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Impact of Rising Natural Gas Prices on U.S. Ammonia Supply

Wen-yuan Huang

Abstract

The volatile and upward trend in U.S. natural gas prices from 2000-06 has led to a 17-percent decline in the Nation's annual aggregate supply of ammonia. During the period, U.S. ammonia production declined 44 percent, while U.S. ammonia imports increased 115 percent. Also, the share of U.S.-produced ammonia in the U.S. aggregate supply of ammonia dropped from 80 to 55 percent, while the share from imports increased from 15 percent to 42 percent. Meanwhile, ammonia prices paid by farmers increased from $227 per ton in 2000 to $521 per ton in 2006, an increase of 130 percent. Natural gas is the main input used to produce ammonia. Additional increases in U.S. natural gas prices could lead to a further decline in domestic ammonia production and an even greater rise in ammonia imports.

Keywords: Natural gas and ammonia prices, ammonia supply, nitrogen fertilizers

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Introduction

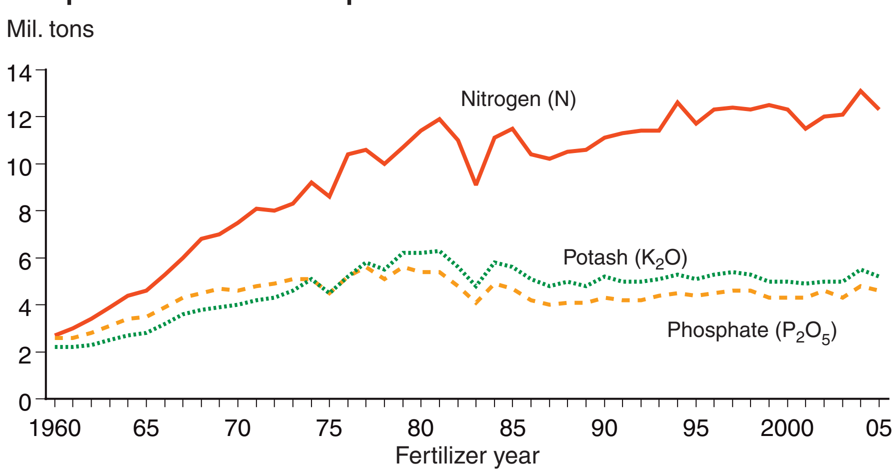
Nitrogen is vital to a plant's ability to develop proteins and enzymes, which, in turn, help the plant grow to produce food, feed, and fiber for animal and human consumption (Kramer). The importance of nitrogen fertilizers to U.S. agriculture is evidenced by its rising use over time. From 1960 to 2005, annual use of chemical nitrogen fertilizers in U.S. agriculture increased from 2.7 million nutrient tons to 12.3 million nutrient tons (fig. 1). This increase is considered to be one of the main factors behind increased U.S. crop yields and the high quality of U.S. agricultural products (TFI (d); Hallaway).

In 2005, U.S. agriculture used 22.15 million tons of chemical fertilizer nutrients (nitrogen, phosphate, and potash), of which nitrogen accounted for 56 percent. About 42 percent of total nitrogen used during the period was attributed to production of corn (ERS(c)). Among crops, corn accounted for the largest share of nitrogen use, followed by wheat. Total nitrogen costs for U.S. production of corn in 2005 and wheat in 2004 were $2.98 billion and $0.9 billion, respectively. Nitrogen costs contributed to the largest operating expense for both corn and wheat producers. Nitrogen application accounted for 18 percent of the operating costs for corn producers and about 30 percent of the costs for wheat producers (table 1).

In the coming years, projected increases in U.S. ethanol production from corn grain are expected to boost demand for nitrogen. Additional corn acres are expected to be planted at the expense of soybean acres because of more favorable returns for corn production than soybean production in 2007 (ERS (a)). Moving from soybeans to corn production may require additional ammonia to provide nitrogen for corn production and may lead to higher ammonia prices. Because natural gas is the main input used to produce ammonia, which, in turn, is the main input used to produce all nitrogen fertilizers, the volatile and upward-trending price of natural gas in recent years

Figure 1

U.S. plant nutrient consumption



Note: Fertilizer year runs from July of the preceding year to June of the year indicated in the chart.

Source: USDA, Economic Research Service using data from AAPFCO.

has affected the price and supply of ammonia, and, thereby, the supply and price of nitrogen fertilizers, which is a great concern to U.S. agriculture. This article analyzes the impact of natural gas prices on the U.S. ammonia supply and assesses future U.S. ammonia supplies.

Table 1

Costs of nitrogen use in U.S. production of corn (2005), cotton (2003), soybeans (2004), and wheat (2004)

Item	Corn	Cotton	Soybeans	Wheat
Nitrogen consumption *(1,000 tons)*	5,959	508	156	1,957
Nitrogen application rate *(pounds per acre)*	138	92	26	90
Average nitrogen price *(dollars per pound)*	0.25	0.23	0.23	0.23
Nitrogen cost *(million dollars)*	2,980	234	72	900
Nitrogen cost per acre *(dollars)*	34.50	21.16	5.98	20.70
Operating costs for crop production *(dollars per acre)*	193.48	304.29	81.77	70.83
Nitrogen share of the operating cost *(percent)*	17.83	6.95	7.31	29.22

Source: USDA, Economic Research Service using data from ARMS 2003-05 (Agricultural Resource Management Survey) (ERS (b) and ERS (c)).

