

Fertilizer Market Situation:
Market Structure, Consumption and Trade Patterns, and Pricing Behavior*

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1 Introduction

It has been well established that low adoption of improved land management practices is one of the main factors behind lagging agricultural productivity in many developing countries. Although an increase in fertilizer use is not the only solution to this problem, countries that have increased their agricultural productivity have also considerably increased their use of fertilizer (Morris et al., 2007). For example, in countries in sub-Saharan Africa with low productivity rates, fertilizer application rates are still far too low, averaging 10 kilograms (kg) of nutrients per hectare (Ha) of arable land, compared with 86 kg/Ha in South Asia, 118 kg/Ha in Latin America, 198 kg/Ha in an average middle-income country, and 288 kg/Ha in a high-income country (FAOSTAT Online database, World Resources Institute Searchable database). Considering the central role that agriculture plays in the rural economy of most developing regions, several policies and programs have been implemented in recent decades to promote fertilizer use, though the debate is still ongoing about what types of mechanisms are actually needed to realize the potential benefits of fertilizer application (see, for example, Hossain and Singh 2000; Gisselquist and Van Der Meer 2001; Crawford, Jayne, and Kelly 2006; Minot and Benson 2009; Morris, Ronchi, and Rohrbach 2009).

In the search for effective and sustainable policies to promote fertilizer use, numerous studies, especially those focused on sub-Saharan Africa, have identified several supply-side (as well as demand-side) constraints at the regional and country level that limit the development of input markets and consequently fertilizer uptake (see, for example, Kelly, Adesina, and Gordon 2003; Gregory and Bumb 2006; Morris et al. 2007). These supply-side constraints include lack of competition among suppliers and distributors within the country or region, poor dealer networks, lack of adequate infrastructure and market information, and limited access to finance. However, not much has been said about market power exertion at the global level in this highly concentrated industry. Given the considerable and increasing dependence of most developing regions on imported fertilizer, examining the relationship between market concentration and prices in international markets is crucial for a full understanding of fertilizer markets as a whole and for adequate policymaking. Although increased concentration in a market may result in cost efficiencies due to economies of scale in production (which appears to be the case in the fertilizer industry), it may also result in market power exertion (and tacit collusion) among firms. Market power exertion may also drive prices further up, to the detriment of farmers' wealth. In addition to higher marketing costs caused by several supply-side (and demand-side) constraints, farmers

in developing regions may also face high input prices resulting from market power exertion by major world producers. Omitting this fact, then, could also limit the effectiveness of policies designed to promote the development of input markets in these regions.

This study is a first attempt to fill this gap in the literature and to promote further research on the topic. We start by providing an overview of the current market situation in the fertilizer industry in terms of production and market concentration at both the global and country level, as well as in terms of consumption, trade, and prices. The analysis is by macronutrient (nitrogen, phosphate, and potash) and by main fertilizer products. Next, we perform a similar market analysis for three key developing regions: sub-Saharan Africa, Latin America, and South Asia. The idea of this analysis is to uncover any differences or similarities across regions with marked differences in the level of production (and market orientation) and consumption, including the level of concentration in these markets. Finally, we carry out a regression analysis to formally examine the relationship between fertilizer (urea) prices and market structure.

The results of the study indicate that the fertilizer industry is a highly concentrated market with high and increasing levels of trade. The top five countries control more than 50 percent of the world's production capacity for the main nitrogen, phosphate, and potash (potassium chloride) fertilizers. There is also a high level of concentration within each main producing country, except for in China. In addition, several regions exhibit a higher dependence on imported fertilizer, which reflects the importance of trade in the industry. Fertilizer prices in major international markets have also shown an upward trend in recent years. Regarding the three regions analyzed, there is a high level of concentration in these markets, as well as an increased dependence on external markets for the provision of fertilizer, despite the differences in production and consumption levels among those three regions. The regression analysis, which uses annual data from a panel of countries, provides some evidence that fertilizer prices are higher in more concentrated markets. In addition to the high levels of concentration in the industry, prices are even higher in further concentrated markets because of the apparently greater market power enjoyed by firms. It thus appears that market power effects outweigh cost-efficiency effects of increased concentration in the industry.

