NITROGEN

By Deborah A. Kramer

Nitrogen (N) is an essential element of life and a part of all plant and animal proteins. Crop plants cultivated for both human consumption and as animal feed require nitrogen for proper nutrition and maturation. Some crops such as alfalfa, soybeans, garden peas, and peanuts can convert atmospheric nitrogen into a usable form in a process called "fixation." However, most nitrogen available for crop production comes from decomposing animal and plant waste or from commercially produced fertilizers.

All commercial fertilizers contain their nitrogen in the ammonium and/or nitrate form or in a form that is quickly converted to these forms once the fertilizer is applied to the soil. Commercial production of anhydrous ammonia is based on reacting nitrogen with hydrogen under high temperatures and pressures. The source of nitrogen is air, which is almost 80% nitrogen. Hydrogen is derived from a variety of raw materials, including water, and crude oil, coal, or natural gas hydrocarbons. Other nitrogen fertilizers are produced from ammonia feedstocks through a variety of chemical processes. Small quantities of nitrates are produced from mineral resources principally in Bolivia and Chile.

In 1997, there were 26 ammonia producers with 42 plant locations in the United States. U.S. ammonia production totaled 14.3 million metric tons of contained nitrogen, an 8% increase from 1996 production. Apparent consumption of ammonia in 1997 increased by 3% to 16.8 million tons of contained nitrogen. About 86% of the ammonia was used in fertilizer applications. Throughout the year, ammonia prices dropped steadily; by yearend the Gulf Coast price had decreased to 58% of the yearend 1996 price. This decrease led to a significant increase in producer stocks by yearend. Several new plants were planned for Nevada, Texas, and Washington that would increase U.S. ammonia production capacity by about 1.4 million tons by 2000.

World production of ammonia in 1997 was about 102 million tons of contained nitrogen with China and the United States continuing as the principal producers. World urea production declined slightly to 43.4 million tons, and total world exports also dropped primarily as a result of China's decision in April to stop importing urea. Increases in ammonia production capacity are planned in many areas throughout the world. The most immediate effect on world supply is expected to be the two new plants in Trinidad and Tobago scheduled to come on-stream in the first half of 1998, adding more than 1 million tons to world ammonia production capacity. Including these two plants, worldwide ammonia production capacity is projected to increase by 11% by 2000, with the largest percentage increase (16%) in Asia.

Legislation and Government Programs

A lawsuit was filed on behalf of survivors and victims of the

Oklahoma City bombing in 1995 against Farmland Industries Inc. and an affiliate, the Kansas Co-op Association. The suit alleges that the companies violated State and Federal laws by selling ammonium nitrate used to destroy a Federal office building. The lawsuit was filed in Kansas in August, but no legal action was undertaken by yearend (Fertilizer Markets, 1997a).

In June, the U.S. Environmental Protection Agency's (EPA) National Advisory Committee approved interim Acute Exposure Guideline Levels (AGEL's) for ammonia. This committee is charged with establishing AGEL's for 85 priority substances, including ammonia. The AGEL program began in 1995 with the goal of establishing uniform standards for use by Federal, State, and local agencies for emergency planning, response, and prevention programs. Once AGEL's are determined, EPA may use these levels in its risk management program. In the June meeting, the committee established an interim AGEL-2 for ammonia of 160 parts per million for 30 minutes and 110 parts per million for 60 minutes. (AGEL-2 is defined as the concentration of an airborne substance at or above which it is predicted that the general population, including sensitive but not hypersusceptible individuals, could experience irreversible or other serious long-lasting effects or impaired ability to escape.) Before final levels are adopted, the interim levels will be published in the Federal Register to solicit additional comments (The Fertilizer Institute, 1997a).

Production

Industry statistics for anhydrous ammonia and derivative products were developed by the Bureau of the Census, U.S. Department of Commerce. Summary of production of principal inorganic fertilizers by quarter is reported in the series MQ28B, and industrial gases (including nitrogen) are reported in the quarterly report MQ28C. The Bureau of the Census surveys approximately 250 producers of inorganic fertilizer materials. Final data are subsequently published in a companion annual report MA28B.

Production of anhydrous ammonia (82.2% N) increased by 8% in 1997 to 14.3 million metric tons of contained nitrogen compared with a revised figure of 13.2 million tons in 1996. Eighty-six percent of the production was for use as a fertilizer; the remaining 14% was used in other chemical and industrial sectors. (See tables 1 and 2.)

The United States remained the world's second largest producer and consumer of elemental and fixed types of nitrogen following China. Urea, ammonium phosphates, ammonium nitrate, nitric acid, and ammonium sulfate are the major downstream products produced from ammonia in the United States, in order of importance. Their combined production was 11.0 million tons of contained nitrogen, with urea accounting for about 29% of the

production. (See table 3.)

Ammonia producers in the United States operated near design capacity. Nearly 58% of total U.S. ammonia production capacity was concentrated in the States of Louisiana (37%), Oklahoma (15%), and Texas (6%), owing to large indigenous reserves of natural gas feedstock. Farmland Industries Inc., PCS Nitrogen Inc., Terra International Inc., CF Industries Inc., and Union Chemical Co., in order of importance, accounted for 59% of total U.S. ammonia capacity. (*See table 4*.)

Potash Corp. of Saskatchewan Inc. (PCS) completed its acquisition of Arcadian Corp. in March and merged Arcadian into PCS Nitrogen, a wholly owned subsidiary of PCS. The acquisition makes PCS the world's second largest nitrogen producer (Green Markets, 1997t).

PCS announced that it would close its Wilmington, NC, nitrogen plant by April 1998 because it was too costly to operate compared with its other facilities. The plant was part of PCS's acquisition of Arcadian and has the capacity to produce 161,000 tons of nitric acid and 408,000 tons of nitrogen solutions annually. Part of the high cost of operating the facility is that ammonia must be purchased because is not produced at the plant (Fertilizer Markets, 1997c).

Several new nitrogen projects were planned to either expand current production capacity or build new plants in the United States. In October, Terra Industries Inc. announced that it would invest \$57 million to add an ammonia production loop to its methanol plant in Beaumont, TX. Capacity of the new loop will be 231,000 tons per year, and construction is expected to be completed by the fourth quarter of 1999. Byproduct hydrogen from the methanol operation will be used to produce the ammonia, but Terra also will need to purchase hydrogen from other vendors. Foster Wheeler USA Corp. will be the principal contractor for the project, which will use Haldor Topsoe ammonia technology (Green Markets, 1997cc).

COGA Industries LLC moved forward on its plans to construct a coal gasification plant in Girard, IL. The project has been under consideration for several years, but the company reportedly signed a coal contract with Freeman Energy Corp. to supply about 1.2 million tons of coal, or about 3% of Illinois' annual coal production. This was at a cost estimated to be less than \$1 per million British thermal units (about \$18 per ton). The total cost of the gasification plant is estimated to be about \$950 million, and the plant is projected to produce 450,000 tons of granular urea, 725,000 tons of nitrogen solutions, and 390,000 tons of ammonium nitrate annually. COGA also has received State environmental permits and options to participate in the project from Norsk Hydro A.S., Chase Manhattan Bank, and Unicom Resources Inc., a subsidiary of Commonwealth Edison Co. Construction of the new plant is expected to take about 30 months after all the financing and other details are completed (Green Markets, 1997h).

