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USDA Natural Resources Conservation Service

What is a Conservation Practice?

- A structural or vegetative measure, or management activity used to protect or reduce the degradation of soil, water, air, plant, animal, or energy resources.

Slide courtesy of USDA NRCS

What is a Conservation Practice Standard?

- A document containing statements which:
  - define the technology
  - identify the purposes and applicability of the practice
  - establish criteria supporting each purpose
  - list special considerations useful in planning and applying the practice
  - establish installation, operation and maintenance requirements

Slide courtesy of USDA NRCS

A Practice Standard:

- Delivers technology
- Puts emphasis on the important aspects of the technology (design elements) and the latitude you have to manipulate those elements (criteria) to adapt the technology to the site
- Is about putting the "thing" on the ground

Slide courtesy of USDA NRCS

DEFINITION

Surface application of gypsiferous products to change the physical or chemical properties of soil.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where gypsiferous products will be used to alter the physical and/or chemical characteristics of soil to help achieve one of several specific purposes.

To remediate sodic soils, use the conservation practice Salinity and Sodic Soil Management (Code 610)

Fresno, CA sodic soils

Fresno series

Photo courtesy of Mike Singer

General Criteria Applicable To All Purposes

Validation of product.

It is the responsibility of the amendment provider to furnish the following documentation to the producer:

Chemical analysis of the product, which will include the calcium and sulfur content

Content of heavy metals and other potential contaminants (Table 1)

Flue gas desulfurization (FGD) gypsum that is produced after the removal of fly ash is acceptable for these uses.

Table 1. Comparison of background levels of elements in US soils; in Spent Foundry Sand; in FGDG produced after removal of fly ash; limits for elements in biosolids; limits for elements in Spent Foundry Sand; and suggested screening value for elements in FGDG produced after fly ash removal for use as soluble Ca soil amendment (a full risk assessment for beneficial use of FGDG has been begun at US-EPA but will not be available for several years). [September 11, 2014 revision.]

Element	Units	USGS 95%ile All so	USDA 95%ile Farm soils	SFS 95%ile	FGDG 95%ile Ohio St.	Biosolids "503" Limit	SFS Limit	Draft NRCS Recommendation Screening Value in soluble Ca amendment	
Ag	mg kg^{-1}	<1.0							No limit required.
Al	g kg^{-1}	7.98							No limit required.
As	mg kg^{-1}	13.1					8.	8.	
B[†]	mg kg^{-1}							200.[†]	
Ba	mg kg^{-1}	956.						1000.	
Be	mg kg^{-1}	2.5						2.5	
Ca	g kg^{-1}								Ca fertilizer; no limit required.
Cd[‡]	mg kg^{-1}							1.0[‡]	
Co	mg kg^{-1}							18.	
Cr(III)	mg kg^{-1}								No limit required.
Cu	mg kg^{-1}							30.	
Fe	g kg^{-1}								No limit required.
Hg	mg kg^{-1}	0.10			1.02	17.		2.5	
Mg	g kg^{-1}			3.06					Fertilizer; No limit required.
Mn	mg kg^{-1}	1520.		670.	79.1			1500.	
Mo	mg kg^{-1}	2.27		21.8	2.48	40.[†]		10.	
Ni	mg kg^{-1}	38.5	56.8	102.	2.39	420.	200.[§]	200.	
Pb	mg kg^{-1}	44.5	23.0	15.3	1.00	300.		30.	
Sb	mg kg^{-1}	1.49		1.23	<0.8			1.5	
Se	mg kg^{-1}	0.80		0.20	27.9	100.		50.	
Sn	mg kg^{-1}	3.1							No limit required.
Tl	mg kg^{-1}	0.80		0.09	<0.10			1.0	
V	mg kg^{-1}	136.		9.90	5.27			100.	
Zn	mg kg^{-1}	125.	126.	72.1	15.0	2800.	300.[§]	100.	

Spent Foundry Sand Limits

[†] Should not apply greater than 1 kg hot water soluble B/ha with soluble Ca product application rate.
[‡] Cd is 1% of Zn limit to restrict food-chain risks of soil Cd.
[†] Based on O'Connor et al. (2001), J. Environ. Qual. 30:1490-1507.
[§] Higher limits for Cu, Ni and Zn in Spent Foundry Sand were based on sorption capacity of these sands not present in FGDG.