The remainder of the document is organized as follows. Section 2 describes recent global patterns of fertilizer production, consumption, trade, and prices, with special emphasis on the level of

concentration of the industry. Section 3 examines the fertilizer market situation in sub-Saharan Africa, Latin America, and South Asia. Section 4 formally evaluates the impact of market concentration on urea prices. Section 5 presents concluding remarks.

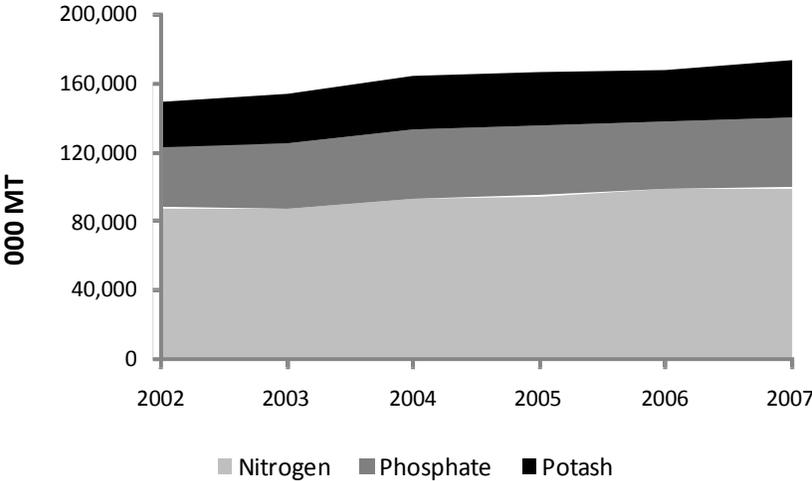
2 Global Trends

This section describes recent global patterns of production, consumption, and trade in the fertilizer industry. Special emphasis is given to the level of concentration of the industry at both the global and the country level. The analysis is by macronutrients (nitrogen, phosphate, and potash) and by main fertilizer products. International price trends are also examined at the end of this section.

2.1 Production

The production of fertilizer has continued to show an upward trend in recent years. Global fertilizer production increased at an annual rate of 3.1 percent from 2002 to 2007, reaching almost 175 million metric tons (MT) of nutrients in 2007. As shown in Figure 1, nitrogen is the main macronutrient produced worldwide, followed by phosphate and potash. Of the 980 million MT of nutrients produced during 2002–2007, nitrogen accounted for 58 percent, phosphate for 24 percent, and potash for the remaining 18 percent. Figure 1 also shows that in recent years, the production of potash has shown a higher increase (4.9 percent per year) than phosphate (2.7 percent) and nitrogen (2.6 percent); this rapid growth is mainly due to the rapid expansion of the production of potash in China.