Btu Energy advanced plans that it had announced in 1996 to construct a nitrogen plant near Walla Walla, WA. In December, the company awarded a contract to Monsanto Enviro-Chem Systems to build a 360,000-ton-per-year granular urea plant and a 225,000-ton-per-year ammonia plant at a cost of \$200 million. Startup of construction is planned for 1998, with completion scheduled for late 1999 (Green Markets, 1997e).

J.R. Simplot Co. also was proceeding with plans to build a new nitrogen complex near Wells, NV. The project was announced in 1996, and in December 1997, the company finalized plans to build a \$480 million nitrogen complex. Simplot plans to build a 612,000-ton-per-year ammonia plant; the plant also would produce unspecified quantities of nitric acid, urea, nitrogen solutions, ammonium thiosulfate, and low-density ammonium nitrate. M.W. Kellogg Co. will be the principal contractor for the project. This will be the largest single train ammonia plant in North America. About 70% of the ammonia production will be used for Simplot's California fertilizer plants and for its customers in the Western United States (Green Markets, 1997aa).

Farmland Industries announced plans to construct a 450,000-ton-per-year nitrogen solutions plant at its Coffeyville, KS, oil refinery. The plant will produce ammonia as a byproduct of petroleum coke production, which will in turn be used to make urea-ammonium nitrate (UAN) solutions. Production capacity at the plant will be 1,000 tons per day of ammonia; 540 tons of this will go to produce 1,360 tons per day of UAN solutions. Plant construction is expected to take 2 years at a cost of about \$200 to \$250 million including storage facilities. Texaco is expected to supply the gasification component of the project using an existing unit in Barstow, CA, that was previously used for power generation (Green Markets, 1997j).

Formosa Plastics Corp. U.S.A. was considering construction of a 300,000-ton-per-year ammonia plant in Point Comfort, TX. The Taiwanese plastics firm reportedly contacted several engineering firms about designing the plant, which would cost \$70 million and be completed by 2000. At yearend, no decision was finalized (Green Markets, 1997bb).

LaRoche Industries Inc. completed the second phase of its three-phase upgrade program in June. As a result of this upgrade at its Cherokee, AL, nitrogen complex, LaRoche has the capability to produce an ammonium nitrate product that is larger, harder, and more uniform, while increasing production capacity by 75% to 132,000 tons per year. LaRoche also modernized its older nitric acid plant to reduce nitrogen emissions by about 30%. Production capacity at the nitric acid plant was doubled. Phase three of the upgrade is expected to increase ammonia capacity by 40% to about 200,000 tons per year (Green Markets, 1997o).

In July, El Dorado Nitrogen Co. broke ground for its 400,000-ton-per-year, \$60 million nitric acid plant that will supply nitric acid to Bayer Corp.'s polyurethane plant in Baytown, TX. The new plant is scheduled to be completed by the end of 1998 (Green Markets, 1997i).

Environment

Both the ammonium and nitrate forms of N are highly soluble in water and are readily available for crop plant uptake. Ammonium is held by soil particles therefore not subject to movement down through the soil during periods of rainfall or irrigation. However, nitrates do move downward with soil water. This leaching process can lead to nitrate accumulation in ground water. As soils are warmed during the growing season, the ammonium form of nitrogen is subject to conversion to nitrate in a process called "nitrification." Most of the ammonium not used by the crop is eventually converted to nitrate. Nitrogen stabilizers

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and nitrification inhibitors can slow the conversion of soil ammonium to nitrate. Best management practices to increase nitrogen use efficiency and reduce nitrate leaching include application of fertilizer close to the time of actual crop use, multiple applications, terracing, grass waterways, and strip cropping.

In a survey of U.S. nitrogen fertilizer manufacturers conducted by The Fertilizer Institute, emissions, as reported to the Environmental Protection Agency for its 1995 Toxics Release Inventory, were reduced by 14%. Emissions calculated as a ratio compared to tons produced decreased by 11.5% from the 1994 level. Since reporting began for the Toxics Release Inventory in 1987, the nitrogen fertilizer industry has reduced emissions 75% as a ratio of pounds released to tons produced (The Fertilizer Institute, 1997b).

Consumption

Apparent consumption of ammonia increased to 16.8 million tons of contained N, an increase of 3% from that of 1996. Apparent consumption is calculated as the production plus imports minus exports, adjusted to reflect any changes in stocks.

Consumption of nitrogen fertilizers in the United States for the 1997 crop year (ending June 30, 1997) is reported in table 5. Consumption increased slightly from 1996 values to 11.4 million tons of contained N. Anhydrous ammonia was the principal fertilizer product representing 32% of fertilizer consumption. (See table 5.)

Urea and UAN solutions together constituted 37% of fertilizer consumption during the 1997 crop season. Urea is typically 45.9% N, and UAN solutions are typically 29.8% to 29.9% N. In the industrial sector, urea is used extensively as a protein supplement in ruminant animal feeds, for the production of ureaformaldehyde adhesives, and for the synthesis of plastics and resins.

Ammonium nitrate was used primarily in solid and liquid fertilizers, in industrial explosives, and as blasting agents. Total production of ammonium nitrate in 1997 was 2.5 million tons of contained nitrogen. After World War II, ammonium nitrate became the leading solid nitrogen fertilizer in the United States and worldwide, and remained such until about 1975, when its use was surpassed by synthetic urea. In 1997, approximately 24% of ammonium nitrate production was used in fertilizer consumption. Ammonium nitrate containing 33.9% N constituted 5% of 1997 nitrogen fertilizer consumption.

Ammonium sulfate was used mostly as a fertilizer material, valued for its nitrogen content (21.2% N) and for its readily available sulfur content (24.3% sulfur). It is commonly produced as a byproduct of caprolactam production, an intermediate in nylon manufacture. Since the introduction of ammonium nitrate and urea, the relative importance of ammonium sulfate worldwide has steadily decreased. In the 1997 crop year, fertilizer consumption of ammonium sulfate based on nitrogen content was 2% of the market. Nonfertilizer uses constitute approximately 40% of the total ammonium sulfate market (on a contained nitrogen basis), including food processing, fire control, tanning, and cattle feed.

Nitric acid production is shown in table 3. Nitric acid is used

in salt formation reactions to produce metal nitrates and in metal degreasing, treating, and pickling for graphic and galvanic industries. Nitration reactions with benzene, phenol, and toluene produce dyestuffs, pharmaceutical products, trinitrotoluene (TNT) explosives, and disinfectants. Esterification reactions with glycol, glycerol, and cellulose produce nitroglycerine explosives (dynamite), celluloid, and nitrocellulose lacquers. Oxidation reactions with toluene, p-xylene, and cyclohexanone produce polyurethanes and polyester fibers (nylon), respectively.

Other uses of ammonia are for the production of amines, cyanides, and methyl methacrylate polymers (plexiglass); liquid home and industrial cleaners; pulp and paper products; industrial refrigeration; metallurgy; and as a propellant in vehicular air bags.