Background

Until around 1920, the supply of nitrogen for crop production depended entirely on limited natural sources of nitrogen, mainly from animal and vegetable waste. In the 1920s, chemically processed nitrogen became available through the development of the Haber-Bosch process of using natural gas to synthesize ammonia (American Chemical Society). Since then, synthesized ammonia has been the main source of chemical nitrogen fertilizers for use on crops.

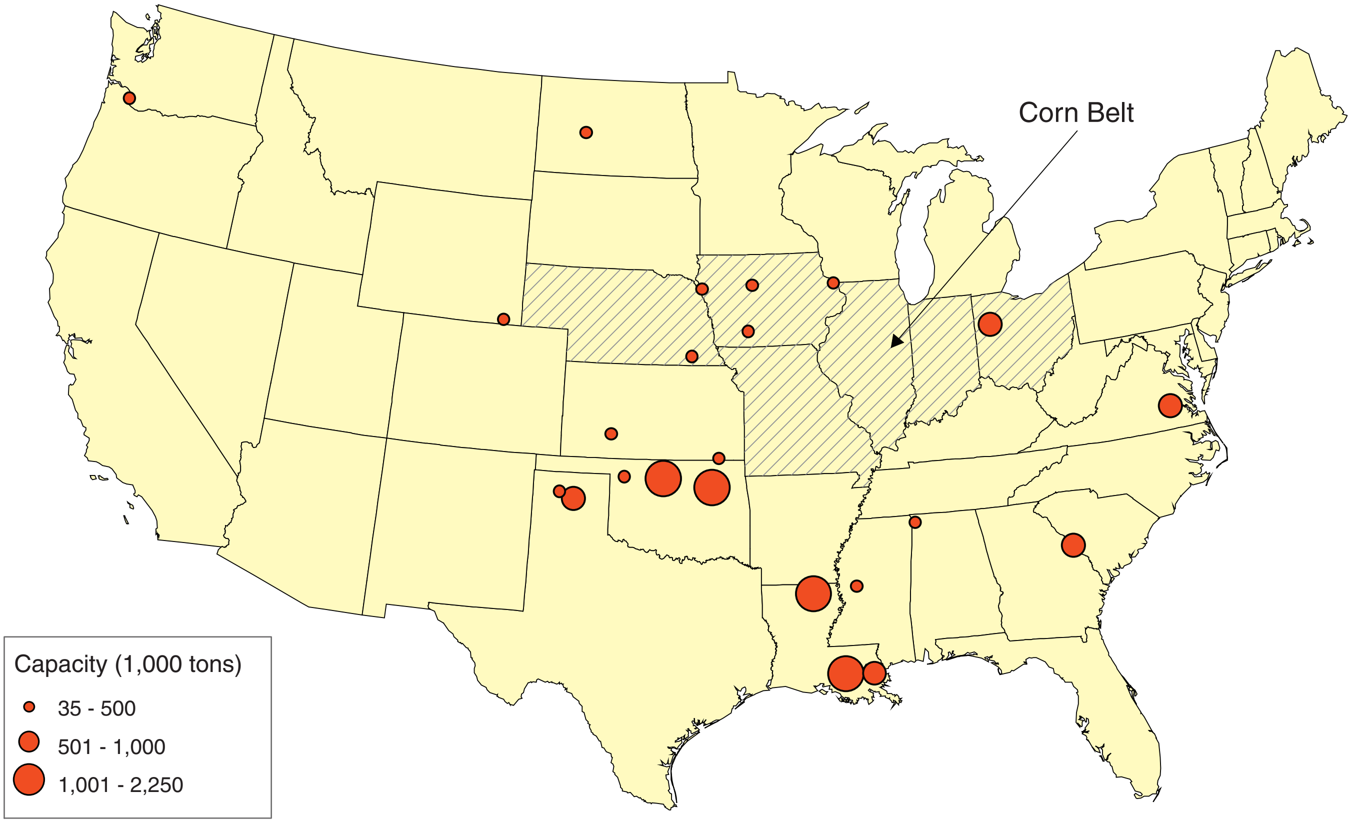
Ammonia is the main input source for all nitrogen fertilizers. Ammonia, which contains 82 percent nitrogen, is the main source for nitrogen in various types of fertilizers used in crop production. Ammonia can be directly applied to soil as fertilizer or it can be used as a raw material to produce nitrogen fertilizers, such as urea, ammonia nitrate, and nitrogen solutions. It also can be used as a raw material to produce more complex fertilizers, such as diammonium phosphate (DAP) and monammonium phosphate (MAP), which are two main phosphate fertilizers used by farmers for crop production. Furthermore, when combined with phosphoric acid and potassium chloride, ammonia and its derivatives are the basic material used in the formulation of various mixed fertilizers containing nitrogen, phosphate and potash, which are used extensively by farmers. Thus, a change in the price of ammonia often leads to changes in the prices of all nitrogen fertilizers.

Ammonia and its derivatives have a diverse mix of nonfertilizer use. Ammonia is used as an antifungal and a preservative for some crops. Its derivative urea is used extensively as a source of protein in livestock feeds for ruminating animals. Ammonia is also used in the manufacture of plastics, fibers, and chemicals in various industries (Kramer). In 2005, nonfertilizer use accounted for 11 percent of U.S.-produced ammonia.

Alternative systems are used to deliver ammonia. Most plants that produce ammonia continuously are located near the source of natural gas in the South (Gulf region) and the Southwest (fig. 2), while most nitrogen fertilizers are consumed in the Corn Belt within a very short timeframe in the fall and in the spring. To bridge these geographic and seasonal gaps, alternative distribution and storage systems, comprising pipelines, barges, and railways, move and handle large volumes of fertilizer products from domestic production sites in the South to the consuming regions further north (Mahan; Klindworth).