Figure 1. Global production of fertilizer by macronutrient, 2002–2007

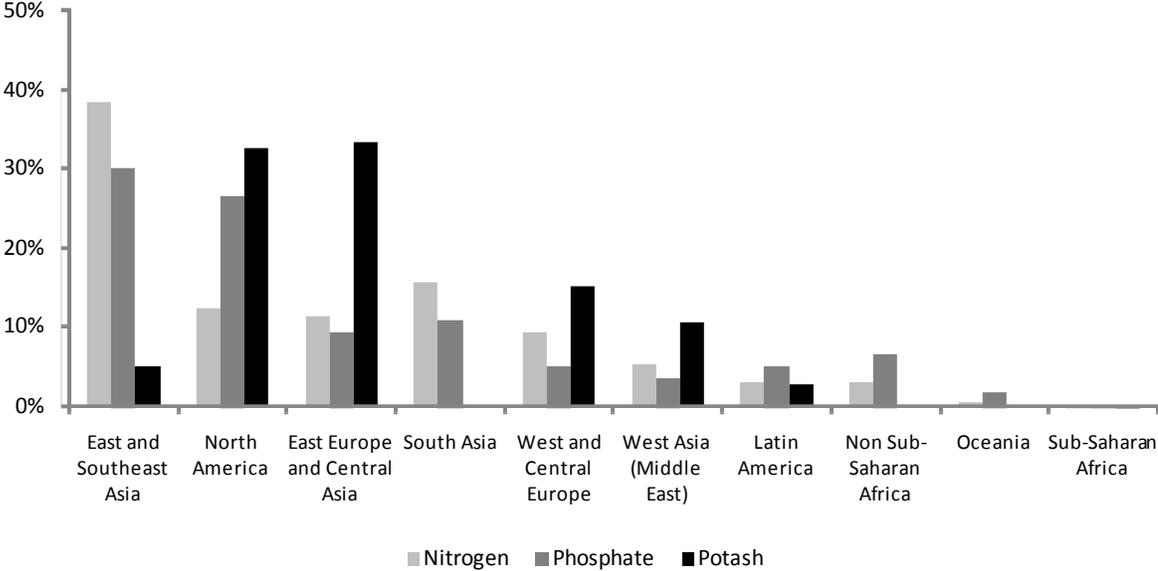


Source: FAOSTAT online database.

An analysis of production by region indicates that the global production of fertilizers is characterized by a high and increasing level of concentration and consolidation. As indicated by Gregory and Bumb (2006), this trend basically explained by the fertilizer industry being a capital-intensive industry with economies of scale in production and a high requirement of raw materials, such as natural gas, phosphate rock, and potassium salts, which constitute 70–90 percent of cash production costs.¹

The production of nitrogen is concentrated in East and Southeast Asia, specifically China (Figure 2). The region as a whole accounted for almost 40 percent of world nitrogen production in 2002–2007, while China alone accounted for 33 percent of global production during that same period. Other regions that account for a significant share of nitrogen production include South Asia (mainly India) with 16 percent, North America (United States) with 13 percent, and East Europe and Central Asia (Russia) with 12 percent. This geographic pattern of production is highly correlated with the geographic availability of natural gas, the main raw material used in the production of nitrogen.

Figure 2. Distribution of global fertilizer production by macronutrient and region, 2002–2007



Source: FAOSTAT online database.

¹ For example, natural gas represents 72–85 percent of the costs of producing ammonia (Huang 2007), while raw material costs constitute 90 percent of the production costs of diammonium phosphate (DAP) in the United States.

The production of phosphate is also concentrated in East and Southeast Asia, as well as in North America, where there are important reserves of phosphate rock. East and Southeast Asia accounted for more than 30 percent of total production in 2002–2007, while North America accounted for 27 percent. Within these regions, China and the United States are by far the main producers, with 27 percent and 26 percent, respectively, of global production. South Asia (India) accounts for another 11 percent of total global production of phosphate, followed by East Europe and Central Asia (Russia) with 9 percent. It follows, then, that global production of both nitrogen and phosphate is concentrated in the same regions.

Potash, in turn, is mainly produced in East Europe/Central Asia and North America, with the largest deposit of potash being located in North America. Each region accounted for 33 percent of the total amount of potash produced in 2002–2007. In particular, Canada accounted for 30 percent of global production, Russia for 18 percent, and Belarus for 15 percent. West and Central Europe (Germany) and West Asia (Israel and Jordan) accounted for another 15 percent and 11 percent, respectively, of global production. The production of potash is even more concentrated than the production of nitrogen and phosphate, because there are relatively few deposits of potash throughout the world.

An analysis by product using the International Fertilizer Industry Association (IFA) open-access database for 2002–2008 confirms that East and Southeast Asia is the main producer of both ammonia and urea, the most widely used nitrogen fertilizers (see Figure A.1 in the Appendix). Other important producers of ammonia include East Europe and Central Asia, West and Central Europe, South Asia, and North America. The other main producer of urea is South Asia. In the case of ammonium nitrate (AN), the main producers are East Europe and Central Asia, West and Central Europe, and North America. Regarding the main phosphate fertilizers—diammonium and mono-ammonium phosphate (DAP/MAP) and phosphoric acid—North America and East and Southeast Asia are the main producers. The other important producers of DAP/MAP are South Asia and East Europe and Central Asia. Africa is the third most important producer of phosphoric acid. Potash, which is basically potassium chloride, is mainly produced in North America and East Europe and Central Asia.

Overall, the global production pattern of fertilizer analyzed either by macronutrient or by product indicates that production is highly concentrated in certain regions and, in turn, is correlated with higher availability of raw materials in these areas.