Elemental nitrogen is used extensively by the electronics, metals, food, and aerospace industries because of its inert and cryogenic properties. Nitrogen can be used to prevent fires and explosions, as a purging agent for cleaning and processing equipment, and as a controlling atmosphere for annealing and heat treating and other metal preparation processes where oxygenation is a concern.

Stocks

At yearend 1997, stocks totaled 2.2 million tons N, a 61% increase from 1996 stocks of 1.3 million tons N. (*See table 6.*) The most significant increase was in ammonia stocks. Significant declines in prices during the year led to the increase in producer stocks.

Transportation

Ammonia was transported by refrigerated barge, rail, pipeline, and truck. Three companies serve 11 States with pipelines 4,900 kilometers in length, with 4,800 kilometers of river barge transport, and by rail and truck used primarily for interstate or local delivery.

Koch Industries operated the Gulf Central ammonia pipeline from the Gulf of Mexico (Louisiana) to the Midwest as far north as Iowa, covering 3,070 kilometers, and to the east to Huntington, OH. The annual capacity of this pipeline was about 2 million tons, with a storage capacity of more than 1 million tons.

Mapco Ammonia Pipeline Inc. operated its own pipeline and its subsidiary, Mid-America Pipeline System, that extended from Borger in northern Texas to Mankato in southern Minnesota, covering 1,700 kilometers. The Mapco pipeline had an annual capacity of more than 1 million tons and about 500,000 tons of ammonia storage capacity. In December, The Williams Companies Inc. entered into a merger agreement with Mapco to acquire the company in a nontaxable stock-for-stock transaction. Stockholders of both firms are scheduled to vote on the transaction in 1998 (Green Markets, 1997hh).

In November, BP Chemicals Inc. announced a \$40 million project to construct storage and marine loading and unloading facilities for ammonia and acrylonitrile at Port Comfort/Port Lavaca, TX. BP operates acrylonitrile production facilities in Green Lake, TX, and Texas City, TX, which consume about 235,000 tons of ammonia annually. After completion, the port is

expected to be able to accommodate ammonia import vessels between 18,000 and 35,000 tons. In addition, a 25,000-ton ammonia storage tank and 25-mile pipeline from the port to Green Lake will be constructed. Although final approval is contingent on receiving necessary regulatory permits, the facility is scheduled to be operational in early 1999 (Green Markets, 1997d).

CF Industries Inc. and Cargill Fertilizer, Inc. jointly operated the Tampa Bay Pipeline (TBP) system with a 135-kilometer route. TBP moved nitrogen compound and ammonium phosphate for fertilizer producers in Hillsborough and Polk Counties, FL.

Capacities for trucks and railcars are usually 20 and 100 tons, respectively. Depending on the product loaded and the volume of the container, barges can accommodate from 400 to 2,000 tons.

Ammonium nitrate is transported by rail, road, and water, but its transportation on U.S. navigable waterways is restricted. Urea is shipped either in bulk or as bagged material.

Prices

Anhydrous ammonia prices fell steadily throughout 1997. Gulf Coast prices, quoted in Green Markets, dropped from \$225 per short ton at the beginning of the year to \$130 per short ton by yearend. Urea prices followed the same pattern. Gulf Coast granular material was quoted at \$188-\$190 per short ton at the beginning of 1997, and this price range declined to \$102-\$103 per short ton by yearend. Urea prices most likely fell in response to China's decision to stop importing urea in April, and the prices of other nitrogen fertilizer materials fell in response to the decline in urea prices. Anticipation of the two new plants scheduled to start up in Trinidad in 1998 also contributed to the decline in ammonia prices. (*See table 7*.)

Ammonium nitrate prices also declined significantly in 1997, beginning the year at \$160-\$170 per short ton and falling to \$122-\$125 per short ton by yearend. However, ammonium sulfate prices rose from \$119-\$130 per short ton to \$124-\$130 per short ton during 1997.

Foreign Trade

Ammonia exports declined by about 9% from the 1996 level. The Republic of Korea remained the largest destination, accounting for 96% of total U.S. exports of ammonia. Imports of ammonia increased by about 4%. Trinidad and Tobago, Russia, and Canada accounted for 89% of total U.S. ammonia imports. (See tables 8 and 9.)

Trade of other nitrogen materials is shown in tables 10 and 11. The overall decrease of 44% in exports of urea partially resulted from China's decision to eliminate urea imports near the beginning of 1997. This decline in urea exports contributed to the overall decline in exports of nitrogen compounds. Imports of nitrogen compounds were slightly higher than those in 1996. (See tables 10 and 11.)

World Review

Anhydrous ammonia and other nitrogen materials were produced in more than 80 countries. Global ammonia production

in 1997 was about the same as that of 1996. Total ammonia production was 102 million tons contained nitrogen in 1997, based on data reported to the U.S. Geological Survey. About 23% of global ammonia production originated in China. Asia contributed 41% of world total ammonia production, and the United States and Canada represented 18% of the global total. Countries in the former U.S.S.R. were 13% of the total; Western Europe, 10%; Middle East, 7%; Latin America, 5%; and Eastern Europe, Africa, and Oceania contributed the rest. (*See table 12*.)

World ammonia exports in 1997 increased about 4% compared with those of 1996, to 11.4 million tons of contained nitrogen. Russia (22%), Trinidad and Tobago (14%), Ukraine (11%), and Canada (7%) accounted for 54% of the world total. The United States imported 31% of global ammonia trade, followed by Western Europe (30%) and Asia (20%) (International Fertilizer Industry Association, 1997a).

World urea production declined slightly to 43.4 million tons contained nitrogen in 1997, but world exports dropped by nearly 7% to 10.3 million tons N. China and India accounted for 43% of 1997 world production; production in both countries increased by about 14% from 1996 levels. The United States and Canada produced about 11% of the total. Because of China's decision to stop importing urea in April, exports from most geographic areas declined, with the exception of Asia. Russia and Ukraine accounted for 24% of total exports; Middle East, 24%; Asia, 15%; Canada and the United States, 10%; Eastern Europe, 9%; Western Europe, 9%; Latin America, 8%; and Africa and Oceania shipped minor tonnages. Asia accounted for 49% of global urea imports, Western Europe accounted for 14%, Latin America accounted for 14%, and North America accounted for 9% (International Fertilizer Industry Association, 1997b).

Argentina.—In negotiations that were finalized in May, Agrium Inc. joined Petroquímica Argentina S.A. and Yacimentos Petroliferos Fiscales S.A. in a partnership to build a nitrogen complex in Argentina. Each company will own one-third of the new firm Profertil S.A. Although a site has not been finalized, the leading candidate is Bahia Blanca. Projected annual capacity for the \$450 million plant is 600,000 tons of ammonia and 800,000 to 1 million tons of urea. No startup data was announced (Green Markets, 1997a).

Australia.—In June, Wesfarmers CSBP Ltd. announced plans to build a \$150 million ammonia plant at its current production site in Kwinana, Western Australia. New production, totaling 650 tons per day, will replace an equivalent quantity of imported material. Construction of the plant is scheduled to begin in the second quarter of 1998, and completion is scheduled for the third quarter of 1999 (Green Markets, 1997q).

