PHOSPHATE ROCK

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Phosphorus is an essential element for plant and animal nutrition. Most phosphorus is consumed as a principal component of nitrogen-phosphorus-potassium fertilizers used on food crops throughout the world. Phosphate rock minerals are the only significant global resources of phosphorus.

The United States was the world's leading producer and consumer of phosphate rock, which was used to manufacture phosphate fertilizers and industrial products (Potash and Phosphate Institute, 1999.) In 1998, 11 companies operated 18 phosphate rock mines. More than 93% of the phosphate rock mined was used to produce chemical fertilizers and animal feed supplements, although production decreased by 4% compared with 1997. Companies in Florida and North Carolina accounted for 88% of the marketable phosphate rock mined in the United States and processed most of the refined mineral in fertilizer upgrading facilities. The average value of marketable phosphate rock increased by 4% compared with that of 1997.

Phosphate rock also was mined in Idaho and Utah, where the mineral was upgraded into high-analysis phosphate fertilizers and elemental phosphorus (P_4). Two companies in Idaho produced P_4 for use in downstream industrial products.

In the United States, consumption of marketable phosphate rock increased by 3% compared with that of 1997. U.S. phosphate rock sold or used by producers was 43.7 million metric tons (Mt), a 4% increase compared with that of last year. The U.S. Department of Commerce (DOC) reported that wet-process phosphoric acid (WPPA) production was 11.4 Mt as available phosphorus pentoxide (P_2O_5), which represented an industry operating rate of 96% (Bureau of the Census, 1999). The United States accounted for 55% of global interregional converted phosphate (P_2O_5) trade. The major products, were, in order of importance, diammonium phosphate (DAP), monoammonium phosphate (MAP), granular triple superphosphate (TSP), and WPPA.

Legislation and Government Programs

The Florida Department of Environmental Protection drafted new standards aimed at preventing spills from water-containment systems on phosphogypsum stacks. This was in response to a December 1997 accident at the Mulberry Phosphates, Inc., plant that allowed 1,900 hectoliters of acidic water to flow into the Alafia River (Green Markets, 1997). The new regulations will require operators to demonstrate that stacks are constructed with sound engineering practices to prevent accidental discharges. In addition, companies must maintain documentation detailing the inspection program and emergency plan. The new standards were set to take effect July 1, 1999; companies, however, will have 9 months to meet the provisions of the rules and 3 years to close water systems that cannot be brought up to the new standards (Fertilizer Markets, 1998c).

In Maryland, the State General Assembly passed The Water Quality Improvement Act of 1998, which was signed into law by the Governor on May 12. The law resulted from recommendations contained in the 1997 Citizen's Pfiesteria Action Commission report. A key finding of the study indicated a probable link between populations of the microorganism, *Pfiesteria piscicida*, and nutrient enrichment, which resulted in fish kills in three waterways in 1997. A concurrent study by another group concluded that phosphorus runoff can be high even in soils without significant erosion. This led to a higher emphasis on phosphorus in the nutrient management program. The Act requires that a mandatory nitrogen- and phosphorus-based nutrient-management program for commercial fertilizer users must be developed by December 31, 2001, and implemented by December 31, 2002. Farmers using animal manure or sludge have until July 1, 2004, to submit a plan that must be implemented by July 1, 2005. The Act also orders that chicken feed include an enzyme additive to reduce the phosphorus content of the manure. Other provisions of the law provide tax credits and assistance to farmers to help achieve compliance (Simpson, 1998).

Production

Domestic production data were collected by the U.S. Geological Survey (USGS) from monthly and semiannual voluntary surveys of producers of phosphate rock. All 11 phosphate rock companies responded to the canvass, which represented 100% of U.S. production.

Domestic marketable production of phosphate rock decreased by 4% compared with that of 1997 (tables 1-2). U.S. mines operated at 80% of rated production capacity owing to several mines in Florida that were closed or operational for part of the year to reduce inventory and conserve reserves (table 13). After several years of consolidation, the phosphate industry in the United States has moved toward greater vertical integration. Of the 20 phosphoric acid plants in the United States, only 4 relied entirely on purchased rock. Of these four, one planned to open its own mine by 2004.

Southern States.—In Florida, phosphate rock was mined and processed by six companies—Cargill Fertilizer, Inc.; CF Industries, Inc.; IMC-Agrico Co.; Agrifos LLC; Nu-Gulf Industries, Inc.; and PCS Phosphate, Inc., their mines and plants were located in Hamilton, Hardee, Hillsborough,

Manatee, and Polk Counties. U.S. Agri-Chemicals Corp., Farmland Industries, Inc.-Norsk Hydro, L.P., and Mulberry Phosphates operated WPPA and ammonium phosphate plants at Fort Meade, Green Bay, and Mulberry, respectively, using phosphate rock purchased from other producers in Florida as feed. The Piney Point Phosphates, Inc., ammonium phosphate plant in Manatee County was idle, but it was scheduled to reopen in mid-1999. Six concentrated phosphate plants were located along the Gulf of Mexico. IMC-Agrico operated facilities at Faustina, Taft, and Uncle Sam, LA, using phosphate rock from the firm's mines in Florida. The PCS Nitrogen, Inc. plant in Geismar, LA, on the Mississippi River and Mississippi Chemical Corp. plant in Pascagoula, MS, on the Gulf of Mexico used phosphate rock imported from Morocco. The Agrifos plant in Pasadena, TX, supplemented rock from the company's mine in Florida with imports from Morocco.