2.1.1 Industry Structure

A more detailed analysis of the industry structure can be obtained from the Worldwide Fertilizer Capacity Listings by Plant, published by the International Fertilizer Development Center (IFDC). Published separately for each fertilizer product, these publications provide a list of operative plants and companies, as well as their production capacity, for every fertilizer year (July 1–June 30) and country. The listings reveal that the production capacity for the global fertilizer industry is highly concentrated among a few countries, as is to be expected from the previous analysis. However, they also indicate a high level of concentration among producers within each main producing country, which can probably be explained by economies of scale in the production of fertilizers.

Table 1 shows that a small number of countries control most of the production capacity for the main nitrogen, phosphate, and potash fertilizers.² Except for AN, the top five countries control more than 50 percent of the world's production capacity for all major fertilizer products. In the case of potash, this concentration ratio was close to 77 percent for fertilizer year 2008/09. In the case of nitrogen and phosphate fertilizers, the same six countries control the majority of the production capacity for ammonia, urea, DAP/MAP, and phosphoric acid.

Table 1 also reveals that as of fertilizer year 2008/09, China has exhibited, by far, the largest production capacity for urea, complex fertilizers (NPK), and ammonia. Together with the United States, China is also the main producer of DAP/MAP and phosphoric acid. The United States, in turn, is the largest producer of AN, together with Russia. Finally, Canada is by far the largest producer of potash.

² NPK are complex fertilizers that may contain nitrogen, phosphate, and potash, or a combination of the three.

Table 1. Concentration of world fertilizer production capacity, 2008/09

Fertilizer	Top 5 Countries (% of world in parentheses)	Top 5 Capacity (000 MT)	Top 5 Share (% of world)
Ammonia	China (22.8), India (8.9), Russia (8.5), United States (6.5), and Indonesia (3.9)	84,183	50.6
Urea	China (33.1), India (13.1), Indonesia (5.4), Russia (4.2), and United States (4.1)	95,802	59.9
AN	United States (15.4), Russia (14.7), China (7.7), Uzbekistan (4.8), and Romania (4.5)	28,770	47.1
DAP/MAP	China (23.3), United States (21.2), India (11.4), Russia (6.0), and Morocco (4.0)	22,896	65.9
Phosphoric acid	United States (20.9), China (19.3), Morocco (9.6), Russia (6.2), and India (5.3)	28,274	61.3
Potash	Canada (37.6), Russia (13.2), Belarus (9.9), Germany (8.2), and China (7.7)	39,687	76.7
NPK	China (29.3), India (8.2), Russia (6.0), France (4.0), and Turkey (3.0)	47,186	50.4

Source: IFDC 2009.