A new Kellogg Advanced Ammonia Process was brought onstream at Incitec Ltd.'s Gibson Island, Queensland, ammonia plant. This upgrade increased the plant's capacity by 11% to 800 tons per day and reduced energy consumption (Green Markets, 1997ee).

Linde (Australia) Pty. Ltd. announced plans to construct a 600-ton-per-day ammonia plant that will use natural gas as a feedstock sourced from the AGL South West Queensland to Mount Isa pipeline. (Green Markets, 1997gg).

Bolivia.—U.S.-based Devco and Technopor of Bolivia and other unnamed partners planned a feasibility study for a nitrogen

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complex in Puerto Suarez. The proposed plant would produce 1,000 tons per day of ammonia and 1,500 tons per day of granular urea. Completion of the study is scheduled for the first quarter of 1998 (Green Markets, 1997r).

Canada.—Simplot Canada Ltd. completed an expansion at its Brandon, Manitoba, nitrogen complex. The upgrade increased production capacities as follows: ammonia, from 600 to 1,250 tons per day; urea, from 415 to 625 tons per day; and granulated urea, from 400 to 500 tons per day. Production of UAN is expected to increase as well. Because of the expansion, which involved replacing two ammonia plants with one that had been dismantled and brought in from Sicily, Simplot no longer will need to purchase ammonia for its upgraded products; it will have excess ammonia for sale instead. Total cost of the upgrade was \$160 million including upgrading of existing utilities and an additional ammonia storage tank (Green Markets, 1997z).

Terra Industries stopped producing solid ammonium nitrate at its Courtright, Ontario, complex in July. The nitric acid capacity that was used to support the 91,000-ton-per-year ammonium nitrate unit will be used to make an additional 110,000 tons per year of UAN solution (Fertilizer Markets, 1997d).

Chile.—After a delay of nearly 1 year, Kap Resources Ltd.'s Minera Yolanda unit began operating its iodine and nitrate production plants in northern Chile. By September, one solar pond and the leaching operation were working, although nitrate yield from ore leaching was lower than expected. At full capacity, the plant is expected to produce 160,000 tons of potassium nitrate, 75,000 tons of sodium nitrate, and 290 tons of iodine annually (Fertilizer Week, 1997d).

China.—In an attempt to attain self-sufficiency in urea by 2000, the State Planning Commission halted issuance of import licenses for urea at the end of April, and imports of urea into China ceased. Within 3 years, the country plans to have enough urea capacity in place to satisfy its needs. China was the world's largest urea importer, importing 6 million tons in 1996. Market observers question whether there will be enough additional capacity constructed to meet the projected demand increase from 26 million tons in 1996 to 30 million tons by 2000 (Fertilizer International, 1997b).

Production of a new granulated urea that is four times larger than traditional urea reportedly began in China at the Hainan Natural Gas Chemical Plant. The new granules are expected to improve the efficiency of nitrogenous fertilizer by 12% because their consistency in twice as hard as traditional granules (Green Markets, 1997f).

Egypt.—The Egyptian Government set up a new joint-venture company, Misr Fertilizers Co., to implement two new projects—an ammonia-urea complex and an ammonium nitrate plant. The ammonia-urea complex, to be built west of Alexandria, will include a 1,200-ton-per-day ammonia plant and a 2,000-ton-per-day granular urea plant. The second complex, at Helwan, will have the capacity to produce 2,400 tons per day of granular ammonium nitrate, 1,000 tons per day of ammonia, and 1,800 tons per day of nitric acid. Plans are in the preliminary stage, and neither project is expect to be on-stream by 2000 (Fertilizer Week, 1997a).

India.—Jacobs Engineering Ltd. of London, United Kingdom, was awarded a contract to increase the capacity of an existing

ammonia plant at Coromandel Fertilizers Ltd.'s Vishakhapatnam, Andhra Pradesh, facility from 300 to 400 tons per day (Green Markets, 1997m).

The Public Investment Board reportedly rejected a proposal by Indian Farmers Fertiliser Cooperative Ltd. (IFFCO) to construct a 726,000-ton-per-year urea plant in Nellore because it did not think the project would be feasible either economically or technically. The Planning Commission also reportedly opposed the proposed plant because urea production costs were expected to be higher than the cost of imported urea. IFFCO stated that the low international urea prices were temporary and that by the time the new plant is commissioned in 2001 the price scenario will have changed (Green Markets, 1997u). IFFCO also plans to construct a new ammonia-urea facility at its existing Pulpur complex. The company expects to add a 1,350-ton-per-day ammonia plant and two urea plants with a total capacity of 1,100 tons per day to be operational by January 1998. IFFCO completed a debottlenecking program at it ammonia-urea complex in Kalol, Gujarat, in August. This has increased capacity at the ammonia plant from 910 to 1,100 tons per day. Urea plant capacity was increased from 1,200 to 1,650 tons per day (Green Markets, 1997ff).

Rashtriya Chemicals & Fertilizers Ltd. (RCF) has planned several expansions and retrofits at its facilities, the largest of which is an addition of two production streams of urea and one unit of ammonia at its Thal facility. The addition of these units along with modernization of existing capacity is expected to increase total production capacity at the complex by 40% (Green Markets, 1997x).

Indonesia.—PT Pupuk Iskandar Muda announced plans to construct a second urea plant at Lhokseumawe with a capacity of 600,000 tons per year. Feedstock gas will be provided domestically by the state energy company, and production is expected to begin by 2000 (Fertilizer International, 1997a).

In November, a consortium of Japanese and Indonesian firms—Mitsubishi Corp. (Japan), Asahi Chemical Industry Co. Ltd. (Japan), PT Pama Raya (Indonesia), and Yayasan Kaltim (Indonesia)—announced plans to construct a 495,000-ton-peryear ammonia facility in Bontag, East Kalimantan, Indonesia. The partners will become shareholders in a new company called PT Kaltim Pama Industri for a total investment of \$240 million, most of which will be supplied by the Japanese partners. Construction of the new plant is expected to begin in early 1998, with completion scheduled for mid-2000. Gas for the plant will be supplied from the local gasfields, and Asahi is expected to be the principal customer, using the ammonia to feed its acrylonitrile plants (Green Markets, 1997p).

Israel.—Haifa Chemicals Ltd. plans to spend \$70 million to increase capacity at its potassium nitrate plants in Haifa and Mishor Rotem. Currently, the combined capacity of the two plants is 400,000 tons per year, but the company has not said what the size of the increase would be (Green Markets, 1997k).

Mexico.—Because of high ammonia prices in Mexico, significant capacity at many of Mexico's nitrogen upgrading plants was idled in the third quarter. As a result, Petroleos Mexicanos, the Government energy company and sole producer of ammonia, was estimated to lose 125,000 tons per month of domestic sales as long as the upgrading plants were closed.

Agromex closed its urea and ammonium nitrate plants in September, including a new granular urea plant that had just begun operation in August. These were closed for 2 to 3 months for maintenance. Grupo Ferquimex-Fertima also closed its urea and ammonium nitrate facilities. Many of the country's ammonium sulfate facilities were either closed or operating at reduced capacity as well (Fertilizer Markets, 1997b).

