



BLAST-FURNACE SLAG AS AN AGRICULTURAL LIMING MATERIAL and SOURCE OF MINOR PLANT NUTRIENTS

The benefit to agricultural crop production and soil fertility of having proper levels of alkalinity has been well-established. People in all types of cultivation periodically add liming material to their soil to attain proper pH. They also recognize the need for adding minor elemental nutrients, such as boron. Soil tests determine how many tons per acre of liming material and nutrients to apply.

In areas where iron and steel are manufactured, an agricultural blast-furnace slag product may be available as an economical alternative to agricultural limestone or dolomite and as a better source of minor nutrients.

Agricultural Slag Comes From Limestone and Dolomite

Agricultural slag, or Ag-Slag, is a fine-screened material from the processing of iron blast-furnace slag, a by-product of the iron and steel industry. The slag can be water-cooled, granulated, or air-cooled. Chemically, blast-furnace slag is the nonmetallic material consisting essentially of calcium and magnesium silicates and aluminosilicates. It is the direct result of adding limestone and dolomite to the blast furnace to flux or combine with the nonmetallic elements in the iron ore. Iron blast-furnace slag should not be confused with steel-furnace slag or other types of slag.

The Use of Ag-Slag is Time-Proven

Ag-Slag has proven its value as an agricultural liming material since the 1920's in all types of crop production and landscaping.

- Farmers use Ag-Slag for maximum yields of cultivated crops and pasture.
- Home vegetable gardeners need an easy-to-spread slag liming material. It also helps to improve soil texture, i.e., break up clay-like soil. Minor nutrient fertilization from Ag-Slag is a big attraction.
- Parks, golf courses and lawns need to correct soil acidity in order to assure optimum benefit of applied fertilizer. Ag-Slag flows easily through lawn spreaders.
- Nurseries and greenhouses use Ag-Slag is making rich soil for plant beds and potting soil.
- Land reclamation projects, e.g., coal strip mining, need a liming material to neutralize high soil acidity.

Ag-Slag Performance is Equivalent to Limestone

According to studies as far back as 1927 by Penn State University, Ohio State University, U.S. Department of Agriculture, Auburn University, and Canadian research, Ag-Slag applications have been equivalent to limestone and dolomite in increasing crop yields at equal levels of fineness.

Agricultural slag corrects soil acidity basically in the same manner as limestone. Calcium carbonate equivalence (CCE) ratings can be directly compared. CCE levels for Ag-Slag should be above 90 and often greater than 95 due to higher levels of magnesium than in past years.

Although a finer gradation of any liming material will work faster because of more surface area exposed, coarser gradings will last longer, i.e. five-year crop rotation period.

Ag-Slag is more often coarser than limestone but should be adequate to maintain proper levels of soil pH. To quickly correct a low pH or acid soil problem, a finer graded agricultural slag material should be used. It is also easier to spread, particularly in a damp condition.

Because agricultural slag corrects soil acidity by a slightly different chemical reaction, the CCE test procedure in ASTM C-602 specification, Agricultural Liming Materials, is slightly different for slag than it is for limestone, as recommended by the Association of Agricultural Chemists.

Based on soil tests and the desired crop, the application of a magnesium-bearing, liming aid is usually recommended. Present-day Ag-Slag with 10-14% magnesia (MgO) should be sufficient.

Table 1 The major chemical constituents in 17 sources of blast-furnace slags in the United States are listed below:

	<u>% Range</u>	<u>% Average</u>
Calcium as calcium oxide, CaO	34.0-42.7	38.5
Magnesium as magnesium oxide, MgO	9.9-14.9	11.8
Aluminum as aluminum oxide, Al ₂ O ₃	6.9-11.7	10.0
Silicon as silicon dioxide, SiO ₂	26.6-38.0	35.7
Sulfur as sulfur, S	1.0-1.8	1.5
Iron as iron oxide, Fe ₂ O ₃	0.3-0.6	0.5
Manganese as manganese oxide, MnO	0.15-0.76	0.5

Boron and Other Minor Elements Give Greater Value to Slag's Liming Effect

Table 2 Minor elements in Ag-Slag:

	Parts Per Million
Zinc, Zn	2-24
Copper, Cu	3-17
Boron, B	80-200
Potassium, K	2,000-10,000
Molybdenum, Mo	1-3

In experiments where Ag-Slag gave better results than limestone, the reason most often cited was the minor plant nutrient elements that blast-furnace slag possesses. Many researchers believe that slag has value greatly in excess of its actual liming value. These include:

- Victor A. Tiedjens, Associate Professor of Vegetable Gardening, Rutgers University: *"Slag is a fine material to use and is worth even more than pulverized limestone, if the soil is low in minor elements . . . I have seen some results with this material that approached a miracle."*
- Dr. F .H. Crane, Assistant Chief in Soil Fertility, Illinois College of Agriculture and Experiment Station: *"Tests at Pennsylvania indicate that. . . slag apparently had an effect in increasing yields beyond that which its content of calcium and magnesium would lead one to expect."*
- J.W. White, F.J. Holben and C.D. Jeffries, Pennsylvania State College: *"(Experiments show) slag has a value greatly in excess of its actual lime content."*
- Dr. H.P. Thomas, Professor of Soils at the University of Maryland: *"It has been my observation that slag frequently stimulates plant growth when other forms of lime do not. . . It is believed that minor elements may play an important part in the stimulation."*
- G. W. Yolk, R.B. Harding and C.E. Evans, Ohio Agricultural Experiment Station: *"Blast-furnace slag can be used more freely than limestone because it does not raise the pH or sweeten the soil as rapidly as limestone. 'Over-liming' injury may be avoided by the use of blast-furnace slag. Slag used on soils that were boron deficient produced better yields than did limestone without borax."*

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