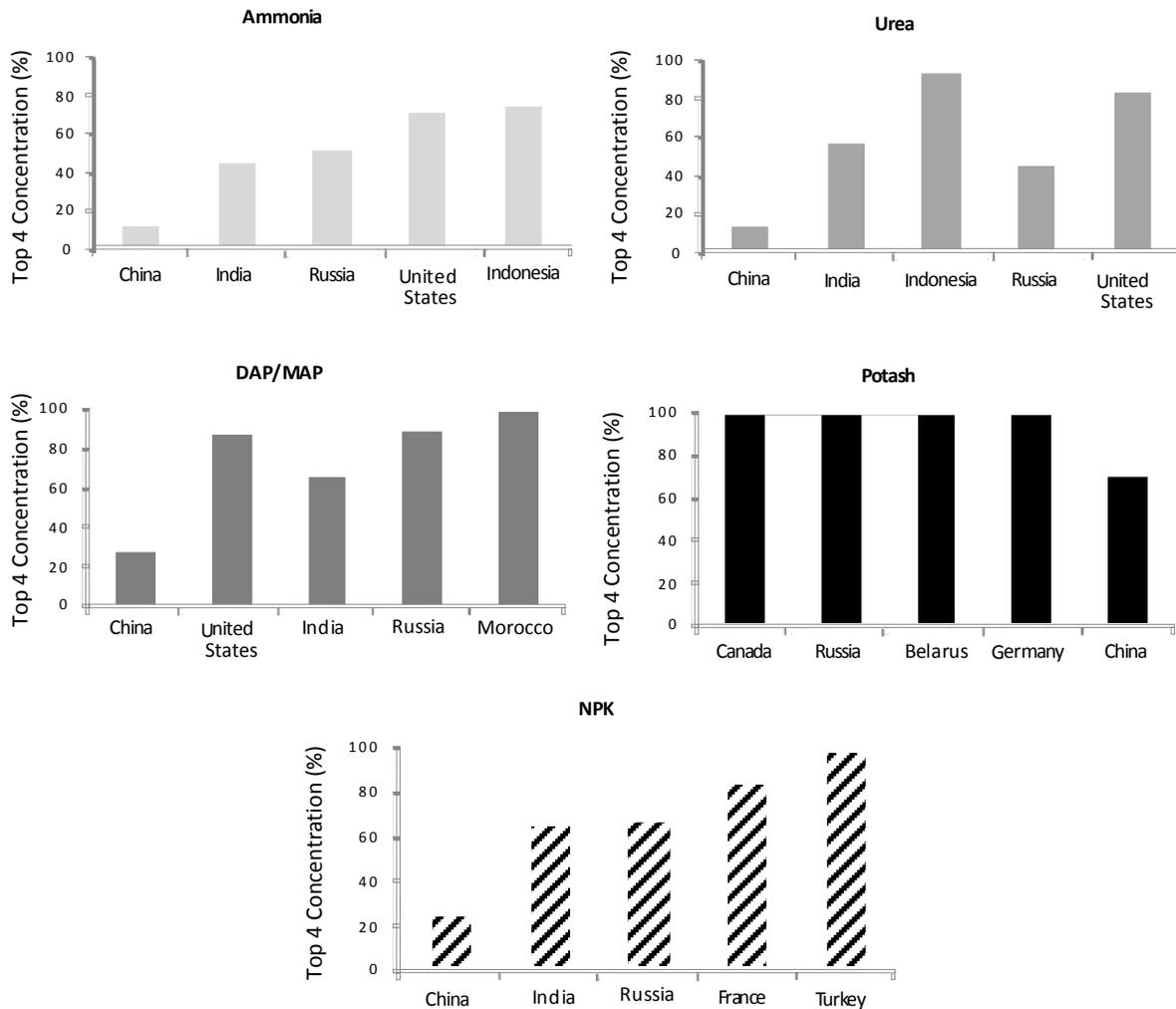
Note: Based on capacity for operative plants in 2008–2009.

Except for China, the industry also shows a high level of concentration among fertilizer producers within each main producing country. Figure 3 shows the top-four concentration ratios (that is, the market share of the top four producers) for ammonia, urea, DAP/MAP, potash, and NPK within each of the top five producing countries. In most cases, the top four firms control more than 50 percent of the country's production capacity for the corresponding fertilizer product. In particular, the production of potash is extremely concentrated at the country level. In four of the five main potash-producing countries, the top four firms account for all of the production capacity; even China, the other main producer of potash, exhibits a top-four concentration ratio of 70 percent. For DAP/MAP and NPK, four of the main five producing countries show a top-four concentration ratio above 50 percent; for ammonia and urea, three countries show this pattern.

In general, several of these country-specific markets comprise a small number of firms—in some cases, only one company operates in the country (for example, Belaruskali in Belarus and K+S KALI GmbH in Germany for potash and OCP Group in Morocco for DAP/MAP). Although the availability of raw materials explains the geographical pattern of global fertilizer production, economies of scale in production might explain the industry structure at the country level. It is worth mentioning that the estimates of concentration do not include potential associations or partnerships between companies, so the levels of concentration might be even higher. In addition, some firms operate in different countries,

especially American companies (for example, PCS Nitrogen Fertilizer, Mosaic Company, Terra Industries, and Koch Industries) and European companies (for example, Yara and Groupe Roullier).

Figure 3. Concentration of fertilizer production capacity for selected products by country, 2008/09



Source: IFDC 2009.

Note: Based on capacity for operative plants in 2008/09.

2.2 Consumption

In recent years, global fertilizer consumption has also increased, even more rapidly than production.