Norway.—In February, Norsk Hydro A/S announced that it would upgrade its Porsgrunn ammonia plant and increase capacity from 1,250 to 1,450 tons per day. The upgrade, which is scheduled to be completed in the third quarter of 1998, would reduce nitrogen discharge to the water and reduce energy consumption (Green Markets, 1997s).

Oman.—A final joint-venture agreement was signed in April between the Oman Oil Co. Inc. (OOC) and Indian nitrogen producers RCF and Krisnak Bharati Cooperative Ltd. (Kribhco) to build a \$1.1 billion ammonia-urea complex in Oman. The complex at Sur includes two 1,750-ton-per-day ammonia units and two 2,200-ton-per-day urea units. OOC will have a 50% stake in the joint venture and RCF and Kribhco each will have 25%. Oman will provide the land and natural gas for the project, and the two Indian companies will have a 20-year purchase agreement to buy all the urea at prices lower than those in the international market. Plant construction was expected to begin in 1998, with the plant coming on-stream by 2000 (Fertilizer Week, 1997b).

Pakistan.—Al Noor Fertilizer Industries Ltd. and Morocco's Office Cherifen des Phosphates (OCP) finalized a joint-venture agreement to construct a urea-diammonium phosphate (DAP) complex in Dhabejei. The \$220 million complex, which is scheduled to begin production by yearend 1998, will have the capacity to produce 1,200 tons per day of urea and 1,300 tons per day of DAP. OCP will supply the complex's phosphoric acid requirements, Pakistan will supply the natural gas, and an existing 955-ton-per-day ammonia plant was purchased and relocated from the United Kingdom to Pakistan (Green Markets, 1997c).

Pak-American Fertilizers Ltd.'s new ammonia-urea complex in Mianwali was scheduled to be on-stream in 1998, with a capacity of 1,080 tons per day of urea and 600 tons per day of ammonia. A \$59 million retrofit of Engro Chemical Pakistan Ltd.'s Daharki facility, which is planned to be completed in mid-1998, will increase capacity from 750,000 to 850,000 tons per year.

Qatar.—A \$520 million expansion of Qatar Fertilizer Co.'s (Qafco) ammonia-urea complex began operation in March. The expansion increased ammonia capacity from 750,000 to 1.3 million tons per year and urea capacity from 830,000 to 1.5 million tons per year (Green Markets, 1997v). In December, Qafco commissioned a feasibility study that would further expand capacity at the company's nitrogen plants. The potential expansions would include 500,000 tons of ammonia and 750,000 tons of urea annually (Green Markets, 1997w).

Saudi Arabia.—The Saudi Arabian Fertilizer Co. (SAFCO) reportedly signed a contract with Tecnimont SpA of Italy to construct the new nitrogen complex at Jubail that was announced in 1996. The new plant, scheduled to be completed in 1999, would add 500,000 tons of annual ammonia capacity and 600,000 tons of annual urea capacity to SAFCO's total production capacity

(Green Markets, 1997y).

Trinidad and Tobago.—CL Financial Ltd., along with its joint-venture partners Transammonia, Agrium Inc., Ferrostaal AG and Proman, announced plans to build a 500,000-ton-per-year ammonia plant at Point Lisas. Construction at the \$400 million complex is expected to begin in January 1998, but no timetable has been set for completion (Green Markets, 1997b).

PCS Nitrogen's new ammonia plant was scheduled to come onstream at the beginning of 1998, bringing the company's total production capacity in Trinidad to about 2 million tons per year. In addition Farmland and MissChem Ltd.'s 516,000-ton-per-year ammonia plant also is scheduled to be on-stream by the first half of 1998. Together, these two new plants will add more than 1 million tons of additional production capacity in Trinidad.

An explosion at Hydro Agri Trinidad Ltd.'s 215,000-ton-peryear ammonia plant on September 20 shut down the plant for the remainder of the year. Operating a turbine at high speed with onehalf of a bearing missing was cited as the cause of the explosion that killed two workers. The plant was expected to restart by the end of January 1998 (Green Markets, 1997l).

United Arab Emirates.—India's Southern Petrochemical Industries Corp. (SPIC) plans to construct a \$160 million nitrogen fertilizer complex in the Jebel Ali free zone of Dubai. Production capacity at the complex will be 685 tons per day of ammonia and 1,200 tons per day of prilled urea. The plant is expected to begin operating in the first quarter of 1999. Refurbished equipment from a SPIC complex in Sri Lanka that was closed in 1992 will serve as the basis for the new plant (Fertilizer Week, 1997c).

United Kingdom.—Terra Industries signed a purchase agreement for Imperial Chemical Industries PLC's fertilizer business in the United Kingdom for \$340 million. Included in the sale are two ammonia production facilities in England with a combined annual production capacity of 740,000 tons. Much of this ammonia is upgraded to ammonium nitrate and nitric acid for agricultural and industrial uses in Europe. The new unit will be named Terra Nitrogen UK (Green Markets, 1997dd).

Venezuela.—Koch Industries Inc., Petroquímica de Venezuela, and two other partners signed a formal agreement in October to build an ammonia-urea complex at Jos. The complex, consisting of a 1.2-million-ton-per-year ammonia plant and a 1.5-million-ton-per-year granular urea plant, is estimated to cost \$900 million. Snamprogetti SpA, one of the partners is expected to construct the plant, beginning in early 1998. Production is scheduled to start by the end of 2000 (Green Markets, 1997n).

Current Research and Technology

Planet Polymer Technologies Inc. received a patent for a new form of controlled-release coating for plant nutrients. The patented material, EnviroPlastic-CRT, was designed for coating urea granules to produce a urea fertilizer that is insoluble in water, but is biodegradable in soil. The fertilizer is released over a period of up to 120 days, and the company claims that this controlled release will improve the efficiency of the nitrogen fertilizer. Preliminary test results in China indicated that crop yields improved by 10% to 20%; this would reduce fertilizer costs to the farmer. With controlled release of the fertilizers, the potential for groundwater contamination by excess fertilization is

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minimized (Green Markets, 1997g).

Outlook

The outlook for overall nitrogen demand in the United States is mixed with several factors exerting positive and negative influences on demand. Planted acreage in 1998 for the eight major crops (the largest of which are corn, soybeans, and wheat) is projected to increase by 1.4%, and crop prices are expected to remain steady (Douglas, 1998). Based on those projections, overall fertilizer demand could increase by 1.5% to 2% from the 1997 level. However, weather and the financial situation in Asia could affect these projections significantly to the extent that there may be a decline in demand for fertilizers. The strong U.S. dollar coupled with record crops in the southern hemisphere could affect U.S. food exports to Asia. The U.S. Department of Agriculture projects that cereal grain plantings will increase for the 1997-98 fertilizer year, but that yearend stocks will increase and exports will decrease (Fertilizer International, 1998).

The International Fertilizer Development Center (IFDC) projects increases in world ammonia production capacity from 2% to 5% per year through 2002. More immediately the addition of 1 million tons of production capacity in Trinidad and Tobago in early 1998 will significantly impact U.S. markets. If demand grows at 1.5% to 2% per year and export markets decline, as was projected for 1998, an overcapacity situation will exist during most of this period.

The departure of China from the world urea market will have an impact on urea demand depending on how long the country's ban on imports lasts. World urea production is projected to increase by 12% by the end of the century, with China and India traditionally as the largest consumers. If China does not reenter the world market, there also will be an overcapacity in urea production.