IMC Global Inc. completed a restructuring program in the fourth quarter of 1998 to consolidate the phosphate and potash businesses of IMC-Agrico into a single operating unit, IMC Crop Nutrients. The phosphate business will be known as IMC-Agrico Phosphates and the potash business, IMC Kalium (IMC Global Inc. 1998). IMC-Agrico which is a joint venture between IMC Global and Phosphate Resource Partners Limited Partnership, was the world's largest producer of phosphate rock and fertilizers. As part of the company reorganization, IMC-Agrico will close one of its seven mines in 1999 owing to depletion of reserves and close two other mines for at least 6 months to reduce mining costs, to work down stockpiles of rock, and to conserve reserves. The company also adjusted production schedules at its phosphate plants in response to seasonal demand (Green Markets, 1998e). The Nichols, FL, phosphoric acid plant was closed in October and the Taft DAP plant was closed in February, November, and December (IMC Global Inc., 1998). In 1998, the company did not report any production of uranium oxide (U_3O_8) and will close the U_3O_8 recovery plants in Florida and Louisiana permanently in 1999. IMC-Agrico Feed Ingredients began expansion of its defluorinated phosphate production capacity. This will increase phosphate animal feed production capacity to 700,000 metric tons per year (t/yr) (Phosphate Resource Partners Limited Partnership, 1998).

In April, IMC-Agrico purchased reserves from Mississippi Chemical in Hardee County, FL, covering 5,000 hectares (ha) for $57 million (Green Markets, 1998c). As of December 31, the company reported total proven rock reserves of 481 Mt, with an average grade of 30.4% P_2O_5; an additional 103 Mt was classified as resources. The company also continued its efforts to obtain permits for two new mines, Pine Level and Ona, that will be located further south of the current phosphate mining areas in DeSoto, Hardee, and Manatee Counties. The new mines will be required when reserves at operating mines are depleted (Phosphate Resource Partners Limited Partnership, 1998).

Cargill operated two mines and two WPPA/fertilizer plants in central Florida. A third mine was inactive in 1998. In early October, one of the two phosphate rock crushing mills at the firm's Riverview, FL, WPPA plant had mechanical problems, and repairs were not completed until late November. This caused a decrease in the company's annual output of concentrated phosphate fertilizers (Fertilizer Markets, 1998b).

Nu-Gulf, a subsidiary of Mulberry Corp., reopened its Wingate Creek Mine in Manatee County, FL, in September. Closed since 1992, the mine had a production capacity of 1.45 million metric tons per year (Mt/yr). In May, the company purchased a 1,820-ha tract adjacent to the mine containing an estimated 40 Mt of reserves, grading 30.4% P_2O_5, giving the mine total reserves of 50 Mt covering 3,100 ha (Green Markets, 1998d). It was the only mine in the United States to use dredge mining. Wingate Creek began supplying the Mulberry Phosphates plant in December and will supply the Piney Point Phosphates plant in Manatee County when it reopens in mid-1999; both companies are subsidiaries of the Mulberry Corp. Mulberry Corp. became a member of the Phosphate Chemicals Export Association, Inc. (PhosChem), on April 1, joining IMC-Agrico, PCS Phosphate, and Mississippi Chemical. PhosChem is the exclusive export marketing association for its members (Phosphate Chemicals Export Association, Inc., 1998).

PCS Phosphate operations include the White Springs facility in Hamilton County, FL, and the Aurora facility in Beaufort County, NC, which is one of the largest integrated phosphate production complexes in the world. The Aurora location includes a high-purity phosphoric acid plant that is operated in a joint-venture agreement with Albright and Wilson Co. According to PCS Phosphate, combined total proven and probable reserves of phosphate rock for both mines on December 31, was 451 Mt, averaging 30.7% P_2O_5 (Potash Corporation of Saskatchewan Inc., 1998).

Agrifos purchased the Mobil Corp. DAP plant in Pasadena, TX, in September. Mobil had been toll processing phosphate rock ore from the Agrifos' Nichols mine, which Mobil had sold to Agrifos in 1996. The mine will continue to serve the Pasadena plant, as well as export contracts (Fertilizer Markets, 1998a).

Mississippi Chemical completed expansion of its DAP production and storage capacity and installed a new phosphogypsum disposal facility in the first half of 1998. Production capacity of the Pascagoula plant increased from 653,000 t/yr to 816,000 t/yr, and storage doubled to 73,000 metric tons (t) (Mississippi Chemical Corp., 1998a). The DAP facility was damaged by Hurricane Georges on September 27 and remained closed until October 19. Approximately 49,000 t of DAP sustained water damage and had to be scrapped after the roofs of several warehouses were destroyed by the storm (Mississippi Chemical Corp., 1998b).