From 2002 to 2007, the global consumption of nutrients increased at an annual rate of 4.2 percent,

totaling 179 million MT of nutrients in 2007. By macronutrient, nitrogen was by far the main nutrient

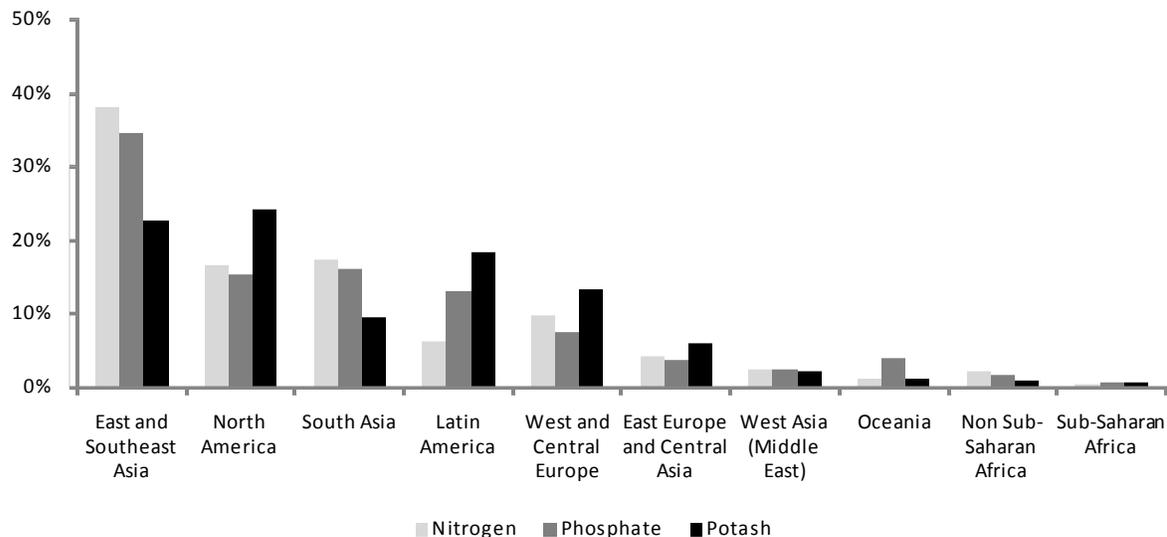
consumed. During 2002–2007, the aggregate consumption of nitrogen (588 million MT) was more than double the consumption of phosphate (236 million MT) and was almost four times the consumption of potash (156 million MT). Furthermore, nitrogen consumption increased by 4.8 percent per year, as opposed to 4 percent in the case of phosphate and 2.1 percent in the case of potash.

As shown in Figure 4, nitrogen is consumed mainly in East and Southeast Asia, particularly in China, which is also the main producer. From 2002 to 2007, the region as a whole accounted for 38 percent of the global consumption of nitrogen, whereas China alone accounted for 31 percent of total consumption. Other regions that consume a significant amount of nitrogen include South Asia (mainly India), with 18 percent, and North America (United States), with 17 percent. Note that these two regions (and these two countries in particular) are also important producers of nitrogen. Phosphate is also consumed mainly in East and Southeast Asia, which accounted for 35 percent of total consumption in 2002–2007. Within this region, China, the top producer, is also the top consumer, with 28 percent of total world consumption. South Asia (India), North America (United States), and Latin America (Brazil) are also important consumers of phosphate, with shares of 16 percent, 15 percent, and 13 percent, respectively. All of these regions, except Latin America, are among the top producers of phosphate. Finally, the consumption of potash is more widely distributed among North America (United States), with 24 percent of the total consumption; East and Southeast Asia (China), with 23 percent; Latin America (Brazil), with 19 percent; and West and Central Europe (France, Spain, Germany, and the United Kingdom), with 13 percent. Of these regions, only North America and West and Central Europe are among the main producers of potash.