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¹Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1 SALIENT AMMONIA STATISTICS 1/2/

(Thousand metric tons of contained nitrogen unless otherwise specified)

	1993	1994	1995	1996	1997 p/
United States:					•
Production	12,600	13,300 r/	13,000	13,200 r/	14,300
Exports	378	215	319	435	395
Imports for consumption	2,660	3,450	2,630	3,390 r/	3,530
Consumption, apparent 3/	15,100	16,500	15,300	16,300 r/	16,800
Stocks, Dec. 31; producers'	852	956	959	881 r/	1,530
Average annual price, dollars per short					
ton product, f.o.b. gulf coast 4/	\$121	\$211	\$191	\$225	\$130
Net import reliance 5/ as a					
percent of apparent consumption	17	19	15	19 r/	15
Natural gas price; wellhead 6/	\$2.04	\$1.85	\$1.55	\$2.17 r/	\$2.42
World:					
Production	91,600 r/	93,700 r/	99,800 r/	102,000 r/	102,000 e/
Trade 7/	9,060	10,000	10,800	11,000	11,400

- e/ Estimated. p/ Preliminary. r/ Revised.
- 1/ Data are rounded to three significant digits, except prices.
- 2/ Synthetic anhydrous ammonia, calendar year data, Bureau of the Census; excludes coke oven byproduct.
- 3/ Calculated from production, plus imports minus exports, and industry stock changes.
- 4/ Green Markets, Fertilizer Market Intelligence Weekly.
- 5/ Defined as imports minus exports, adjusted for industry stock changes.
- 6/ Monthly Energy Review, U.S. Department of Energy. Average annual cost at wellhead in dollars per thousand cubic feet.
- $7/\operatorname{International Fertilizer\ Industry\ Association\ Statistics\ World\ Anhydrous\ Ammonia\ Trade.}$

TABLE 2 FIXED NITROGEN PRODUCTION IN THE UNITED STATES 1/

(Thousand metric tons of contained nitrogen)

	1996 r/	1997 p/
Anhydrous ammonia, synthetic:		
Fertilizer	11,500	12,300
Nonfertilizer	1,720	1,980
Total	13,200	14,300

p/ Preliminary. r/ Revised.

Source: Current Industrial Reports, MA28B and MQ28B,

Bureau of the Census.

 $^{1/\}operatorname{Data}$ are rounded to three significant digits; may not add to totals shown.

TABLE 3 MAJOR DOWNSTREAM NITROGEN COMPOUNDS PRODUCED IN THE UNITED STATES 1/2/

(Thousand metric tons)

Compound	1996	1997 p/
Urea:		
Gross weight	7,740 r/	7,040
Nitrogen content	3,550 r/	3,230
Ammonium phosphates: 3/		
Gross weight	16,900	16,700
Nitrogen content	2,820 r/	2,880
Ammonium nitrate:		
Gross weight	8,190 r/	7,490
Nitrogen content	2,780 r/	2,540
Nitric acid:		
Gross weight	8,350	8,230
Nitrogen content	1,840	1,810
Ammonium sulfate: 4/		
Gross weight	2,420	2,550
Nitrogen content	512 r/	540

p/ Preliminary. r/ Revised.

- $2/\,\mbox{Ranked}$ in relative order of importance by nitrogen content.
- 3/ Diammonium phosphate (DAP), monoammonium phosphate (MAP), and other ammonium phosphates.
- 4/ Excludes coke plant ammonium sulfate.

Sources: Current Industrial Reports, MA28B and MQ28B, Bureau of the Census.

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

${\bf TABLE~4}\\ {\bf DOMESTIC~PRODUCERS~OF~ANHYDROUS~AMMONIA~IN~1997~1/}$

(Thousand metric tons per year of ammonia)

Company	Location	Capacity 2/
Agrium Inc.	Borger, TX	439
Air Products and Chemicals Inc.	Pace Junction, FL	46
Allied Signal Inc.	Hopewell, VA	409
Avondale Ammonia 3/	Fortier, LA	399
Borden Chemicals Inc.	Geismar, LA	364
CF Industries Inc.	Donaldsonville, LA	1,730
Coastal Chem, Inc.	Cheyenne, WY	174
Coastal St. Helens Chemical	St. Helens, OR	88
Dakota Gasification Co.	Beulah, ND	321
E. I. du Pont de Nemours & Co. Inc.	Beaumont, TX	451
Farmland Industries Inc.	Beatrice, NE	255
Do.	Dodge City, KS	255
Do.	Enid, OK	919
Do.	Fort Dodge, IA	345
Do.	Lawrence, KS	409
Do.	Pollock, LA	459
Green Valley Chemical Corp.	Creston, IA	32
IMC-Agrico Co.	Faustina (Donaldsonville), LA	482
IMC Nitrogen Co.	East Dubuque, IL	269
J.R. Simplot Co.	Pocatello, ID	93
Koch Industries	Sterlington, LA	1,110
LaRoche Industries Inc.	Cherokee, AL	159
Mississippi Chemical Corp.	Yazoo City, MS	481
Monsanto Co.	Luling, LA	446
Nitromite Fertilizer	Dumas, TX	128
PCS Nitrogen Inc. 4/	Augusta, GA	622
Do.	Clinton, IA	237
Do.	Geismar, LA	476
Do.	LaPlatte, NE	182
Do.	Lima, OH	551
Do.	Woodstock, TN	356
Shoreline Chemical	Gordon, GA	31
Terra International, Inc.	Blytheville, AR	390
Do.	Port Neal, IA	319
Do.	Verdigris, OK	955
Do.	Woodward, OK	446
Triad Nitrogen Inc. 5/	Donaldsonville (Ampro), LA	554
Do.	Donaldsonville (Triad), LA	417
Union Chemical Co. (Unocal)	Finley, WA	150
Do.	Kenai, AK	1,180
Wil-Grow Fertilizer Co.	Pryor, OK	86
Do.	Pryor, OK (II)	247
Total		17,500

^{1/} Data are rounded to three significant digits; may not add to total shown.

Sources: International Fertilizer Development Center (IFDC); North American Fertilizer Capacity, Ammonia, February 1998. Blue, Johnson and Associates, North American NPK Plants and Capacities, Foster City, CA.

^{2/} Engineering design capacity adjusted for 340 days per year of effective production capability.

^{3/} Joint venture between American Cyanamid and LaRoche Industries Inc. formed in 1994.

^{4/} Plants formerly owned by Arcadian Corp.

^{5/} Plants formerly owned by Mississippi Chemical Corp.

TABLE 5 U.S. NITROGEN FERTILIZER CONSUMPTION, BY CROP YEAR, BY PRODUCT TYPE 1/

(Thousand metric tons nitrogen)

Fertilizer material 2/	1996	1997 p/
Single-nutrient:		
Anhydrous ammonia	3,590	3,610
Nitrogen solutions 3/	2,570	2,650
Urea	1,630	1,620
Ammonium nitrate	646	598
Ammonium sulfate	200	223
Aqua ammonia	69	47
Other 4/	251	326
Total	8,960	9,070
Multiple-nutrient 5/	2,170	2,370
Grand total	11,100	11,400

- p/ Preliminary.
- 1/ Data are rounded to three significant digits; may not add to totals shown.
- 2/ Ranked in relative order of importance by product type.
- 3/ Principally urea-ammonium nitrate (UAN) solutions, 29.9% N.
- 4/ Includes other single-nutrient nitrogen materials, all natural organics, and statistical discrepencies.
- 5/ Various combinations of nitrogen (N), phosphate (P), and potssium (K): N-P-K, NP, and N-K.