Idaho and Utah.—In Utah, Simplot-Farmland Phosphates Ltd. Co. (SF), a joint venture between J.R. Simplot Co. and Farmland Industries, operated a major mining and phosphate rock beneficiation facility near Vernal. The beneficiated phosphate rock was transported by a 155-kilometer (km) slurry pipeline to the company's phosphate fertilizer production plant at Rock Springs, WY. SF announced that it would increase the production capacity of the Rock Springs plant by 25%. The estimated cost will be $35 million at the plant and $600,000 at the mine. Most of the increase will be in the production of

merchant-grade WPPA, with the balance in MAP and superphosphoric acid (Green Markets, 1998f).

In Idaho, four companies conducted open-pit mining in Caribou County. FMC Corp. operated the Dry Valley Mine on Federal and private leases to provide feedstock for P_4 production at its Pocatello plant. Solutia, Inc., and Monsanto Co. produced phosphate rock (in a joint-venture agreement) from the Enoch Valley Mine in the Caribou National Forest for P_4 production at the Solutia Soda Springs, ID, plant. Agrium Inc. produced phosphate rock from the Rasmussen Ridge Mine, also in the Caribou National Forest, to feed its Conda WPPA and DAP plant. J.R. Simplot operated the Smoky Canyon Mine, which supplied its WPPA plant in Pocatello via a 138-km slurry pipeline.

Environment

The U.S. Bureau of Land Management (BLM) delayed awarding new phosphate leases in the Caribou National Forest until problems associated with selenium runoff from phosphate deposits can be studied. In 1996, several horses were euthanized after developing severe selenium toxicosis from grazing in a pasture adjacent to a phosphate mine. Blood samples from cows in the area also tested high in selenium. This contradicted a multiagency environmental impact study conducted in the 1970's that suggested toxic element releases would be unlikely in the area. The four active mining companies and Rhodia, Inc., which has phosphate leases in the area, have combined with the BLM, the USGS, the U.S. Forest Service, the U.S. Fish and Wildlife Service, and State agencies and universities to study the extent of selenium contamination in the area and how to mitigate and prevent future problems. Human health problems have not been reported because affected streams are not sources of drinking water (Green Markets, 1998d).

FMC received a civil penalty of $11,864,800, the largest ever obtained under the Resource Conservation and Recovery Act, for repeated violations of hazardous waste laws at its P_4 plant near Pocatello. The U.S. Environmental Protection Agency cited FMC for numerous violations; the most serious involved storage of ignitable and reactive wastes in containment ponds. The ponds can ignite spontaneously and generate toxic gases that can cause serious health and environmental problems. The company has agreed to spend more than $158 million to bring the facility into compliance with regulations and to conduct a public health assessment of the area (U.S. Environmental Protection Agency, October 16, 1998, Press release, accessed October 23, 1998, at URL http://epainotes1.rtpnc.epa.gov:7777/r10/owem.nsf/enforce/fmcpress).

Consumption

In 1998, U.S. apparent domestic consumption of phosphate rock increased by 3% compared with that of 1997 (table 1). Phosphate sold or used by producers increased 4% compared with 1997 (table 3). More than 93% of total phosphate rock consumed was used to manufacture 11.4 Mt P_2O_5 for downstream fertilizer and animal feed derivatives and purified WPPA for industrial applications (table 4; Bureau of the Census, 1999). The balance was used to produce P_4 and sodium phosphate compounds. The DOC withheld P_4 production figures to protect company proprietary data. About 65% of P_4 was used to manufacture 240,000 t of thermal process acid (Bureau of the Census, 1999), which was used in industrial applications, including detergent and food additives, water- and metal-treatment chemicals, vitamins, soft drinks, toothpaste, photographic film, light bulbs, bone china, optical glass, and other consumer goods. The remaining 35% was used to produce phosphorus trichloride, pentasulfide, and other compounds, which were used in herbicides, insecticides, flame-retardant chemicals, and plasticizers.

Stocks

Yearend producer stocks of phosphate rock were slightly higher than those of 1997 and equal to 2 months production (table 2).

Transportation

In Florida, beneficiated phosphate rock was moved by truck and rail to phosphate-upgrading facilities. Phosphate rock and finished phosphate materials were sent by rail to ports at Tampa and Jacksonville, and then were shipped for domestic use or exported. About 23 Mt/yr of phosphate-related materials move through the port of Tampa, representing nearly 50% of all shipments (Phosphorus and Potassium, 1998c). Phosphate fertilizers produced by companies along the Gulf of Mexico were transported by barge on the Mississippi River and other major tributaries for domestic consumption. Producers also sent material to consumers by rail and truck. In the west, phosphate was sent from the mine via truck, rail, and slurry pipeline.