Figure A.2 in the Appendix shows the regional distribution of fertilizer consumption by main product for 2002–2008. These data were obtained from the IFA open-access database. East and Southeast Asia is by far the top consumer of ammonia and urea, the main nitrogen fertilizers. Recall that this region is also the top producer of these products. Except for the moderate consumption of urea in North America, all the other important consumers of both ammonia and urea are also the top producers: North America, West and Central Europe, South Asia, and East Europe and Central Asia in the case of ammonia, and South Asia in the case of urea. Regarding the other fertilizer product with a high content of nitrogen—ammonium nitrate—West and Central Europe, North America, East Europe and Central Asia, and East and Southeast Asia (to a lower extent) are among the main consumers. In the case of phosphate fertilizers, East and Southeast Asia, South Asia, North America, and Latin America are the top consumers

of DAP/MAPP, and North America, East and Southeast Asia, and South Asia are the main consumers of phosphoric acid. Each of these regions is also among the top producers of these products, except for Latin America for DAP/MAP and South Asia for phosphoric acid. As mentioned previously, although potash is consumed mainly in East and Southeast Asia, North America, Latin America, and West and Central Europe, only North America and West and Central Europe are among its main producers.

Figure 4. Distribution of global fertilizer consumption by macronutrient and region, 2002–2007



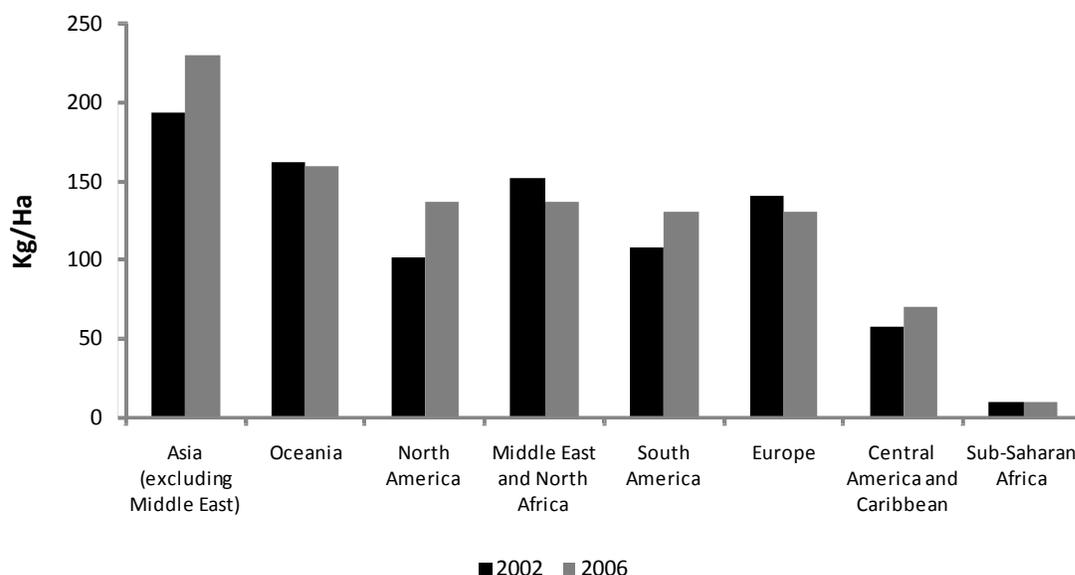
Source: FAOSTAT online database.

In sum, several of the top producers of the different nitrogen, phosphate, and potash fertilizers are also the top consumers; these regions include East and Southeast Asia, North America, South Asia, and West and Central Europe. East Europe and Central Asia is an important supplier of nitrogen fertilizers, DAP/MAP, and potash for other regions. The same is true for the production of potash in West Asia (Middle East) and the production of phosphoric acid in Africa. Trade flows of fertilizers are discussed in detail later in this paper.

Another way to examine consumption patterns is to analyze fertilizer use intensity or application rates by region. Fertilizer use intensity is the amount of fertilizer (nutrients) consumed in agriculture per hectare (Ha) of temporary and permanent cropland. Figure 5 shows application rates for different regions, obtained from the World Resources Institute (WRI) for the years 2002 and 2006. First, it is worth noting that although global fertilizer use intensity increased during 2002–2006 (from 154 to 173 kg/Ha), application rates did not increase in all regions. Only Asia and the American continents

registered an average increase in application rates. Second, Asian countries, especially Korea, Japan, and China, exhibited the highest application rates (222 kg/Ha on average), followed by Oceania (New Zealand, in particular) with 160 kg/Ha. North America, the Middle East and North Africa, South America, and Europe show similar application rates (131–138 kg/Ha). Third, sub-Saharan Africa is by far the region with the lowest application rates of around 10 kg/Ha.³

Figure 5. Fertilizer use intensity by region, 2002 and 2006



Source: World Resources Institute (WRI), EarthTrends Searchable Database Results.

