



Natural Resources Conservation Service
CONSERVATION PRACTICE STANDARD
AMENDING SOIL PROPERTIES WITH GYPSUM PRODUCTS
CODE 333
(Ac.)

DEFINITION

Using gypsum- (calcium sulfate dihydrate) derived products to change the physical and/or chemical properties of soil.

PURPOSE

This practice may be applied for one or more of the following purposes:

- To improve soil health by improving physical/chemical properties and increasing infiltration of the soil;
- To improve surface water quality by reducing dissolved phosphorus concentrations in surface runoff and subsurface drainage;
- To improve soil health by ameliorating subsoil aluminum toxicity;
- To improve water quality by reducing the potential for transport of pathogens and other contaminants from areas of manure and biosolids application.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where land application of gypsum products will be used to alter the physical and/or chemical characteristics of soil.

CRITERIA

General Criteria Applicable to All Purposes

Validation of Product. It is the responsibility of the amendment provider to furnish chemical analysis documentation for the product to the producer. The chemical analysis documentation will include the calcium and sulfur content, the content of heavy metals, and all other potential contaminants listed in Table 1. Concentrations of potential contaminants cannot exceed maximum allowable concentrations listed in Table 1. In addition, the radium-226 concentration in the gypsum-derived product cannot exceed 10 picocuries per gram (pCi/g).

Flue gas desulfurization (FGD) gypsum that is produced by forced-oxidation wet systems after the removal of fly ash is acceptable for this practice. Gypsum-derived products must have a particle size less than 1/8 inch. Fluid application is acceptable.

Application Rates. The prescribed minimum application rates shall be based on a calcium sulfate dihydrate equivalency of 100 percent. Application rates for products that are less than 100 percent calcium sulfate dihydrate equivalence must be adjusted accordingly.

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service [State Office](#) or visit the [Field Office Technical Guide](#).

Do not exceed annual application rates of 5 tons/acre for the purposes defined in this standard. Use a soil analysis no older than 1 year that provides cation exchange capacity (CEC), calcium, magnesium, pH, and phosphorus, as a minimum, to plan the appropriate application rate of the gypsum products.

Gypsum may be applied to fields any time livestock are not present. Do not allow livestock reentry until the gypsum products have been removed from the vegetation by rainfall or irrigation.

Table 1. Screening values for elements in gypsum-derived products for use as a soil amendment.

Symbol (Element)	Units gram (g) kilogram (kg) milligram (mg)	Screening Value for Gypsum-Derived Products	Comment
Ag (Silver)	mg kg ⁻¹	...	No limit required
Al (Aluminum)	g kg ⁻¹	...	No limit required
As (Arsenic)	mg kg ⁻¹	13.1	...
B [†] (Boron)	mg kg ⁻¹	200. [†]	...
Ba (Barium)	mg kg ⁻¹	1000.	...
Be (Beryllium)	mg kg ⁻¹	2.5	...
Ca (Calcium)	g kg ⁻¹	...	Ca fertilizer; no limit required
Cd [‡] (Cadmium)	mg kg ⁻¹	1.0	...
Co (Cobalt)	mg kg ⁻¹	20.	...
Cr(III) (Chromium)	mg kg ⁻¹	100.	...
Cu (Copper)	mg kg ⁻¹	95.	...
Fe (Iron)	g kg ⁻¹	...	No limit required
Hg (Mercury)	mg kg ⁻¹	2.5	...
Mg (Magnesium)	g kg ⁻¹	...	Mg fertilizer; no limit required
Mn (Manganese)	mg kg ⁻¹	1500.	...
Mo (Molybdenum)	mg kg ⁻¹	10.	...
Ni (Nickel)	mg kg ⁻¹	100.	...
Pb (Lead)	mg kg ⁻¹	30.	...
S* (Sulfur)	g kg ⁻¹	220.	S fertilizer; *limit access to ruminants
Sb (Antimony)	mg kg ⁻¹	1.5	...
Se (Selenium)	mg kg ⁻¹	50.	...
Sn (Tin)	mg kg ⁻¹	...	No limit required
Tl (Thallium)	mg kg ⁻¹	1.0	...
V (Vanadium)	mg kg ⁻¹	136.	...
Zn (Zinc)	mg kg ⁻¹	125.	...

[†] Should not apply greater than 0.9 lb. hot water soluble B/acre with gypsum amendment application rate.

[‡] Cd is 1% of Zn limit to restrict food-chain risks of soil Cd.

* Prevent ruminant livestock from ingesting gypsum from storage piles; prevent grazing on amended pastures until one rainfall (or irrigation) event to wash forage.

Additional Criteria to Improve Soil Health by Improving Physical/Chemical Properties and Increasing Infiltration of the Soil

Use Tables 2a and 2b to determine the application rate of gypsum products when slow infiltration and percolation due to poor aggregation is caused by an imbalance between calcium and magnesium.

CEC is an indirect indicator of clay and organic matter content of soil and is related to how adjustment is needed when certain cations are excessive or deficient. The saturation ranges in Table 2a represent optimal cation availability for good soil structure as well as plant and biological use.

Table 2a. Target ranges for base saturation of cations to improve soil chemical and physical properties.