Prices

The weighted average value for marketable phosphate rock in 1998 was $25.59 per metric ton, f.o.b. mine, a 4% increase from that of 1997 (table 5), which was attributed to a drop in production and tighter supply.

Foreign Trade

Imports of phosphate rock were estimated to be 1.76 Mt; more than 99% of which was imported from Morocco. Reported imports of phosphate rock were only 807,000 t because some data were suppressed by the Bureau of the Census (table 12). PCS Nitrogen and Mississippi Chemical used phosphate rock from Morocco in phosphate conversion plants in Geismar, LA and at Pascagoula, MS respectively. The Agrifos DAP plant in Texas used phosphate rock from Morocco in addition to rock from its mine in Florida.

Phosphate rock exports increased by 13% after reaching a record low of 335,000 t in 1997 (table 6). In 1998, one company in Florida became a major supplier to a P_4 plant in the Netherlands, which should keep exports stabilized near the

current rate in 1999 (table 10; Fertilizer Markets, 1998d). Most companies no longer export rock because the emphasis has shifted to exporting higher value, high analysis fertilizers and conserving resources at existing mines.

In November, the Bureau of the Census revised monthly export statistics for DAP and MAP for 1997 and January through August 1998 (tables 8-9); because the data were not separated by country, the data in table 8 do not add to totals shown. U.S. converted phosphate trade showed an increase in exports of DAP and MAP. DAP exports to China and India showed significant growth. Exports of WPPA (table 10) and concentrated superphosphate (table 7), however, decreased slightly. According to preliminary data from the International Fertilizer Industry Association, U.S. DAP exports were 65% of the world total; MAP, 43%; TSP, 22%; and WPPA, 8%.

PhosChem signed a 2-year agreement with the China National Chemicals Import and Export Corporation (Sinochem) for the sale of DAP to China. Sinochem will receive monthly shipments at the market price at the time of the shipment for calendar years 1999 and 2000 (Phosphorus Chemicals Export Association, Inc. 1998).

World Review

World production of phosphate rock increased slightly to 145 Mt (table 14). The United States accounted for 30%, of the world total followed by China and Morocco with 17% each. World P_2O_5 consumption was estimated to have increased slightly and continued to be driven by demand in Asia and Latin America. China and India were the largest importers of phosphate fertilizer materials. Although China was a major producer of phosphate rock, it lacked the production capacity to manufacture enough fertilizer to meet domestic demand.

Australia.—Construction began on the WMC Fertilizers Ltd. Queensland Fertilizer Project at Phosphate Hill, which will include a mine and phosphoric acid, ammonia, and granulation plants. A sulfuric acid plant also will be constructed nearby at Mount Isa. The fertilizer plant, scheduled to begin production in late 1999, will have an annual output of about 1 Mt of ammonium phosphate fertilizers. Cargill signed a 5-year agreement with WMC to be the exclusive marketer of up to 500,000 t/yr of export tonnage from the plant. Other domestic and export agreements have been completed for the remaining products (Green Markets, 1998a).

Jordan.—Jordan Phosphate Mining Co. (JPMC), continued a three-phase expansion project at the Eshidiya Mine. The completed first phase increased production capacity to 3.2 Mt/yr. The second phase which was under development, will boost capacity to 7.45 Mt/yr by 2001. The future third phase will bring mine production capacity up to 10 Mt/yr and exports of 6 Mt/yr to 7 Mt/yr. Eshidiya eventually will become the company's only mine after reserves are depleted at its other two mines, Al-Hassa and Al-Abiad. JPMC has entered into four joint-venture agreements to ensure long-term supply contracts—three of the projects began operation in 1997, and the fourth, with Hydro-Agri International of Norway, was dependent on the construction of a rail link from Eshidiya to the port of Aqaba (Ashkar, Baderkhan, and Madani, 1998). In 1998, rock and phosphoric acid produced at Eshidya where transported by truck to the port. A 25-km rail line was needed at Aqaba to connect the terminus of the line located at the JPMC export terminal to the firm's phosphate complex in Aqaba. The Jordanian Ministry solicited technical proposals for maintaining and expanding the railway and received bids from 19 international companies. In December, the Ministry reduced the initial list of 19 companies to 4. The contract award was expected in mid-1999 (Phosphorus and Potassium, 1998a). In conjunction with the other projects, Aqaba will be upgraded with a new two-berth jetty that can accommodate two ships of 50,000 deadweight tons simultaneously (Phosphorus and Potassium, 1999).

Morocco.—Office Chérifien des Phosphates (OCP) exported 11.7 Mt of phosphate rock in 1998; Mexico (19%), Spain (16%), and the United States (15%) were the principal destinations. OCP began construction of a new phosphoric acid plant at the Jorf Lasfar chemical complex. The Indo Maroc Phosphore S.A., which is a 50-50 joint venture between OCP and the Birla Group of India, was expected to start in mid-1999. The facility will have a production capacity of 300,000 t/yr P_2O_5 merchant-grade acid and include a 3,300-metric-ton-per-day sulfuric acid plant. Birla will use up to two-thirds of the annual production to meet the requirements of its fertilizer subsidiaries in India. OCP will export the remaining tonnage or use it to produce DAP (Phosphorus and Potassium, 1998b).

