration of
Agricultural Uses of
Gypsum and Other FGD
Materials



November 17-19, 2009
Indianapolis, IN

Past Workshops Held:

12-14 September, 2006

St. Louis, MO

(http://www.oardc.ohio-state.edu/agriculturalfgdnetwork/workshop_files/2006workshop.htm)

23-24 October, 2007

Atlanta, GA

(<http://www.fgdproducts.org/Presentations.htm>)

November 4 (afternoon), Pittsburgh, PA
<https://www.acsmeetings.org/>

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National Research and Demonstration Network of FGD Products in Agriculture

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Long-term Gypsum Effects on Crop Yield



Gypsum application may increase crop yields for an extended time. Corn grain yields were increased by 29 to 50% and alfalfa yields by 70% in the 16th year after

gypsum was applied a to coarse sandy loam soil in Georgia. The long-lasting beneficial effects of gypsum on crop yield enabled the expense of gypsum application to be amortized during an extended period of time. Soil Science Society of America Journal 63:891-895, July-August 1999.

No-tillage and Gypsum



Gypsum applications may promote the expansion of no-tillage crop production systems onto clay soils that have usually not been no-tilled because of

compaction and aeration problems. Gypsum can increase water penetration and improve internal soil drainage because it dissolves quickly to release calcium that promotes the aggregation of soil clay particles.

<http://www.oardc.ohio-state.edu/agriculturalfgdnetwork/>

Location of Network Sites



National Network Cooperators

State	Institution	Principle Investigator	Project Years
North Dakota	North Dakota State University	Tom DeSutter	2007-2009
New Mexico	New Mexico State University	Dan Smeal	2007-2010
Indiana	USDA-ARS, Purdue University	Darrell Norton	2008-2009
Arkansas	University of Arkansas	Leo Espinoza	2008-2009
Ohio	The Ohio State University	Warren Dick	2008-2010
Alabama	USDA-ARS, Auburn University	Allen Torbert	2008-2009
Alabama	Auburn University	Charles Mitchell	2009-2010
Wisconsin	USDA-ARS, University of Wisconsin	Darrell Norton	2008-2010

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NORTH DAKOTA

Coal Creek Generating Station – Great River Energy

The Coal Creek Generating Station of Great River Energy (headquarters in Elk River, MN) is located near Underwood, ND. It is supporting research at two sites located about 8 miles south of Dickinson, ND. The soil at #1 (Wayne) is classified as Lawther silty clay from the White River formation. This site has a slope of 0 to 2 percent and has been in wheat-fallow for greater than 20 years. The soil at #2 (Gary) is classified as a Belfield-Daglum silt loam from the Golden Valley formation. This site has a slope of 0 to 2 percent and has been in a wheat-fallow rotation for greater than 10 years. Wheat crops were grown at both sites in 2007 and 2008 using no-till management. Yields, and soil and grain samples for chemical quality measurements were collected each year. Gypsum rates for both FGD gypsum and commercial gypsum were 0, 1, 5, and 10 tons/acre (0, 2.24, 11.2, and 22.4 Mg/ha).

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[Great River Energy - North Dakota](#)

[Public Service of New Mexico San Juan Generating Plant](#)

[Cinergy Cayuga Plant - Indiana](#)

[Entergy White Bluff Plant - Arkansas](#)

[TVA Widows Creek Fossil Plant - Alabama](#)

[Buckeye Power Cardinal Plant - Ohio](#)

[We Energies Pleasant Prairie Plant - Wisconsin](#)

Great River Energy - North Dakota

[North Dakota Study Description](#)

[2007 Wheat Yield Gary site](#)

[2007 Wheat Yield Wayne site](#)

[2007 Wheat Grain Chemistry Gary site](#)

[2007 Wheat Grain Chemistry Wayne site](#)

[2007 Soil Chemistry Gary site](#)

[2007 Soil Chemistry Wayne site](#)

[2007 Gypsum Chemistry](#)

[2008 Wheat Yield Gary site](#)

[2008 Wheat Yield Wayne site](#)

[2008 Wheat Grain Chemistry Gary site](#)

[2008 Wheat Grain Chemistry Wayne site](#)

[2008 Soil Chemistry Gary Site](#)

[2008 Soil Chemistry Wayne Site](#)

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2008 Wheat Yield Data - Treatment Means

Treatment (Tons/A)	Grain Yield (Bu/A)
Check (0)	20.0
FGD-Gypsum (1)	22.5
FGD-Gypsum (5)	21.9
FGD-Gypsum (10)	24.6
Mined Gypsum (1)	20.9
Mined Gypsum (5)	24.7
Mined Gypsum (10)	21.1

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Rep	Treatment tons/A	% Nitrogen	% Carbon	% Sulfur	Hg ppb or ng/g
1	Check0	2.65	43.70	0.237	2.161
2	Check0	2.83	43.46	0.284	3.655
3	Check0	2.86	43.36	0.268	1.096
4	Check0	2.77	44.06	0.242	1.276
1	FGDGyp10	2.69	43.52	0.315	1.415
2	FGDGyp10	2.86	43.42	0.300	1.297
3	FGDGyp10	2.84	43.69	0.308	1.086
4	FGDGyp10	2.66	43.54	0.265	2.169
1	CommGyp10	2.85	43.61	0.299	1.719
2	CommGyp10	2.88	43.54	0.295	1.420
3	CommGyp10	3.09	43.81	0.383	2.123
4	CommGyp10	2.91	43.37	0.309	0.905