Base Saturation	Balanced
Calcium	70–80%
Magnesium	10–13%
Potassium	2–5%
Hydrogen	1–10%

Of the cations listed in Table 2a, calcium and magnesium have the greatest impact on soil structure. Lower CEC soils that tend to be droughty perform best with calcium at the lower end of the range and magnesium at the higher end. Higher CEC soils tend to perform best with calcium at mid-to-high range and magnesium at the lower end of the range.

Table 2b lists recommended annual application rates based on CEC. Multiple applications at the recommended rates will improve soil chemical and physical properties in a reasonable time without creating soil nutrient imbalances. When the ratios shown in Table 2a are achieved, reduce or stop applications until soil test values indicate otherwise.

Table 2b. Gypsum application rates to improve soil chemical and physical properties. Goal: Base saturation of calcium = 70 to 80 percent.

CEC	Annual Application Rate (tons of gypsum/acre)
<5	0.25
5–10	0.5
10–15	1
>15	2

Additional Criteria to Improve Surface Water Quality by Reducing Dissolved Phosphorus Concentrations in Surface Runoff and Subsurface Drainage

General Use on High Phosphorus Soils. Apply no less than 1 ton/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 no less than 1 ton/acre of gypsum within 5 days after manure application or prior to the next runoff event, whichever occurs first. Mixing gypsum with manure prior to application is acceptable. **CAUTION:** Under anaerobic conditions, gypsum added to liquid manure storage facilities can result in dangerous levels of hydrogen sulfide emissions. Do not perform mixing or agitation of liquid manure with gypsum indoors. Gypsum has also been known to produce excessively high hydrogen sulfide emissions when mixed into outdoor, open-top liquid manure storages.

Additional Criteria to Improve Soil Health by Ameliorating Subsoil Aluminum Toxicity

When exchangeable aluminum below a 12-inch soil depth is greater than 1.0 milliequivalent/100 mg soil, apply gypsum at a rate recommended by the University of Maryland Extension or the Agricultural Research Service (ARS). Use a soil analysis for aluminum no older than 1 year to plan the appropriate application rate of the gypsum products.

Additional Criteria to Reduce the Potential for Pathogen Transport

Apply no less than 2 tons/acre of gypsum within 5 days after manure or biosolid application, or prior to the next runoff event after manure application, whichever occurs first.

Note: Specific programs may dictate criteria in addition to, or more restrictive than, those specified in this standard.

CONSIDERATIONS

General Considerations

If soil pH is less than 5, the application of products with high sulfite content may be harmful to plants that are present at the time of application.

Long-term use of gypsum, or using rates higher than given in the criteria, can have adverse impacts on soil or plant systems. This can include:

- Where gypsum-derived products are alkaline due to impurities, raising the soil pH to a level that is detrimental to plant growth or nutrient balance;
- Creating a calcium imbalance with other mineral nutrients such as magnesium and potassium.

Additional Considerations for Improving Soil Health by Increasing Infiltration and Improving Physical/Chemical Properties of the Soil

There is some research that shows gypsum application can increase crop-rooting depth, total root biomass, and nitrogen uptake.

Additional Considerations to Improve Surface Water Quality by Reducing Dissolved Phosphorus Concentrations in Surface Runoff

Increasing the gypsum application rate beyond that set in Criteria will provide an additional decrease in dissolved phosphorus loss. However, the additional decrease in phosphorus runoff at gypsum rates above 2 tons/acre is not proportional to the additional cost.

PLANS AND SPECIFICATIONS

Plans and specifications for this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail to ensure successful implementation of this practice, and may be recorded in narrative form, on Implementation Requirements (IR) sheets, on fact sheets, or other approved forms.

The appropriate fact sheet(s) and completed 333 IR sheet can serve as the plan and specifications for this practice. The following items shall be addressed, as appropriate:

- Purpose(s) for the use of the amendment product;

- The type of product, e.g., flue gas desulfurized, mined;
- Chemical analysis of the amendment product;
- Soil analyses demonstrating the need for the amendment;
- Application methodology, including rates, timing, sequence of application with other nutrient materials (i.e., manures, biosolids, fertilizers), and mixing instructions when mixed with manure prior to field application;
- Required soil and/or plant analyses after application to determine the effectiveness of the amendment.

Supporting Data and Documentation

The following is a list of the minimum data and documentation to be recorded in the case file:

- Location of the practice on the conservation plan map;
- Assistance notes. The notes shall include dates of site visits, name or initials of the person who made the visit, specifics as to alternatives discussed, decisions made, and by whom;
- Completed IR sheet, and copy of the appropriate fact sheet(s) or other specifications and management plans;

OPERATION AND MAINTENANCE

An Operation and Management (O&M) plan shall be prepared and is the responsibility of the client to implement. The appropriate fact sheet(s) and/or IR sheet may serve as the management plan, as well as supporting documentation, and shall be reviewed with and provided to the client.

At a minimum, the following components shall be addressed in the O&M plan, as applicable:

- Monitor the soil test levels of all nutrients, cation exchange capacity, and base saturations. Do not apply gypsum after the soil test calcium level exceeds the maximum level established by the University of Maryland Extension;
- Do not allow livestock access to stacked gypsum, and do not allow livestock into fields treated with gypsum until the gypsum is washed off the vegetation and residue.

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