Euro Maroc Phosphore, a joint venture among OCP (40%), Prayon-Rupel, S.A. (40%), and Chemishce Fabrik Budenheim (20%), also at Jorf Lasfar, began production of purified phosphoric acid from merchant-grade acid. The production capacity of the plant was 130,000 t/yr P_2O_5. Under the agreement, Budenheim will ship two-thirds of the output to its plant in Germany. The remainder will be marketed by Prayon (El Azrak and Bourgot, 1998).

Senegal.—Industries Chimiques du Sénégal (ICS) began planning for a new phosphate rock mine to replace the existing Keur Mor Fall Mine, which was expected to be depleted by 2003. The new Tobene Mine, located 4 km from the current mine, was expected to have the same 2 Mt/yr capacity and similar grade of 35% to 37% P_2O_5. In 1998, the Keur Mor Fall Mine had difficulties in ore processing that reduced output by more than 10% and exports by 35%. ICS has encountered rising calcium oxide to phosphorus pentoxide ratios as the deposit nears exhaustion. The company conducted tests on methods to increase P_2O_5 recovery (Kotlarevsky, 1998).

Current Research and Technology

The U.S. Department of Agriculture (USDA) awarded the first license for a strain of feed corn that could lead to the reduction in amount of phosphorus carried into bodies of water from manure. Normal corn is high in phytic acid, which stores phosphorus in a form that is unusable to one-stomach animals. The new strain, which is low in phytic acid, allows one-stomach animals to extract more phosphorus from the corn, thus reducing the phosphorus content of the manure. Companies awarded licenses will conduct commercial testing in 1999 and seed may be available by spring 2000 (Agricultural

Research Magazine, 1998).

Outlook

World demand for phosphatic fertilizers is expected to grow at a rate of close to 3% per year over the next 5 years, according to industry analysts. China, India, and the United States accounted for more than 50% of world fertilizer consumption in 1998. Brazil, China, and India, were the leading importers of phosphate materials (Potash and Phosphate Institute, 1999). Although 1998 world production capacity for phosphate rock and phosphoric acid was adequate to meet short-term demand, production capacity, especially in China, will have to increase to meet demand projections beyond 2005. New projects that are scheduled to start by 2003 in Australia, Canada, China, India, Jordan, and Morocco are expected to increase world phosphate rock and phosphoric acid production capacities by 10%. Expansions in phosphoric acid and fertilizer production capacity planned beyond 2003 will be located near phosphate rock mines to reduce costs and to avoid transportation or other disruptions to supply.

Domestic producers have shifted from exporting rock to shipping higher value fertilizer materials. This allowed mining companies in Florida, the largest producing State, to adjust production to demand patterns and thus prolong the life of several mines. New mines that are planned in the United States will be used as replacements for depleted mines and not to increase production capacity. Mine production should continue below rated capacity in the range of 43 Mt/yr to 45 Mt/yr during the next 3 years, whereas consumption is expected to increase about 2% per year during the same period. Overall domestic resources of phosphate rock are sufficient for more than 100 years at the 1998 rate of production; North Carolina and the Western United States will account for a higher percentage in the next century. Projected growth in world demand, together with decreasing reserves in Florida, will require increased imports of rock in the next decade.

U.S. consumption of P_2O_5 in fertilizers is expected to remain at around 4.1 Mt/yr during the next several years, but phosphates could gain slightly in comparison to potash and nitrogen. Total domestic planted crop acreage is forecast to decrease by about 1% in 1999 mainly because of decreases in wheat plantings, according to USDA projections. Planted acreage of corn and soybeans, which use more phosphate are, however, expected to increase slightly.

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TABLE 1
SALIENT PHOSPHATE ROCK STATISTICS 1/

(Thousand metric tons and thousand dollars unless otherwise specified)

	1994	1995	1996	1997	1998
United States:					
Mine production (crude ore)	157,000	165,000	179,000	166,000 r/	170,000
Marketable production	41,100	43,500	45,400	45,900 r/	44,200
P_2O_5 content	12,100	12,800	13,300	13,300 r/	12,900
Value	$869,000	$947,000	$1,060,000	$1,080,000 r/	$1,110,000
Average, dollars per metric ton 2/	$21.14	$21.75	$23.40	$24.40 r/	$25.46
Sold or used by producers 3/	43,900	43,700	43,500	42,100 r/	43,700
P_2O_5 content	13,100	13,000	12,900	12,200 r/	12,700
Value 4/	$929,000	$950,000	$1,020,000	$1,030,000	$1,120,000
Average, dollars per metric ton	$21.14	$21.75	$23.40	$24.50 r/	$25.59
Exports 5/	2,800 6/	2,760 6/	1,570	335	378
P_2O_5 content	886	875	NA	NA	NA
Value	$71,700	$78,300	NA	NA	NA
Average, dollars per metric ton	$25.60	$28.35	$35.82	$34.80 r/	$42.70
Imports for consumption e/ 7/	1,800	1,800	1,800	1,830	1,760
C.i.f. value e/	$87,800	$91,800	$104,000	$91,800	$92,700
Average, dollars per metric ton	$48.76	$51.01	$57.91	$50.19	$52.66
Consumption e/ 8/	42,900	42,700	43,700	43,600 r/	45,000
Stocks, December 31: Producers	5,980	5,710	6,390	7,910 r/	7,920
World: Production	127,000	130,000	135,000	144,000 r/	145,000 e/