Figure 2

U.S. ammonia production plants, 2005-06



Source: USDA, Economic Research Service using data from IFDC.

Impact of Natural Gas Prices on Ammonia Prices

Natural gas is the primary raw material used to produce ammonia. Approximately 33 million British thermal units (mm Btu) of natural gas are needed to produce 1 ton of ammonia. Natural gas accounts for 72-85 percent of the ammonia production cost, depending on the size of the ammonia plant and the price of ammonia (TFI (a)). Ammonia prices were weakly correlated with natural gas prices before 2000, but became strongly correlated after 2000.

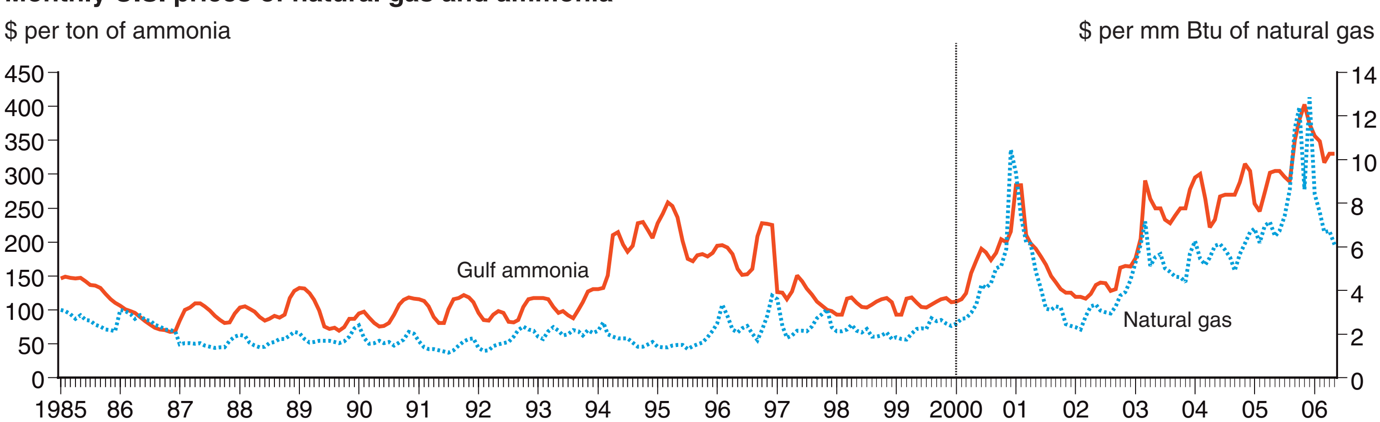
Following the deregulation of the natural gas market in the 1980s, monthly average prices of natural gas were relatively stable over the period 1985-99, ranging from $2 to $4 per mm Btu, with a standard deviation of $0.5 per mm Btu (fig. 3). In the same period, monthly average ammonia prices were relatively stable, except in 1994-97. The price correlation between natural gas and ammonia in this period (1985-99) was weak at 0.17 to 0.07 (table 2). Ammonia prices in this period were influenced mainly by ammonia demand. For example, the price peaks from 1994 to 1997 stemmed from the high demand for ammonia that exceeded production capacity, as more acreage was planted to corn following price increases due to strong export demand. From 2000 to 2006, however, natural gas prices became volatile and trended upward, ranging from $3 to $13 per mm Btu, with a standard deviation of $2.27 per mm Btu. In this period, the price correlation between natural gas and ammonia was strong at 0.8 to 0.7. A co-integration analysis suggests that the estimated longrun ammonia price elasticity with respect to natural gas price is 0.8, which reflects the share of the production cost of ammonia attributed to the cost of natural gas (Huang (b)).

Table 2
Monthly price correlations between natural gas and ammonia

Time period	Ammonia prices to natural gas prices	Ammonia prices lagged 1 month to natural gas prices	Ammonia prices lagged 2 months to natural gas prices
1985–99	+0.172	+0.119	+0.067
2000–05	+0.809	+0.823	+0.733

Source: USDA, Economic Research Service using data from TFI (b).

Figure 3
Monthly U.S. prices of natural gas and ammonia



Source: USDA, Economic Research Service using data from TFI (b).

Effects of Natural Gas Prices on Ammonia Producers

From 2000 to 2006, the increase in natural gas prices decreased the producers' gross return margins (the difference between the cost of natural gas to produce 1 ton of ammonia and the ammonia price (in the Gulf region) received by ammonia producers). The low average gross return margins in 2000-03 suggest that, on average, ammonia production in these 3 years was less profitable than in 1992-98, a period of high average gross return margins (fig. 4). Because of low profitability in recent years, a significant number of ammonia producers ceased production or merged with other producers (IFDC).