Treatment Descriptions

Check0 = No gypsum applied

FGDGyp10 = FGD gypsum at 10 tons/A

CommGyp10 = Commercial gypsum at 10 tons/A

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Great River Energy, North Dakota
Gary Site
2007 Wheat Grain Chemistry

Rep	Sample ID	Treatment tons/A	P µg/g	K µg/g	Ca µg/g	Mg µg/g	S µg/g
1	FGD 55	Check0	4113.3	4253.8	339.4	1691.6	1498.3
2	FGD 57	Check0	3943.9	4281.1	368.8	1681.7	1550.3
3	FGD 62	Check0	4440.8	4356.9	367.4	1856.8	1564.5
4	FGD 63	Check0	4178.1	4524.6	373.9	1856.4	1546.0
1	FGD 54	FGDGyp10	3585.9	3877.8	372.8	1593.0	1665.3
2	FGD 59	FGDGyp10	3978.7	4176.0	413.4	1761.4	1831.4
3	FGD 61	FGDGyp10	4102.5	4054.1	362.2	1836.8	1709.2
4	FGD 64	FGDGyp10	3450.6	3735.2	352.0	1611.8	1676.7
1	FGD 56	CommGyp10	3575.0	3857.3	388.9	1610.3	1791.0
2	FGD 58	CommGyp10	3686.6	4033.9	402.0	1676.2	1851.4
3	FGD 60	CommGyp10	3880.0	3904.2	396.4	1707.2	1823.6
4	FGD 65	CommGyp10	3926.6	4132.6	443.2	1775.1	1970.3

Rep	Sample ID	Treatment tons/A	As µg/g	Ba µg/g	Be µg/g	Cd µg/g	Co µg/g
1	FGD 55	Check0	<1.284	10.040	<0.091	<0.048	<0.146
2	FGD 57	Check0	<1.284	9.608	<0.091	<0.048	<0.146
3	FGD 62	Check0	<1.284	7.315	<0.091	<0.048	<0.146
4	FGD 63	Check0	<1.284	9.307	<0.091	<0.048	<0.146
1	FGD 54	FGDGyp10	<1.284	5.624	<0.091	0.051	<0.146
2	FGD 59	FGDGyp10	<1.284	4.702	<0.091	0.082	<0.146
3	FGD 61	FGDGyp10	<1.284	4.462	<0.091	0.138	<0.146
4	FGD 64	FGDGyp10	<1.284	6.135	<0.091	0.131	<0.146
1	FGD 56	CommGyp10	<1.284	5.279	<0.091	0.050	<0.146
2	FGD 58	CommGyp10	<1.284	5.816	<0.091	0.061	<0.146
3	FGD 60	CommGyp10	<1.284	3.340	<0.091	0.151	<0.146
4	FGD 65	CommGyp10	<1.284	4.380	<0.091	0.101	<0.146

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Al μg/g	B μg/g	Cu μg/g	Fe μg/g	Fe μg/g	Mn μg/g	Mo μg/g	Na μg/g	Zn μg/g
<6.985	<1.523	2.71	59.44	54.15	62.46	<0.225	<13.04	37.95
<6.985	<1.523	2.85	57.93	55.20	64.32	<0.225	<13.04	44.20
<6.985	1.61	3.35	61.16	58.85	63.90	<0.225	<13.04	50.98
<6.985	1.63	3.75	59.95	56.66	70.35	<0.225	<13.04	42.50
<6.985	<1.523	2.37	55.31	50.29	60.31	<0.225	<13.04	40.36
<6.985	<1.523	3.36	61.24	57.38	65.60	<0.225	<13.04	56.11
<6.985	1.68	3.09	55.81	51.56	70.12	<0.225	<13.04	49.62
7.83	<1.523	2.73	50.58	48.15	62.35	<0.225	<13.04	38.98
<6.985	<1.523	3.34	55.24	50.92	64.90	<0.225	<13.04	43.46
<6.985	<1.523	3.11	59.71	55.62	67.70	<0.225	<13.04	48.17
<6.985	2.23	2.91	55.58	53.27	70.52	0.69	<13.04	55.03
<6.985	<1.523	3.70	61.14	58.05	68.90	<0.225	<13.04	54.84
Cr μg/g	Li μg/g	Ni μg/g	Pb μg/g	Sb μg/g	Se μg/g	Si μg/g	Sr μg/g	V μg/g
<0.194	9.143	1.295	<0.774	<1.047	<2.321	71.329	2.153	<0.297
<0.194	9.796	1.222	<0.774	<1.047	<2.321	38.809	2.461	<0.297
<0.194	7.020	0.958	<0.774	<1.047	<2.321	50.585	2.419	0.372
<0.194	8.693	1.612	<0.774	<1.047	<2.321	54.973	2.370	<0.297
<0.194	4.823	1.443	<0.774	<1.047	<2.321	27.190	2.172	<0.297
<0.194	4.711	1.351	<0.774	<1.047	<2.321	45.508	2.619	<0.297
<0.194	4.143	1.215	<0.774	<1.047	<2.321	46.716	2.589	<0.297
<0.194	5.777	1.456	<0.774	<1.047	<2.321	38.387	2.233	<0.297
<0.194	4.963	1.204	<0.774	<1.047	<2.321	33.032	2.543	<0.297
<0.194	5.557	1.617	<0.774	<1.047	<2.321	35.137	2.273	<0.297
<0.194	<3.403	1.186	<0.774	<1.047	<2.321	32.761	2.263	<0.297
<0.194	4.570	1.474	<0.774	<1.047	<2.321	41.681	2.414	<0.297

Earthworm Study





Network Mission

To serve as a repository and source of information on agricultural applications of FGD gypsum and other FGD materials



**Reception
and Poster
Begins Now!**