e/ Estimated. r/ Revised. NA Not available.

1/ Data are rounded to three significant digits; except average values per metric ton.

2/ Average value based on the sold or used values.

3/ Includes domestic sales and exports.

4/ Total value of all domestic and export sales.

5/ Source: Bureau of the Census for 1996-1998.

6/ Exports reported to the U.S. Geological Survey by companies.

7/ Includes some estimated phosphate rock tonnage imported from Morocco not reported by the Bureau of the Census.

8/ Expressed as sold or used plus imports minus exports.

TABLE 2
PRODUCTION OF PHOSPHATE ROCK IN THE UNITED STATES, BY REGION 1/

(Thousand metric tons and thousand dollars)

	Mine production (crude ore)		Marketable production			
			Beneficiated			Ending
Period/region	Rock	P_2O_5 content	Rock	P_2O_5 content	Value 2/	stocks, rock
1997 r/	166,000	19,800	45,900	13,300	1,080,000	7,910
1998:						
January-June:						
Florida and North Carolina	81,700	6,460	19,200	5,580	506,000	6,180
Idaho and Utah	3,050	756	2,620	768	53,900	1,340
Total	84,800	7,210	21,900	6,350	560,000	7,520
July-December:						
Florida and North Carolina	80,400	5,210	19,500	5,650	497,000	6,540
Idaho and Utah	5,020	870	2,870	862	57,600	1,380
Total	85,400	6,080	22,300	6,510	554,000	7,920
Grand total	170,000	13,300	44,200	12,900	1,110,000	XX

r/ Revised. XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Average value based on the sold or used values.

TABLE 3
PHOSPHATE ROCK SOLD OR USED BY PRODUCERS
IN THE UNITED STATES, BY GRADE AND REGION 1/

(Thousand metric tons and thousand dollars)

Period and grade (percent BPL content 2/)	Rock	P_2O_5 content	Value 3/
1997	42,100 r/	12,200 r/	$1,030,000
1998:	22,400	6,610	532,000
January-June:			
60 to less than 66	16,500	4,840	414,000
Other 4/	5,250	1,480	156,000
Total	21,700	6,320	570,000
July-December:			
60 to less than 66	16,400	4,800	410,000
Other 4/	5,500	1,560	138,000
Total	21,900	6,360	548,000
Grand total	43,700	12,700	1,120,000
Florida and North Carolina	38,000	11,000	987,000
Idaho and Utah	5,640	1,650	131,000

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ 1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5
3/ F.o.b. mine.
4/ Includes less than 60% and greater than 66% BPL content.

TABLE 4
PHOSPHATE ROCK SOLD OR USED BY PRODUCERS
IN THE UNITED STATES, BY USE 1/

(Thousand metric tons)

Period and use	Rock	P_2O_5 content
1997 r/	42,100	12,200
1998:		
January-June:		
Domestic:		
Agricultural	20,300	5,930
Industrial	W	W
Subtotal	W	W
Exports: 2/	W	W
Total	21,700	6,320
July-December:		
Domestic:		
Agricultural	20,500	5,990
Industrial	W	W
Subtotal	W	W
Exports: 2/	W	W
Total	21,900	6,360
Grand total	43,700	12,700

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "Total."
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Exports reported to the U.S. Geological Survey by companies.

TABLE 5
VALUE OF U.S. PHOSPHATE ROCK, BY GRADE

(Dollars per metric ton, f.o.b. mine)

Grade	1997			1998		
(percent BPL content 1/)	Domestic	Export	Average	Domestic	Export	Average
70 to less than 72	24.98	W	25.13	19.68	--	19.68
66 to less than 70	29.06	W	29.33	28.71	W	29.51
60 to less than 66	18.00	W	18.07	25.00	W	25.03
Weighted average 2/	24.40 r/	34.80 r/	24.50 r/	25.46	42.70	25.59

r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ 1.0% BPL (bone phosphate of lime or tricalcium phosphate)=0.458% P_2O_5.
2/ Includes less than 60%, and greater than 72%, in addition to the grades listed.

TABLE 6
U.S. EXPORTS OF GROUND AND
UNGROUND PHOSPHATE ROCK 1/

(Thousand metric tons)

Country	1997	1998
Australia	7	2
Canada	24	38
Japan	29	21
Korea, Republic of	186	2
Netherlands	29	270
New Zealand	24	--
Other	36	45
Total	335	378

1/ Data are rounded to three significant digits; may not add to totals shown.