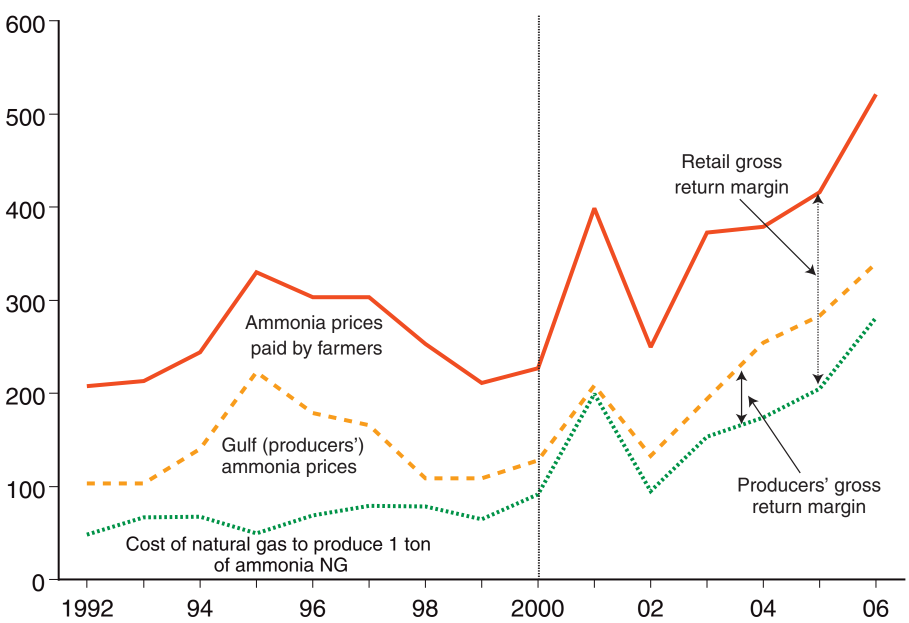
Production capacity and production are declining. Annual U.S. production capacity of ammonia increased from 1998 to 2000 in response to increased demand for ammonia but has since declined steadily (IFDC) (fig. 5). From 2000 to 2006, the annual capacity declined from 20 million tons to 13 million tons, a 35-percent drop. Over the same period, annual U.S. ammonia production fell from 18 million tons to 10 million tons, a 44-percent decline (DOC). About 77 percent of U.S. production capacity was used in 2006. Note that in 1994-97, large demands for ammonia pushed ammonia production near or over the production capacity, causing price jumps (see fig. 3).

Number of ammonia plants is declining also. The total number of U.S. ammonia plants has declined since 1990 (fig. 6) (IFDC). From 1990 to 2000, many less-efficient small plants closed. From 2000 to 2006, the total number

Figure 4

U.S. ammonia prices and cost of U.S. natural gas to produce ammonia

$ per ton

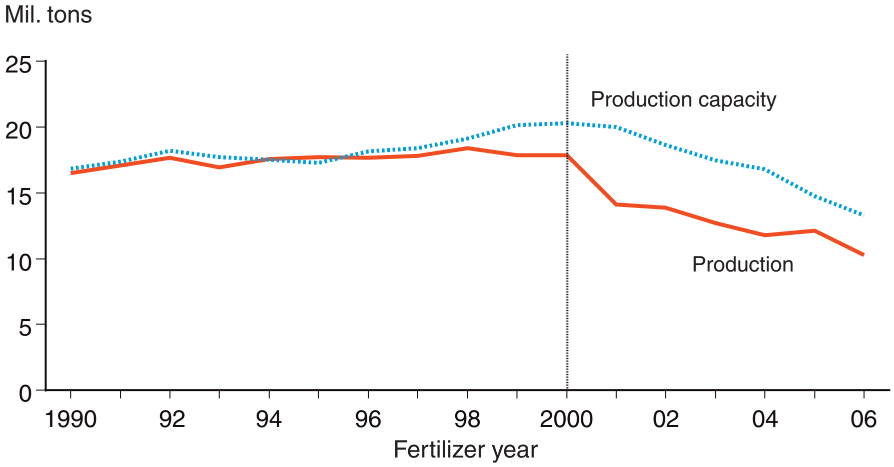


Note: 32.7 mm Btu per ton of ammonia is used to compute the cost to produce 1 ton of ammonia.

Source: USDA, Economic Research Service using data on ammonia prices paid by farmers from NASS, and data on ammonia Gulf prices and natural gas prices from TFI (b).

Figure 5

U.S. ammonia production and production capacity

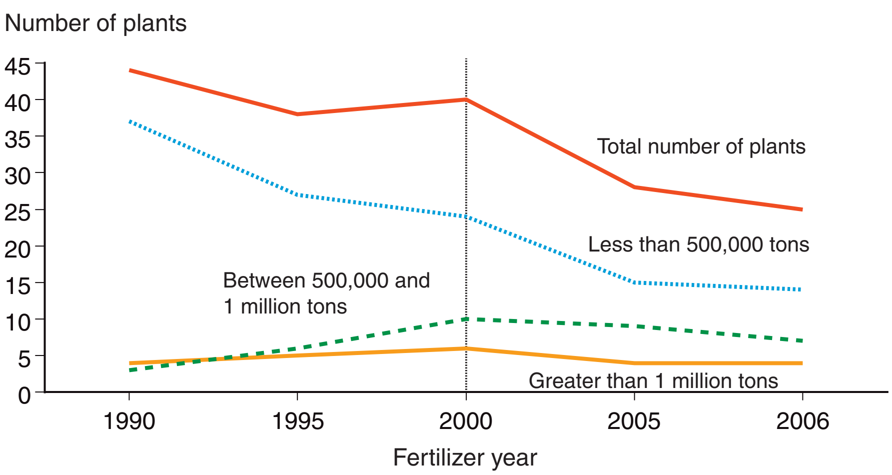


Note: Fertilizer year runs from July of the preceding year to June of the year indicated in the chart.

Source: USDA, Economic Research Service using capacity data from IFDC and production data from DOC.

Figure 6

Number of ammonia plants in three ranges of production capacity per year



Note: Fertilizer year runs from July of the preceding year to June of the year indicated in the chart.

