



## Phosphate Fertilizer Production

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### Introduction

Most agricultural fertilizers contain three basic plant nutrients -- nitrogen, phosphorus, and potassium -- as well as small amounts of certain "micronutrients" such as zinc and other metals necessary for plant growth. Phosphorus is essential for plant photosynthesis, cell enlargement and division, and energy storage. Although most soils naturally contain some phosphorous, only small amounts are accessible to plants (Fertilizer 101, page 28). In fact, phosphorous deficiencies are widely responsible for low crop yields in many global agricultural production regions. This briefing paper describes processes used to produce common phosphorus-based fertilizers.

### Phosphate Fertilizer Production

The production of commercial phosphate fertilizer begins with the mining of phosphorus ore (e.g, fluirapatite) which contains phosphoric acid and was formed from the remains of ancient sea life. Phosphate ore reserves are known to exist in 32 countries, but the United States, China, and Morocco currently account for 68 percent of total world production. Most phosphate rock mined in the United States comes from deposits in the

Florida peninsula between 15 and 50 feet below soil surfaces. Such ore is typically mined using open-pit methods, in which a dragline extracts a mixture of ore deposits (phosphate minerals), sand, and clay. Phosphate rock is then separated from this mixture and shipped to processing plants.

Many phosphate processing plants use a "wet process" to recover phosphorus minerals from phosphate ore.<sup>1</sup> Initially, phosphate ore is crushed and then treated in a reactor vessel with sulfuric acid, phosphoric acid, and recycled nitric acid to isolate phosphorus minerals. The resulting weak form of phosphoric acid is subsequently clarified and concentrated in a vacuum evaporator to produce concentrated phosphoric acid, which is further processed into a range of phosphorous fertilizer products.

### Phosphate Fertilizers

Common granular phosphorus-based fertilizers includes: single superphosphate (SSP), triple superphosphate (TSP), diammonium phosphate (DAP), and monoammonium phosphate (MAP).<sup>2</sup> Each of these fertilizers is produced using slightly different manufacturing processes.<sup>3</sup>

<sup>1</sup> An alternative to the wet process is a less widely used "dry production process." Dry production processes heat phosphate ore in furnaces to produce white or furnace acid. Although some fertilizers use white phosphoric acid as a source of phosphate, it is much more expensive.

<sup>2</sup> See [Briefing Paper 107](#) for a description of the various uses of each phosphate fertilizer.

<sup>3</sup> The general process of granular production is described in [Briefing Paper 112](#).

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### Objective

### Analysis For

### Informed

### Decision Making

SSPs are produced by first removing residual water from clarified phosphoric acid and then using heat to concentrate the result into a molten product, which is then processed in rotating drums to form solid granules. TSP granules are formed through a similar process after concentrated phosphoric acid has been reacted with sulfuric acid and recycled nitric acid.

Phosphoric acid is also used by ammonia production facilities to produce MAP and DAP fertilizers. In both cases, ammonia is added to unheated phosphoric acid in a blending tank to produce either MAP (11-52-0) or DAP (18-46-0) depending on the relative amounts of ammonia used in the blending process.<sup>4</sup> MAP and DAP are commonly sold in granular forms. Granular forms of phosphate fertilizers are either bagged or stored in bulk forms (Figure 1).

## Summary

Phosphorus-based fertilizers are produced by mining phosphorus-bearing rock in open-pit mines using surface-mining techniques. Mined rock is then separated from clay and other substances using acidulation to produce a concentrated form of phosphoric acid. Phosphoric acid solutions are granulated in a variety of ways to produce SSP, TSP, DAP and MAP fertilizers.

## References

The Fertilizer Institute. "[Fertilizer 101](#)". Washington D.C. 2004

**Figure 1: Granular Forms of Phosphate Fertilizers**



(a) Single Superphosphates (SSPs)



(b) Triple Superphosphates



(c) MAP



(d) DAP

<sup>4</sup> Various methods are used to blend compounds for the production of composite fertilizers such as MAP and DAP. Sometimes compounds are blended in solutions before being heated and transformed into granules. Alternatively, the granular forms of each compound are blended in a mixing drum, whose revolutions can be specified to produce the desired blend.