Source: Bureau of the Census.

TABLE 7
U.S. EXPORTS OF SUPERPHOSPHATES
(CONCENTRATED)

(Thousand metric tons)

Country	1997	1998
Argentina	5	2
Australia	231	217
Bangladesh	20	95
Brazil	161	121
Canada	12	12
Chile	92	89
Japan	41	30
Peru	17	17
Uruguay	9	8
Other	46	31
Total	634	622

Source: Bureau of the Census.

TABLE 8
U.S. EXPORTS OF DIAMMONIUM PHOSPHATE 1/

(Thousand metric tons)

Country	1997 2/	1998
Argentina	252	226
Australia	493	626
Brazil	36	73
Canada	119	113
Chile	46	57
China	4,690	5,180
Colombia	76	56
Dominican Republic	31	40
Ecuador	47	47
Germany	--	27
Guatemala	18	22
India	1,090	1,270
Japan	366	352
Kenya	82	39
Mexico	234	251
New Zealand	14	--
Pakistan	213	643
Thailand	131	302
Turkey	124	88
Uruguay	42	42
Other	393	418
Total	9,810 r/	9,870

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ "Total" revised by the Bureau of the Census; data for individual countries was not available.

Source: Bureau of the Census.

TABLE 9
U.S. EXPORTS OF
MONOAMMONIUM PHOSPHATE 1/

(Thousand metric tons)

Country	1997	1998
Australia	282	351
Brazil	339	354
Canada	493	502
Chile	51	44
Colombia	98	117
Guatemala	17	16
Japan	135	130
Mexico	85	35
Thailand	26	59
Other	107	71
Total	1,630	1,680

1/ Data are rounded to three significant digits; may not add to totals shown.

Source: Bureau of the Census.

TABLE 10
U.S. EXPORTS OF PHOSPHORIC ACID 1/

(Thousand metric tons)

Country	1997	1998
Australia	88	106
Canada	64	60
India	174	230
Venezuela	58	21
Other	86	116
Total	470	533

1/ Excludes superphosphoric acid tonnage.

Source: Bureau of the Census as adjusted by the U.S. Geological Survey.

TABLE 11
U.S. EXPORTS OF ELEMENTAL PHOSPHORUS 1/

	1997		1998	
Country	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)
Brazil	67	$104	174	$297
Canada	1,260	2,450	1,380	2,640
Japan	3,540	7,170	2,820	4,970
Korea, Republic of	317	601	98	202
Mexico	3,480	7,270	3,370	7,230
Netherlands	12	23	6	12
Other	130	368	182	402
Total	8,800	18,000	8,020	15,700

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ F.a.s. values.

Source: Bureau of the Census.

TABLE 12
U.S. IMPORTS FOR CONSUMPTION OF PHOSPHATE ROCK AND PHOSPHATIC MATERIALS 1/

(Thousand metric tons and thousand dollars)

	1997		1998	
Phosphatic materials	Quantity	Value 2/	Quantity	Value 2/
Natural calcium phosphates, unground 3/	809	40,600	228	7,950
Natural calcium phosphates, ground 3/	62	3,830	580	34,500
Dicalcium phosphate	6	7,800	7	8,670
Elemental phosphorus	2	4,410	2	4,160
Normal superphosphate	(4/)	90	(4/)	3
Triple superphosphate	39	6,910	76	12,900
Diammonium phosphate	57	14,500	44	11,100
Fertilizer containing nitrates and phosphates	146	11,900	153	12,400
Phosphoric acid	6	2,940	2	778

1/ Data are rounded to three significant digits.
2/ Declared c.i.f values.
3/ Some phosphate rock tonnages and values were suppressed by the Bureau of the Census.
4/ Less than 1/2 unit.

Source: Bureau of the Census

TABLE 13
PHOSPHATE ROCK ANNUAL
WORLD PRODUCTION CAPACITY,
DECEMBER 31, 1998

(Thousand metric tons)

Region/country	Capacity
United States	55,000
Africa	42,500
Asia	31,000
Western Europe and the former U.S.S.R.	16,200
Middle East	14,700
Latin America	6,000
Oceania	1,600
World total 1/	167,000

1/ Data are rounded to three significant digits; may not add to totals shown.

Sources: International Fertilizer Industry Association and the U.S. Geological Survey.