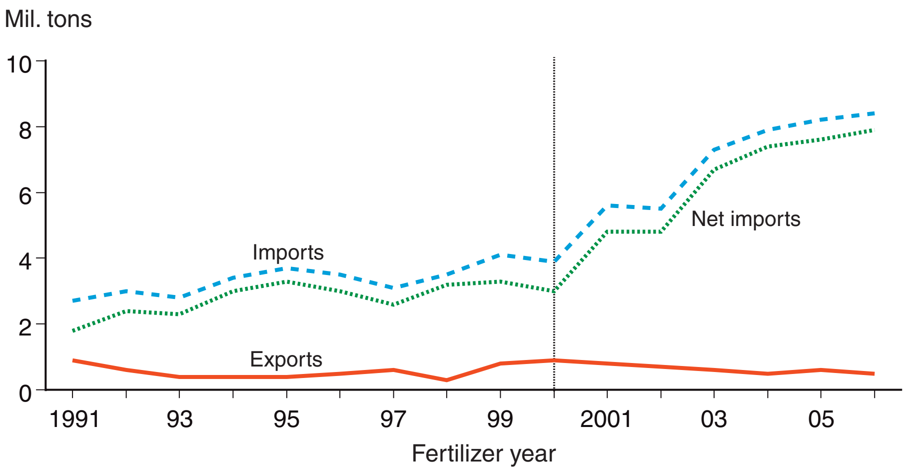
Source: USDA, Economic Research Service using data from IFDC.

of ammonia plants dropped from 40 to 25. The largest decline was in small plants with annual production capacity of less than 500,000 tons. The number of plants in this group declined from 24 to 14 over the period. Most of the small plants that closed were located in the Gulf region, where it became more profitable to use imported ammonia rather than the ammonia produced by plants in the region, largely due to increases in the cost of natural gas. Meanwhile, U.S. ammonia cooperative firms continued to lose market share and increasingly merged with privately owned or publicly traded companies. In 2006, only one cooperative firm remained in operation.

Ammonia net imports are increasing. U.S. net imports of ammonia maintained a relatively constant level from 1991 to 2000. Since 2001, however, with the decline of domestic ammonia production, imported ammonia has become increasingly important to the U.S. ammonia supply. From 2000 to 2006, annual U.S. imports of ammonia increased from 3.9 to 8.4 million tons, an increase of 115 percent, while ammonia exports remained constant (ERS (d)) (fig. 7). During that period, most U.S. ammonia imports came from Trinidad and Tobago, Canada, Russia, and Ukraine (fig. 8). In 2006, Trinidad and Tobago accounted for 57 percent of U.S. ammonia imports. North Dakota and Montana were the main entry ports for ammonia imports from Canada, while the Gulf States were the main entry ports for ammonia shipped from Trinidad and Tobago, Russia, and Ukraine.

Figure 7

U.S. ammonia imports, exports, and net imports

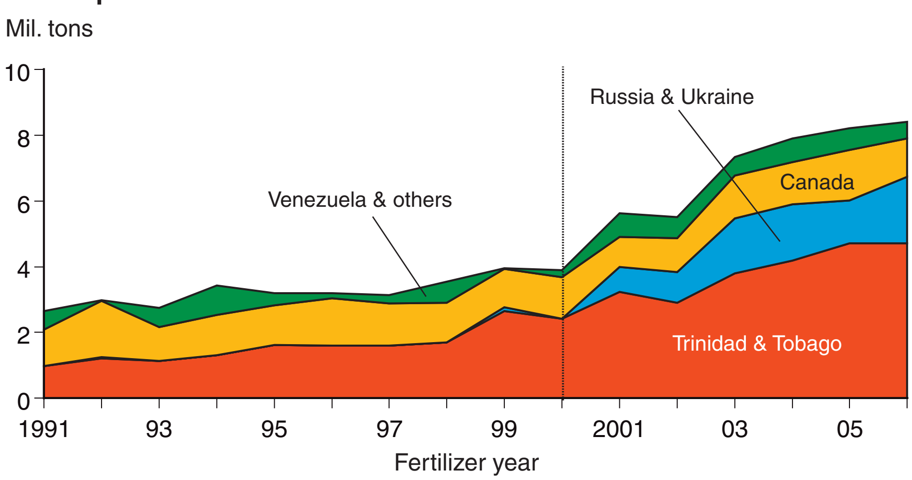


Note: Fertilizer year runs from July of the preceding year to June of the year indicated in the chart.

Source: USDA, Economic Research Service (d).

Figure 8

U.S. imported ammonia



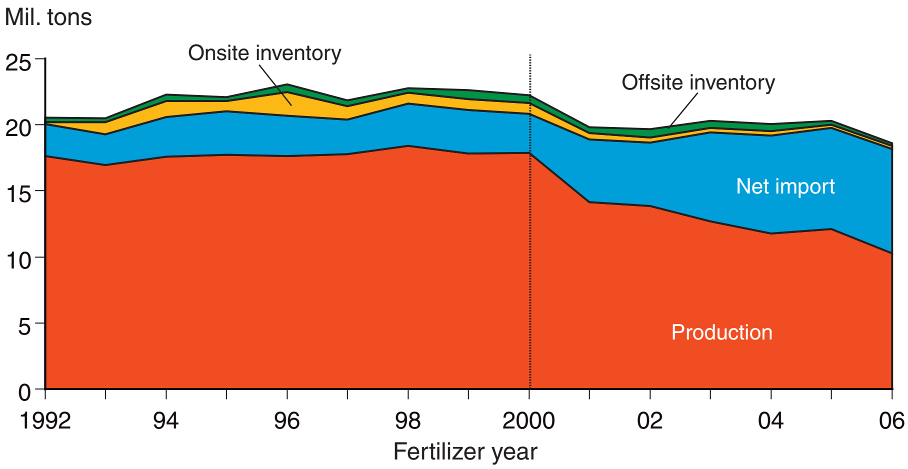
Note: Fertilizer year runs from July of the preceding year to June of the year indicated in the chart.