Source: Commercial Fertilizers. Prepared as a cooperative effort by The Fertilizer Institute, and the Association of American Plant Food Control Officials, December 1997.

TABLE 6 U.S. PRODUCER STOCKS OF FIXED NITROGEN COMPOUNDS AT YEAREND 1/2/

(Thousand metric tons nitrogen)

Material 3/	1996	1997 p/
Ammonia	881 r/	1,530
Nitrogen solutions 4/	248 r/	385
Urea	89	108
Ammonium phosphates 5/	73 r/	94
Ammonium nitrate	59 r/	67
Ammonium sulfate	42	60
Total	1,390 r/	2,240

- p/ Preliminary. r/ Revised.
- $1/\operatorname{Data}$ are rounded to three significant digits; may not add to totals shown.
- 2/ Calendar year ending December 31.
- 3/ Ranked in relative order of importance.
- 4/ Urea-ammonium nitrate and ammoniacal solutions.
- $5/\,\mbox{Diammonium},$ monoammonium, and other ammonium phosphates.

Source: Current Industrial Reports, MA28B and MQ28B, Bureau of the Census.

TABLE 7 PRICE QUOTATIONS FOR MAJOR NITROGEN COMPOUNDS ${\rm AT\ YEAREND}$

(Per short ton product)

Compound	1996	1997
Ammonium nitrate; f.o.b. Corn Belt 1/	\$160-\$170	\$122-\$125
Ammonium sulfate; f.o.b. Corn Belt 1/	119- 130	124- 130
Anhydrous ammonia:		
F.o.b. Corn Belt	233- 245	181- 195
F.o.b. Gulf Coast 2/	225	130
Diammonium phosphate; f.o.b. central Florida	177- 180	174- 175
Urea:		
F.o.b. Corn Belt, prilled and granular	197- 210	125- 135
F.o.b. Gulf Coast, granular 2/	188- 190	102- 103
F.o.b. Gulf Coast, prilled 2/	181- 184	102- 103

^{1/} Illinois, Indiana, Iowa, Missouri, Nebraska, and Ohio.

Source: Green Markets, Fertilizer Market Intelligence Weekly.

 ${\footnotesize \begin{array}{c} {\footnotesize TABLE~8}\\ {\footnotesize U.S.~EXPORTS~OF~ANHYDROUS~AMMONIA,}\\ {\footnotesize BY~COUNTRY~1/} \end{array} }$

(Thousand metric tons ammonia)

Country	1996	1997				
Belgium	26	1				
Canada	15	13				
China	18	(2/)				
Colombia	7	`				
Costa Rica	10					
Korea, Republic of	399	463				
Mexico	16	1				
Morocco	28					
Senegal	7					
Taiwan	1	1				
Other 3/	3	2				
Total	530	481				
1/X/-11-411 D						

^{1/}Value data suppressed by Bureau of the Census.

Source: Bureau of the Census.

^{2/} Barge, New Orleans.

 $^{2/\,}Less$ than 1/2 unit.

^{3/1996} includes 13 countries, 1997 includes 17 countries.

TABLE 9 U.S. IMPORTS OF ANHYDROUS AMMONIA, BY COUNTRY AND REGION 1/

(Thousand metric tons ammonia and thousand dollars)

	199	96	199	997 p/	
	Gross		Gross		
Country or region 2/	weight	Value 3/	weight	Value 3/	
Trinidad and Tobago	1,470	298,000	1,430	263,000	
Canada	1,210	206,000	1,190	219,000	
Russia 4/	1,140	84,000	1,200	100,000	
Ukraine	NA	144,000	NA	58,400	
Mexico	176	34,600	303	52,300	
Venezuela	37	7,300	87	15,000	
Brazil	25	4,800	39	6,410	
West Europe 5/	34	7,000	25	4,410	
Far East 6/	32	6,670	10	1,940	
South America 7/			6	1,340	
Total	4,120 r/	792,000	4,290	722,000	

- p/ Preliminary. r/ Revised. NA Not available.
- 1/ Data are rounded to three significant digits; may not add to totals shown.
- 2/ Ranked in relative order of importance by country and region.
- 3/ C.i.f. value.
- 4/ Quantity data from the Journal of Commerce Port Import/Export Reporting System.
- $5/\ln 1996$ includes Germany and Greece. In 1997 includes Spain, the Netherlands, and France, in order of importance.
- 6/ In 1996 includes Indonesia, Thailand, and Taiwan, in order of importance. In 1997 includes Indonesia and Japan, in order of importance.
- 7/ Data in 1997 is from Colombia.

Sources: Bureau of the Census, Journal of Commerce Port Import/Export Reporting System.

TABLE 10 U.S. EXPORTS OF MAJOR NITROGEN COMPOUNDS 1/

(Thousand metric tons)

	199	96	199	7
	Gross	Nitrogen	Gross	Nitrogen
Compound	weight	content	weight	content
Ammonium nitrate 2/	62	21	45	15
Ammonium sulfate 2/	824	222 r/	840	227
Anhydrous ammonia	530	435	481	395
Diammonium phosphate	7,920	1,430 r/	8,500	1,530
Monoammonium phosphate	1,510	166 r/	1,630	180
Urea	1,470	675	824	378
Mixed chemical fertilizers 3/	390 r/	47 r/	294	35
Other nitrogenous fertilizers 4/	154	46	169	50
Total	12,900 r/	3,040 r/	12,600	2,760

- r/ Revised.
- 1/ Data are rounded to three significant digits; may not add to totals shown.
- 2/ Includes industrial chemical products.
- 3/ Harmonized codes 3105.10.0000, 3105.20.0000, and 3105.51.0000.
- 4/ Harmonized codes 3101.00.0000, 3102.29.0000, 3102.60.0000, and 3102.90.0000.

Source: Bureau of the Census.

${\bf TABLE~11} \\ {\bf U.S.~IMPORTS~OF~MAJOR~NITROGEN~COMPOUNDS~1/}$

(Thousand metric tons and thousand dollars)

		1996			1997	
	Gross	Nitrogen		Gross	Nitrogen	
Compound	weight	content	Value 2/	weight	content	Value 2/
Ammonium nitrate 3/	718	251	110,000	708	240	104,000
Ammonium nitrate-limestone mixtures	75	20	11,200	27	7	3,670
Ammonium sulfate 3/	373	79	38,300	478	101	47,000
Anhydrous ammonia 4/	4,130 r/	3,390 r/	793,000	4,300	3,530	722,000
Calcium nitrate	(5/)	(5/)	10,200	(5/)	(5/)	13,100
Diammonium phosphate	77	16	18,300	57	10	14,500
Monoammonium phosphate	181	22	52,400	115	13	33,500
Nitrogen solutions	877	264	119,000	780	233	89,900
Potassium nitrate	30	4	9,990	19	3	6,190
Potassium nitrate-sodium nitrate mixtures	22	3	3,930	20	3	3,520
Sodium nitrate	99	16	20,000	114	19	22,600
Urea	2,520	1,170	447,000	2,530	1,160	425,000
Mixed chemical fertilizers 6/	337 r/	40 r/	68,100 r/	354	42	71,100
Other nitrogenous fertilizers 7/	195 r/	58 r/	31,400 r/	220	65	31,200
Total	9,630 r/	5,340 r/	1,730,000 r/	9,720	5,430	1,590,000

r/ Revised.