Purpose: Improve soil physical/chemical properties to increase infiltration and reduce soil erosion

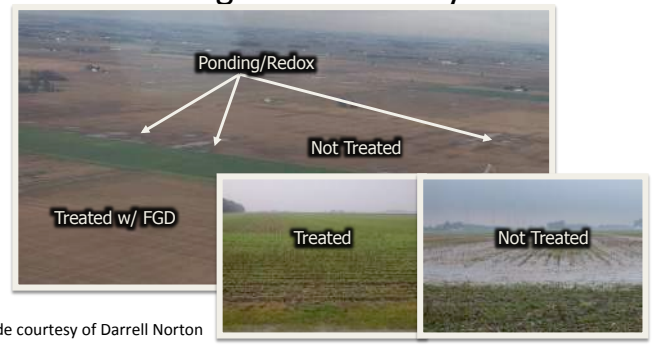
Additional Criteria:
Apply 1.5 tons/acre of gypsum when no crop is growing.

Gypsum may be applied to pasture fields anytime livestock are not present.

Improves Soil Structure

Slide courtesy of Darrell Norton

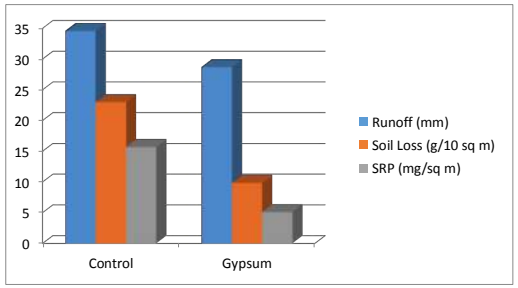
Improved Infiltration/Drainage by Amending Soil in Convoy Ohio



Slide courtesy of Darrell Norton

Tuesday morning April 30, 2013 following 1.9 inch rain
Maryland Coastal Plain

Effect of Gypsum on Erosion in No-till



Slide courtesy of Darrell Norton

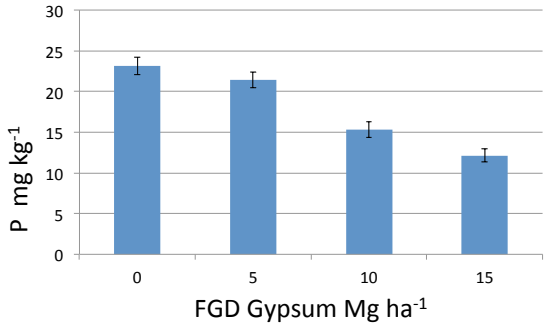
Purpose: Reduce dissolved phosphorus concentrations in surface runoff and subsurface drainage

Additional Criteria:

General Use on High P Soils – Apply 2 tons/acre broadcast on the soil surface when soil test phosphorus (STP) is greater than two times the "maximum optimum level" for crop production, or when the P Index rating for the field is ***HIGH*** or ***VERY HIGH***.

Manure Application – Broadcast 1 ton/acre of gypsum within 5 days after manure application or prior to the next runoff event, whichever occurs first

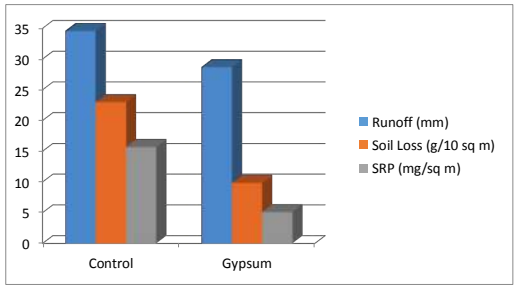
Water Extractable P: 0-15 cm
Jan 2013* (9 months after application)



* Ten-sample transects
USDA-ARS, University Park, PA

Slide courtesy of Loretta Collins

Effect of Gypsum on Erosion in No-till



Slide courtesy of Darrell Norton

Tile Drainage water

Samples were collected from a farm near Hicksville, OH on December 20, 2012.

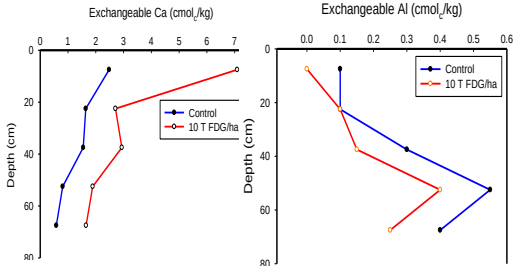
In all we have collected 58 samples, to date, and the soluble P from gypsum treated soils is 0.047 Mg/L (ppm) and from untreated soils it is 0.104 mg/L (Courtesy of Dr. Warren Dick, Ohio State Univ.)