Source: USDA, Economic Research Service (d).

Aggregate U.S. ammonia supply is declining. U.S. aggregate supplies of ammonia increased from 1992 to 2000 but declined from 2001 to 2006 (fig. 9). From 2000 to 2006, supply declined 17 percent from 22.2 million tons to 18.5 million tons, and the beginning onsite and offsite inventories declined 71 percent from 1.4 million tons to 0.4 million tons. During the period, the share of the U.S. supply from domestic production dropped from 80 to 55 percent, while the share of the supply from imports increased from 15 to 42 percent.

Figure 9

U.S. ammonia supply from all sources



Note: Fertilizer year runs from July of the preceding year to June of the year indicated in the chart.

Source: USDA, Economic Research Service using production and onsite inventory data from DOC, net import data from ERS(d), and offsite inventory data from TFI (c).

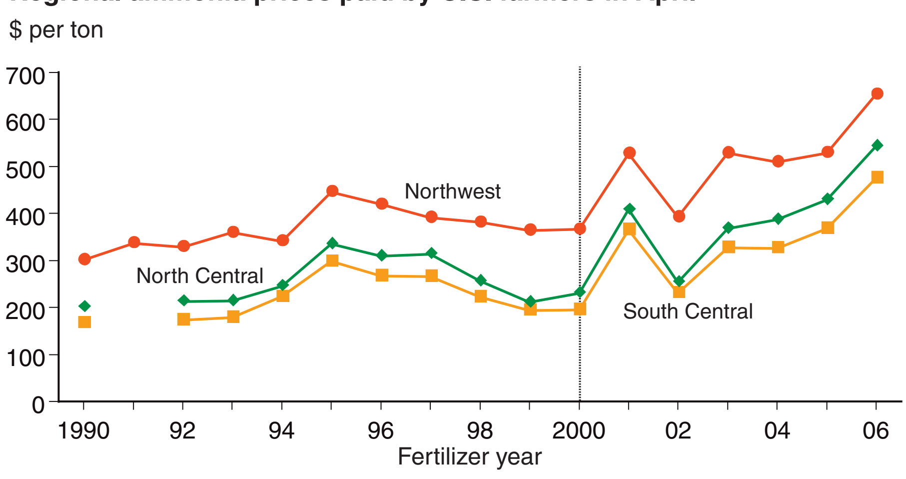
Effects of Rising Natural Gas Prices on Farmers

Increases in natural gas prices from 2000 to 2006 have led to increases in ammonia prices paid by farmers. These higher prices have persisted even though the demand for ammonia due to increased planted corn acreage has increased little during the period. From 2000 to 2006, ammonia prices paid by farmers increased from $227 per ton to $521 per ton, an increase of 130 percent (ERS (c)). In this period, the gross return margins between the cost to produce ammonia and the price paid for ammonia by farmers were relatively constant, suggesting that farmers paid higher ammonia prices as the natural gas prices increased (see fig. 4). Furthermore, increases in ammonia prices were felt equally by farmers in the Northwest region, where ammonia prices were the highest in the Nation; in the South Central region, the major ammonia-producing region, where ammonia prices were the lowest; and in the North Central region, where ammonia consumption was the highest (NASS) (fig. 10). The increase in ammonia prices reduced net returns by 22 percent in corn production and 32 percent in wheat production. The increase, however, had a small impact on returns to soybean production because that sector used a relatively small quantity of nitrogen fertilizers (table 3).

Faced with higher ammonia prices, farmers might be able to reduce losses in net returns by adopting nitrogen-saving crop production practices (Huang (a); Huang and Magleby). For example, a corn producer might reduce the nitrogen application rate by applying the amount as determined by equating the marginal return of nitrogen fertilizer to the high nitrogen price, by delaying the nitrogen application from spring before planting to summer after planting, by increasing use of alternative sources of nitrogen (such as manure), or by switching from corn to soybeans, as soybeans can obtain enough nitrogen from the atmosphere.

Figure 10

Regional ammonia prices paid by U.S. farmers in April



Source: USDA, Economic Research Service using data from NASS.

Table 3

Impact of ammonia price increase on 2005 crop net returns (value of production – operation costs), as ammonia prices increased from $227 per ton to $521 per ton

Commodity	Corn	Cotton	Soybeans	Wheat
Price (*dollars per bushel or per pound for cotton)*	1.81	0.48	6.60	3.17
Yield (*bushels or pounds per acre for cotton*)	156	817	48	36
Net return in 2005 (*dollars per acre*)	91	107	213	42
Nitrogen cost increase (*dollars per acre*)	20	13.8	3.9	13.5
Reduction of net return reduced (*percent*)	22	13	2	32

Source: USDA, Economic Research Service using data from ARMS 2005 (Agricultural Resource Management Survey) (ERS (b) and ERS (c))

Future Sources of Ammonia Supply in the United States

The cost to produce ammonia and the cost to ship ammonia from other countries to U.S. markets are two main factors that will help determine future sources for the U.S. ammonia supply. A relatively low natural gas price in the United States would favor U.S.-produced ammonia because of low shipping costs, while a relatively high natural gas price would favor ammonia imports because of low production cost. Countries with a relatively low ammonia price and a low cost of shipping ammonia to U.S. markets are likely to become the major ammonia suppliers to the United States. For a country to compete as an ammonia exporter, it must make a substantial initial investment to develop an infrastructure to transport ammonia. Ammonia is a hazardous material and it must be transferred in refrigerated vessels or in pressurized containers. The cost to build new plants for ammonia export is also substantial (TFI (a)).