Source: Bureau of the Census.

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

^{2/} C.i.f. value

^{3/} Includes industrial chemical products.

^{4/} Includes industrial ammonia.

^{5/} Less than 1/2 unit.

^{6/} Harmonized codes 3105.10.0000, 3105.20.0000, 3105.51.0000, and 3105.90.0050.

 $^{7/\} Harmonized\ codes\ 3101.00.0000,\ 3102.29.0000,\ 3102.60.0000,\ and\ 3102.90.0000.$

 ${\bf TABLE~12}$ AMMONIA: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons of contained nitrogen)

Country	1993	1994	1995	1996	1997 e/
Afghanistan e/	15 r/	15 r/	10 r/	5 r/	5
Albania e/	15	15	15	15	10
Algeria	380	243 r/	176 r/	150 r/	380
Argentina	72	73	79 r/	80 r/	107
Australia	398	413	433	446 r/	432
Austria e/	400	400	400	400	400
Bahrain	348	338	358	323 r/e/	356
Bangladesh 3/	991	1,027 r/	1,271 r/	1,233 r/	1,080
Belarus	619	650 r/e/	668 r/	678 r/	590
Belgium	535	633 r/	720 r/	750 r/	760
Bosnia and Herzegovina e/	2	1	1	1	1
Brazil	914 r/	939 r/	993 r/	977	1,020
Bulgaria	885	995 r/e/	1,203 r/	1,200 r/e/	1,200
Burma e/	79 r/	70 r/	66 r/	57 r/	62
Canada	3,410	3,470	3,773	3,840 r/	3,980
China e/	19,000	20,100	22,600	23,000	24,000
Colombia	99	112 r/	99 r/	102 r/	81
Croatia	345	311	295	307 r/	331
Cuba e/	135	130	135 r/	135 r/	135
Czech Republic	149	284 r/	254 r/	304 r/	251
Denmark e/	2 4/	2	2	2	2
Egypt	941	1,021 r/	1,096 r/	1,126 r/	1,060
Estonia	150 r/e/	170 r/e/	170 r/	1,120 r/	169 4/
Finland	10 e/	12	6 r/	6 r/e/	6
France	1,871	1,480	1,470	1,500 e/	1,500
Germany	2,100	2,170	2,518 r/	2,485 r/	2,470
	58	2,170 35 e/	52 r/	2,483 r/ 77 r/	2,470
Georgia Greece	58 57	45 r/	65 r/	90 r/	83
	237	302 r/	307 r/	347 r/	339
Hungary			307 1/ 7 r/		
Iceland	9 e/	9		7 r/	7
India 5/	7,176	7,503 r/	8,287 r/	8,549 r/	8,600
Indonesia	2,888	3,012 r/	3,336 r/	3,647 r/	3,770
Iran	723 r/	696	715 r/	882 r/	880
Iraq e/	220 r/	220 r/	220 r/	220 r/	220
Ireland	367	451 r/	408 r/	377 r/	465
Israel 3/	39 r/	46 r/	53 r/	51 r/	45
Italy	729	504	487 r/	397 r/	446
Japan	1,471	1,483	1,584	1,567 r/	1,570
Kazakstan	231	100 r/e/	49 r/	75 r/	75
Korea, North e/	600	600	600	600	600
Korea, Republic of	386 r/	574 r/	616 r/	599 r/	509
Kuwait	317 r/	389 r/	493 r/	412 r/	432
Libya	358 r/	407 r/	534 r/	546 r/	537
Lithuania	275 e/	277	442	461 r/	385
Malaysia	334	313 r/	333 r/	329 r/	243
Mexico	1,758	2,030	1,992	2,054 r/	1,450
Netherlands	2,472	2,479 r/	2,580 r/	2,652 r/	2,500
New Zealand	78	81 r/	79 r/	68 r/	80
Nigeria e/	350	350	170 r/	164 r/	134
Norway	315	270	289 r/	295 r/	279
Pakistan	1,446	1,505 r/	1,493 r/	1,606 r/	1,550
Peru	15 r/	15 r/e/	24 r/	18 r/	15
Poland	1,163	1,230	1,415	1,405 r/	1,500
Portugal	91	58 r/	155 r/	198 r/	196
Qatar	627 r/	646 r/	653 r/	635 r/	943
Romania	1,328	1,182 r/	1,487 r/	1,513 r/	781
Russia	8,138	7,300 r/	7,900 r/	7,900 r/	7,150 4/
Saudi Arabia	1,097	1,340 r/	1,327 r/	1,386 r/	1,410
Serbia and Montenegro	1,097	1,340 1/	135	1,380 1/ 135 e/	135
Slovakia Slovakia	263	255 r/	178 r/	197 r/	229
San footnotes at and of table	203	433 1/	1/01/	19/ 1/	229

See footnotes at end of table.

TABLE 12--Continued AMMONIA: WORLD PRODUCTION, BY COUNTRY 1/2/

(Metric tons of contained nitrogen)

Country	1993	1994	1995	1996	1997 e/
South Africa	683 r/	754 r/	759 r/	770 r/	752
Spain	354	452 r/	453 r/	466 r/	497
Switzerland e/	28 4/	30	30	30	30
Syria	67 r/	93 r/	64 r/	80 r/	84
Taiwan	220	215	226	220 e/	220
Tajikistan e/	40	30	25	20	20
Trinidad and Tobago	1,462	1,649	1,696	1,801	1,800
Turkey	326	350 e/	366 r/	519 r/	500
Turkmenistan e/	50	50	52	70 r/4/	61 4/
Ukraine	3,242	3,000 e/	3,100	3,300 r/	3,400
United Arab Emirates	306 r/	287 r/	363 r/	331 r/	373
United Kingdom	873	1,006	799 r/	850 r/	642
United States 6/	12,600	13,300 r/	13,000	13,200 r/	14,300 4/
Uzbekistan	1,105	900 r/e/	906 r/	950 r/	925
Venezuela	535	505	600	605	610
Vietnam	52	53	52	53	54
Zambia	10	4 r/	1 r/	2 r/	1
Zimbabwe e/	70	70	43 r/	61 r/	64
Total	91,600 r/	93,700 r/	99,800 r/	102,000 r/	102,000

e/ Estimated. r/ Revised.

^{1/}W World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

^{2/} Table includes data available through June 18, 1998.

^{3/} May include nitrogen content of urea.

^{4/} Reported figure.

^{5/} Data are for years beginning April 1 of that stated.

^{6/} Synthetic anhydrous ammonia; excludes coke oven byproduct ammonia.