Crop Production on Reclaimed Phosphate-mined Soils in Florida

Florida produces nearly 80% of the United State’s and up to 25% of the world’s phosphate (1). Begun in the 1800s, Florida phosphate mining occurs mostly in south-central Florida (Bone Valley) and, to a lesser degree, in extreme northern Florida. About 90% of Florida phosphate is used in agricultural fertilizers and 5% goes into animal feed supplements (1). The remainder is used in many products, including soft drinks, flame-proofing compounds, insecticides, plastics, and cleaning products.

Phosphate rock, deposited from sea water at least 10 million years ago, occurs in a layer of variable thicknesses and depths. This layer of ore is made up of a mixture of roughly one-third each of phosphate rock, sand, and clay.

The mining process begins when large draglines (Fig. 1a) remove up to 50 feet of “overburden”, including topsoil, which is placed in piles to be used later in site reclamation. Following removal of overburden, the ore body (or matrix) is removed and placed in a pit where it is liquefied with water and pumped via a pipeline to a processing plant, where the phosphate rock is extracted.

The ore is washed, centrifuged, crushed, and vibrated in several steps designed to separate phosphate particles from sand and clay. These mechanical processes result in three products: coarse phosphate rock that goes to inventory piles, fine clay suspended in water that is pumped to a holding (settling) area (Fig. 1b), and “feed”, which is a mixture of sand and fine phosphate. Feed material requires further processing in several steps with mild chemical additives. The separated sand is pumped to the mining area to fill the mine cavities (Fig. 1c), and the phosphate is conveyed to inventory piles and then to processing plants for manufacture of phosphate fertilizers.

After mining, the disturbed landscape consists of piles of overburden, piles of sand tailings (Fig. 1d), and clay settling areas.

About two-thirds of mined land consists of clay settling ponds. Since 1975, state law has required that mined lands be reclaimed through a detailed procedure that would return the land to such forms as natural wetlands, pastures, forests, and agricultural land useful for crop production.

Crop production uses of reclaimed lands have been minimal except for some citrus grove establishment. Research on use of reclaimed lands for high-value crop production has been minimal, mostly dealing with sand tailings (2-5). Return of reclaimed land to production of high-value crops, such as citrus and vegetables, is very important to the overall economy of the counties in the Bone Valley area. Land values (thus taxes) are reduced greatly once phosphate rock has been mined. As the mining is completed in one county and moves southward, there is a potential negative effect on the county economy.

On 1 Oct. 1985, the Polk County Mined Lands Agricultural Research and Demonstration Project was established. The goal of this project is to determine and demonstrate production practices for high-value agricultural crops. Funding for the 10-year project will be provided largely from the Florida Institute for Food and Agricultural Research, which is a Florida state agency funded from a severance tax on phosphate ore. Other funds will come from Polk County and from “in-kind” support from the IFAS, Univ. of Florida. Research and demonstration projects will be conducted largely by IFAS faculty, county personnel, and by private cooperators on several mined sites in Bone Valley.

Since clay settling ponds comprise the largest portion of reclaimed land, the project will focus on intensive crop production on these lands. This focus will include vegetable, grain, and ornamental crop production.

The phosphatic clay areas present several unique challenges for crop production that are unlike clay soils in other parts of the United States. When deposited, these clays are only 5% solids and usually take many years of consolidation before they will support traffic. Even then, the rooting (aerated) zone may only be several inches deep. Below, the clay remains in semi-liquid form. Recently, new techniques have been used to hasten the drying process so that phosphatic clay surfaces will support machines in only a few years from initial draining.

The phosphatic clay “soil” of these ponds is enriched in almost all plant nutrients except nitrogen. The clay contains high quantities of P, Ca, Mg, and some micronutrients. Potassium is usually in moderate supply. The largest problems in using these clays for crop production are soil tillage, equipment traffic, and crop stand establishment.

The main objectives of the project will be to develop, or translate, existing technology...
Vegetable research at the project will involve soil modifications by incorporating organic matter from several sources, including sludge and in situ-produced biomass. Methods will be studied to modify the soil surface to promote surface drainage, allowing rapid surface drying following rain. This effort will involve study of various land-forming and bedding practices.

Studies also will be directed at modifying the rooting zone to provide optimum aeration and water drainage. Organic matter and sand/clay mixes will be included in these studies. Methods, such as anticrustants to aid crop stand establishment, will be evaluated in the field on amended and unamended clay surfaces.

In preliminary studies, seedling emergence of some crops in unamended clay has been satisfactory (Fig. 2). Other crops may require soil modification. In a greenhouse study, some seed coverings appeared to have promise for increasing plant emergence (Table 1).

In addition to applied production studies, researchers will evaluate the economics of various cropping systems, including the polyethylene mulch system (Fig. 3). These studies will help determine crop selection and timing of production that will fit most appropriately into Florida’s overall vegetable cropping seasons.

Florida produces nearly 20% of the fresh vegetables in the United States, but available, highly productive soil is becoming scarce. Urbanization is claiming large areas of agricultural land in much of the warmer parts of the state, and oxidation of muck will remove large tracts of land from production in the future. The phosphatic clays represent a potentially useful area for intensive crop production. Returning this land to high-value crop production would benefit the population of an area that would otherwise lose economically as phosphate mining is completed. However, large challenges are presented in using these lands for crop production. The Mined Lands Project is a cooperative effort among many participants, including the phosphate companies, Polk County, the state of Florida, and IFAS. The determination and demonstration of specific production practices is the critical first step to returning these soils to the aesthetic and financial benefit for the affected counties and for the state of Florida.

**Literature Cited**


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