Currently (2006), Trinidad and Tobago, Ukraine, and Canada are the major ammonia suppliers, accounting for 56, 16, and 14 percent of all U.S. ammonia imports in 2006, respectively (see fig. 8). Should U.S. natural gas prices continue to move upward, U.S. ammonia imports from several of these countries may increase substantially.

Imports from Canada are limited by high cost of ammonia. Because natural gas markets in Canada are closely tied to gas markets in the United States, a rise in the U.S. natural gas price will lead to a similar rise in Canadian natural gas prices and raise the cost to produce ammonia in Canada. Thus, the cost advantage of producing ammonia in Canada over producing ammonia in the United States may not be significant, and the incentive to increase ammonia imports from Canada may not be substantial. Historically, U.S. imports of Canadian ammonia were relatively steady and have not been strongly correlated with U.S. natural gas prices (see fig. 8). As in the United States, high natural gas prices in Canada in recent years have also caused a decline in the country's ammonia production capacity (IFDC).

Imports from Eastern Europe are limited by high transportation costs. Eastern European countries in the Black Sea region (Russia and Ukraine) have relatively low ammonia production costs because of relatively low natural gas prices in the region. However, the cost to ship ammonia from these countries to U.S. markets is relatively high because of the long distances to the United States. In Russia, trade-distorting natural gas prices keep domestic gas prices low, with prices subsidized by Russian gas sold in foreign markets at much higher prices (PotashCorp (a)). With the artificially low cost of domestic natural gas, the costs of ammonia shipped to the United States from Russia and Ukraine were competitive to those of shipments from Trinidad and Tobago (PotashCrop (b)). However, an increase in the energy cost of shipping ammonia and a rise in natural gas prices (*International Herald Tribune*), stemming from increased demand for natural gas from Western European countries, could reduce the economic advantage of Russian and Ukraine ammonia exports to the United States.

Imports from the Middle East and North Africa are limited by production capacity. Natural gas prices in the Middle East and North Africa are the lowest in the world because substantial gas supplies in these regions far exceed the local demand (PotashCorp (b)). Substantial exports of ammonia from countries in these regions are limited by low ammonia production capacities (PotashCorp (a)). Furthermore, should the countries in the Middle East develop into ammonia exporters, transportation costs will make it more feasible for the Middle East (Arabian Gulf region) countries to ship ammonia to Asian markets (India and China) rather than to U.S. markets (Stokes).

Increases in U.S. ammonia imports are most likely to come from the Republic of Trinidad and Tobago. A substantial increase in U.S. imports of ammonia would likely come from the Republic of Trinidad and Tobago because of the country's relatively low natural gas prices and geographic proximity to the United States. The Republic consists of two main islands, Trinidad and Tobago, and 21 smaller islands located in the Southern Caribbean region. Trinidad and Tobago has 19 trillion cubic feet of natural gas proven reserves, which could supply ammonia for 20 more years (Kamara). The country's annual production capacity is expected to increase from 5.8 million tons in 2006 to 6.7 million tons in 2007 and to 11.6 million tons in 2008 (IFDC).

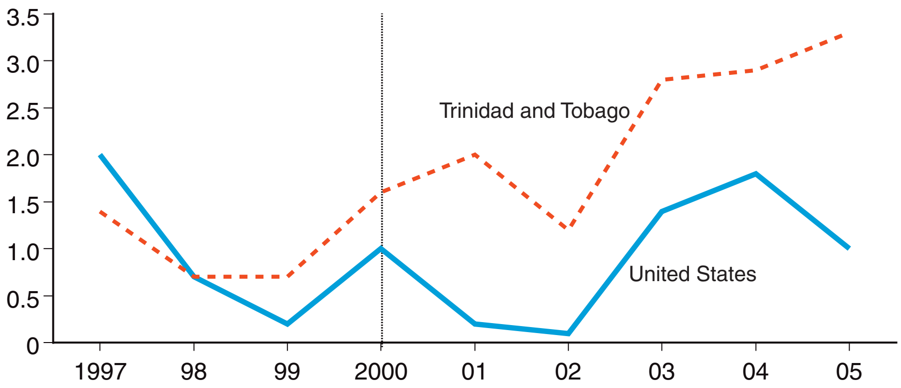
Although current U.S. ammonia imports from Venezuela are relatively small, Venezuela, with proven natural gas reserves eight times larger than that of Trinidad and Tobago, has the potential to become the largest supplier of ammonia to U.S. markets because of its relatively low cost to produce ammonia and its geographical closeness to the United States. Under this scenario, the U.S. market would likely become the largest market for Venezuela ammonia in the Western Hemisphere (DOC (b)). Currently, ammonia production capacity in Venezuela, however, is insufficient to supply the majority of U.S. demands for ammonia imports.

Incentives for Trinidad and Tobago to export ammonia are strong. The ammonia produced in Trinidad and Tobago appears to be very competitive with the ammonia produced in the United States for the U.S. ammonia markets (PotashCorp (a)). In 1997, net returns per 1 unit (mm Btu) of natural gas used to produce ammonia were lower in Trinidad and Tobago than in the United States (fig. 11). From 1999 to 2005, however, ammonia producers in Trinidad and Tobago saw their net returns rise by more than $1 per unit (mm Btu) compared with the net returns of U.S. producers.