TABLE 14
PHOSPHATE ROCK, BASIC SLAG, AND GUANO: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

	Gross weight					P2O5 content				
Commodity and country	1994	1995	1996	1997	1998 e/	1994	1995	1996	1997	1998 e/
Phosphate rock:										
Albania e/	2	2	2	1	1	(3/)	(3/)	(3/)	(3/)	(3/)
Algeria	738	757	1,051	1,068	1,160	226	232	320	325 e/	350
Australia	21	5	1	1 e/	1	5	1	(3/)	(3/) e/	(3/)
Brazil	3,937	3,888	3,823	4,270 r/	4,270	1,387	1,364	1,353	1,500 r/	1,500
Chile	10	12	17	13 r/	13	3	3 r/	5 r/	3 r/	3
China e/	24,100	19,300	21,000	24,500 r/	25,000	7,430	5,790	6,300	7,530	7,500
Christmas Island	260	430	600 e/	600 e/	600	87	145	198 e/	198 e/	198
Colombia	48	50 e/	40 r/	45 r/	50	10	11 e/	8 r/	9 r/	11
Egypt 4/	632	765	808	900 r/	950	178	207	222	240 e/	250
Finland	647	671	667	650 e/	650	236	244	246	240 e/	235
India	1,237	1,332	1,432	1,500 e/	1,550	334	360	387	405 e/	420
Indonesia e/	7	8	8	8	7	2	2	2	2	2
Iraq e/ 4/	1,000	1,000	1,000	1,000	1,000	300	300	300	300	300
Israel 4/	3,961	4,063	3,839	4,047	4,100	1,232	1,264	1,201	1,266 e/	1,270
Jordan	4,217	4,984	5,355	5,896	5,900	1,399	1,655	1,765	1,900 e/	1,900
Kazakhstan e/	1,700 5/	1,700	1,700	1,700	1,600	500	500	500	500	450
Korea, North e/	510	520	520	520	450	163	164	164	164	142
Mexico	547	622	682	714 r/	756 5/	164	180	205	214 r/	227
Morocco 6/	19,764	20,200	20,855	23,367	24,000	6,274	6,381	6,560	7,430 e/	7,560
Nauru	613	496	510	500 e/	500	233	190	194	190 e/	190
Netherlands Antilles e/	15	--	--	--	--	5	--	--	--	--
Pakistan e/	15 5/	10 5/	10	8	9	3	2	2	1	2
Peru	37	30	103	104	104	12	9	32 e/	32	37
Philippines e/	20	20	20	20	20	7	7	7	7	7
Russia e/	8,000	9,000 r/	8,500 r/	9,900 r/	9,800	2,800	3,100 r/	2,900	3,300 r/	3,300
Senegal e/	1,587 5/	1,500 r/	1,340 r/	1,300 r/	1,300	576 5/	545 r/	478 r/	465 r/	465
South Africa	2,545	2,822 r/	2,655 r/	2,732 r/	2,800	995	1,101 r/	1,036 r/	1,066 r/	1,092
Sri Lanka e/	32 5/	30 5/	34	30 r/ 5/	30	11	10	12	10 r/	10
Syria	1,203	1,551	2,189	2,392	2,500	371	477	670	730 e/	750
Tanzania	--	21	3 e/	3 r/ e/	3	--	7	1 e/	1 r/ e/	1
Thailand	8	9	4 r/	4 r/	4	2	3	1 r/	1 r/	1
Togo	2,149	2,570	2,731	2,200 r/ e/	2,200	780	933	991	800 r/ e/	800
Tunisia	5,699	7,241	7,167	7,068	7,950	1,712	2,182	2,150	2,120 e/	2,380
United States	41,100	43,500	45,400	45,900 r/	44,200 5/	12,100	12,800	13,300	13,300 r/	12,900 5/

See footnotes at end of table.

TABLE 14--Continued
PHOSPHATE ROCK, BASIC SLAG, AND GUANO: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

Commodity and country	Gross weight					P2O5 content				
	1994	1995	1996	1997	1998 e/	1994	1995	1996	1997	1998 e/
Phosphate rock--Continued:										
Venezuela	99	169	148 r/	319 r/	250	27	46	40 r/	86 r/	75
Vietnam e/	470 5/	600 r/	475 r/	834 r/	860	144	181 r/	143 r/	250 r/	258
Zimbabwe, concentrate	151	154	123	125 r/ e/	125	45	45 e/	39 e/	40 r/ e/	40
Total	127,000	130,000	135,000	144,000 r/	145,000	39,800	40,400 r/	41,700 r/	44,600 r/	45,100
Basic (Thomas converter) slag: e/										
Egypt	8	8	8	8	8	2	2	2	2	2
France	155 5/	140	77 r/	44 r/	45	28 5/	18	14 r/	8 r/	8
Germany	134 5/	125	125	125	125	20 5/	19	19	19	19
Luxembourg	472 5/	500	500	500	500	85	75	75	75	75
Total	769 5/	773	710 r/	677 r/	678	135 5/	114	110 r/	104 r/	104
Guano:										
Philippines e/	5	5	5	5	5	2	2	2	2	2

e/ Estimated. r/ Revised.

1/ Table includes data available through May 7, 1999. Data for major phosphate rock-producing countries derived in part from the International Fertilizer industry Association; other figures are from official country sources where available.

2/ World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

3/ Less than 1/2 unit.

4/ Beneficiated.

5/ Reported figure.

6/ Includes production from Western Sahara.