Slide courtesy of Darrell Norton

Purpose: Mitigate subsoil aluminum toxicity

Additional Criteria:
When exchangeable aluminum below a 12-inch soil depth is greater than 1.0 meq/100 mg soil, apply gypsum at a rate recommended by the Land Grant University (LGU) or ARS.

GYPSUM AMELIORATES SUBSOIL ACIDITY

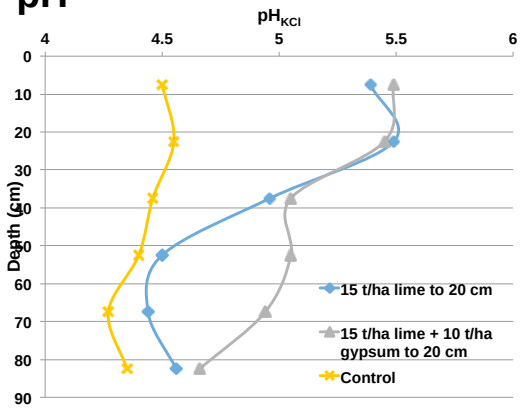


The University of Georgia

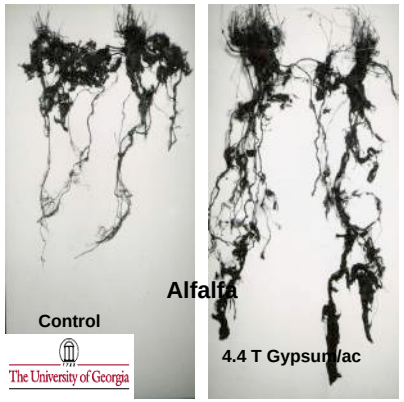
Sumner et al. (1986)

Slide courtesy of Malcolm Sumner

Effect of Gypsum on Soil pH



Slide courtesy of Malcolm Sumner



Slide courtesy of Malcolm Sumner

Long-term Effects of Gypsum

(Toma et al., 1999)

Gypsum applied in 1982 (T/ha)	Exch. ions ($cmol_c$/kg) at various depths (cm) in 1997						Yields (T/ha)		
	25-50		50-75		75-100		Alfalfa	Corn	Alfalfa
	Ca	Al	Ca	Al	Ca	Al	1982-89	1997	1998
0	1.2	1.3	0.8	2.0	0.4	2.0	5.28	6.6	5.35
10	2.2	0.9	2.0	1.0	1.9	1.5	7.50	8.5	9.10

The University of Georgia

Slide courtesy of Malcolm Sumner

Purpose: Reduce the potential for pathogen transport

Additional Criteria:

Apply 2.0 tons of gypsum within 5 days after manure or biosolid application, or prior to the next runoff event after manure application, whichever occurs first.

Subplot (1 x 2 m) within a 4- x 6-m plot

Slide courtesy of Michael Jenkins

Percentage of *E. coli* recovered in runoff

Treatment	2009 Simulation	2011 Simulation
	Percent	
Control	0.55[a]	2.9E-6[a]
GypNoPL+	0.23[a]	0.20[b]
GypLowPL+	0.86[a]	0.27[b]
GypMedPL+	2.83[a]	0.10[b]
GypHighPL+	0.09[a]	0.003[c]
GypHighCntl	0.07[a]	1.0E-6[a]

Results

- **After a third year application of FGD gypsum, the high rate of 9.0 Mg ha^{-1} decreased the *E. coli* load in runoff.**
- **Our results demonstrated that FGD gypsum applications may be considered a management practice capable of reducing hydrologic loads of fecal bacteria and other pathogenic fecal microorganisms.**

Slide courtesy of Michael Jenkins

PLANS AND SPECIFICATIONS

Source of the product, e. g., flue gas desulfurization, mined

Purpose(s) for its use, and the planned outcomes.

Chemical analysis of the amendment product

Soil and/or plant analyses that demonstrate the need

Application methodology, including rates, timing, sequence of application with other nutrient materials (i.e., manures, biosolids, fertilizers), mixing instructions

Required soil and plant analyses after application to determine the effectiveness of the amendment as appropriate.

OPERATION AND MAINTENANCE

Do not allow livestock access to stacked gypsum.

Do not resume grazing until rainfall or irrigation has washed gypsum off of the vegetation.

Do not apply gypsum after the soil test calcium level exceeds the maximum level established by the Land Grant University.

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Questions?