Other factors, however, may affect the Republic's ammonia exports to the United States. For example, the incentive for Trinidad and Tobago to export ammonia may hinge on the comparative economic advantage of exporting ammonia over exporting liquefied natural gas (LNG). Historically, the return to natural gas used in ammonia production in Trinidad and Tobago was hedged by indexing the natural gas price with the price of ammonia sold in the United States (NGC). Thus, this return would have to be greater than the return from exporting LNG to the United States to ensure the economic advantage of exporting ammonia to the United States. In 2005, Trinidad and Tobago exported 439,246 million cubic feet of LNG to the United States (70 percent of U.S. LNG imports), with an average U.S. price of $7.68 per thousand cubic feet, which was a relatively high return for the

Figure 11

Net returns per mm Btu of natural gas used to produce ammonia in the United States and in Trinidad and Tobago



Note: Net return ($/mm Btu) = [ammonia price ($/ton) - 32.75 (mm Btu ton) * natural gas price ($/mm Btu) - other production costs ($/ton) - shipping cost ($/ton)] / 32.75 (mm Btu/ton). 32.75 mm Btu of natural gas is required to produce 1 ton of ammonia. Gulf ammonia prices and natural gas prices from TFI (b), and other production costs from TFI (a), are used to estimate net returns per mm Btu of the U.S. natural gas, while Gulf ammonia prices, natural gas prices and shipping costs (ocean freight and insurance) from NGC (Trinidad), and other production costs from TFI (a), are used to estimate net returns per mm Btu of Trinidad and Tobago natural gas.

Source: USDA, Economic Research Service.

gas, compared with the return for the price of $5.84 in 2004 (DOE (a)). Larger returns from higher gas prices for LNG may increase LNG exports and reduce ammonia exports.

Similarly, the incentive for Trinidad and Tobago to export ammonia also may be affected by the increase in the Republic's urea exports. Urea, containing 45 percent nitrogen, can substitute for ammonia as a source for nitrogen. Because it is relatively safe to handle, use, store and transport, urea is the most widely traded nitrogen fertilizer in international markets. Trinidad and Tobago exported 484,637 tons of urea to the United States in 2005 and planned to double its urea production capacity in 2007 (IFDC). Larger returns from urea exports to the United States or to other countries may also reduce the Republic's ammonia exports.

Summary and Implications

Ammonia is the main input source of nitrogen for most chemical fertilizer products used in U.S. agriculture, and natural gas is the main raw material input used to produce ammonia, accounting for 72-82 percent of the ammonia production cost. Since 2000, the volatile and upward trend in U.S. natural gas prices has led to a significant change in the supply of ammonia in the United States. From 2000 to 2006, U.S. ammonia production capacity declined 35 percent, U.S. ammonia production declined 44 percent, the number of U.S. ammonia plants dropped from 40 to 25, and U.S. ammonia imports increased 115 percent. Concurrently, the share of U.S.-produced ammonia in the U.S. aggregate ammonia supply dropped from 80 to 55 percent. Since 2000, the annual aggregate ammonia supply in the United States has declined 17 percent, while the inventory level has declined 71 percent.

Further increases in natural gas prices in the United States could lead to a continuous decline in U.S. ammonia production and an increase in U.S. ammonia imports. A substantial increase in U.S. ammonia imports will likely come from Trinidad and Tobago in the short run and from Venezuela in the long run because of their relatively low natural gas prices and large gas reserves.

An increase in the share of U.S. ammonia imports could make the U.S. aggregate supply of ammonia more susceptible to global competition for nitrogen fertilizers. Increases in demand for nitrogen fertilizers from other countries could drive up the costs and reduce U.S. ammonia imports, lead to a reduction in the U.S. aggregate ammonia supply, and cause an increase in ammonia prices in the United States. In addition, strong demand for nitrogen fertilizers from other countries could reduce imports of nitrogen fertilizers such as urea, nitrogen solution, and ammonium nitrate, causing higher ammonia prices.

Further increases in natural gas prices in the United States could also lead to a continuous change in the U.S. ammonia industry. More merging of U.S. fertilizer companies to improve production and marketing efficiency would be expected. A reduction in the number of ammonia plants could result in additional job loss and a lower tax base in some regions, impacting local economies. Supply chains would become longer because of ammonia imports. Some adjustments of the current fertilizer delivery system would be required to accommodate large shipments of ammonia from the Gulf States to the Cornbelt. Unexpected adverse weather conditions and political factors may cause serious disruptions of the supply chain.

A continuous decline in the U.S. aggregate ammonia supply could make U.S. ammonia markets more vulnerable to an unexpected change in demand for and supply of ammonia. The current "just-in-time" supply practice used by the U.S. ammonia industries to minimize the inventory costs could lead to lower inventory levels of ammonia, which could cause a price jump in the event of an unexpected decline in U.S.-produced ammonia or imported ammonia, or an increase in demand for ammonia.

Will the expansion of ethanol production in the United States lead to an increase in ammonia prices? Currently (2006), the U.S. ammonia industry has 3 million tons of unused ammonia production capacity (see fig. 5). This additional capacity could provide enough ammonia for 10 million additional corn acres needed for projected ethanol production in 2010 if the current (2006) level of ammonia imports is maintained. However, the additional supply from the domestic ammonia industry is limited because a significant share of this capacity is uneconomical to use at current (2006) U.S. natural gas prices. Further increases in ammonia prices will be needed to bring this unused production capacity into production. As U.S. ethanol production is expanding, without further increases of domestic ammonia production or imports of ammonia and other nitrogen fertilizers (such as urea and nitrogen solutions), large increases in ammonia prices in the United States may follow.

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