Note: Fertilizer use intensity is the amount of fertilizer (nutrients) consumed by agriculture per hectare of temporary and permanent cropland. In the case of sub-Saharan Africa, the fertilizer use intensity for 2002 corresponds to 2004.

2.3 Trade

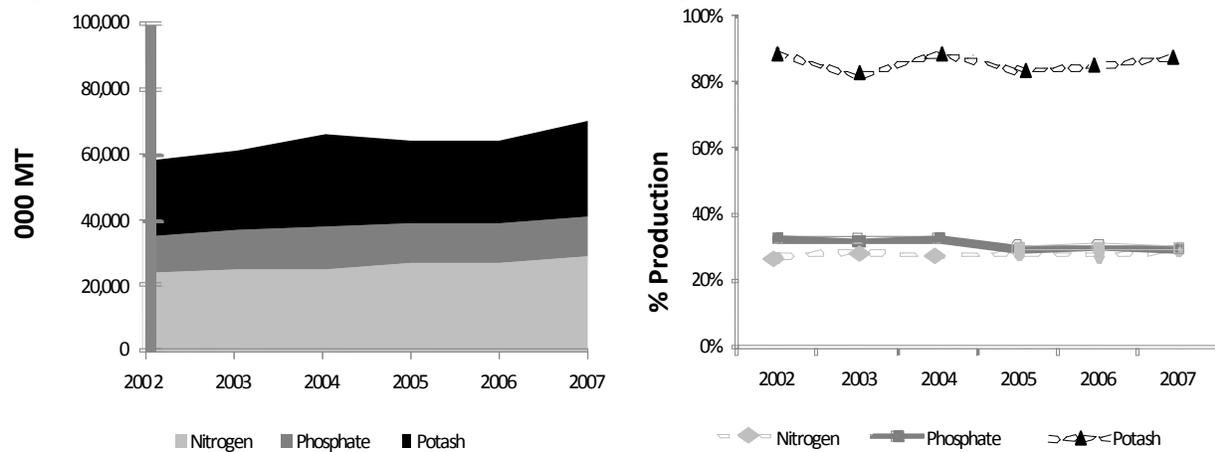
Global exports of fertilizer nutrients also showed an upward trend from 2002 to 2007, increasing at an annual rate of 3.7 percent and reaching almost 71 million MT of nutrients in 2007. By macronutrient, the exports of nitrogen and potash were more than double the exports of phosphate. Out of the total amount of nutrients exported during 2002–2007 (389 million MT), nitrogen accounted for 41 percent, potash for 40 percent, and phosphate for the other 19 percent. In terms of growth, the exports of

³ Fertilizer application rates may differ across (and within) regions due to market failure, differences in purchasing power and knowledge across farmers or differences in crop mixes, but an attempt to thoroughly explaining these differences is beyond the scope of this study.

potash have increased at a slightly higher rate than the exports of nitrogen (4.7 percent as compared with 4 percent) and at a much higher rate than the exports of phosphate (0.8 percent). The significant growth in potash sales is partially explained by the increase in Russia’s exports; this country, which is the second main producer of potash in the world, almost doubled its global exports from 2002 to 2007. The increase in nitrogen exports is partially explained by the increase in exports from China, which is the main producer of nitrogen fertilizers.

The high levels of trade in the industry, particularly in the commercialization of potash, become clearer when comparing the amount of nutrients exported with the amount produced. As depicted in Figure 6, the percentage of potash traded, relative to global production, fluctuated between 82 and 89 percent between 2002 and 2007. The percentage of nitrogen and phosphate traded, relative to total production, fluctuated around 30 percent. The fraction of nitrogen and phosphate fertilizers produced for export is obviously much lower than that of potash; however, it is higher than the level shown in the 1980s and early 1990s (around 20 percent). Note that these fractions have been quite stable in recent years. Overall, the fertilizer industry seems to be a global industry with relatively high trade levels due to the limited availability of raw materials in specific regions.

Figure 6. Global exports of fertilizer in levels and as a percentage of production by macronutrient, 2002–2007



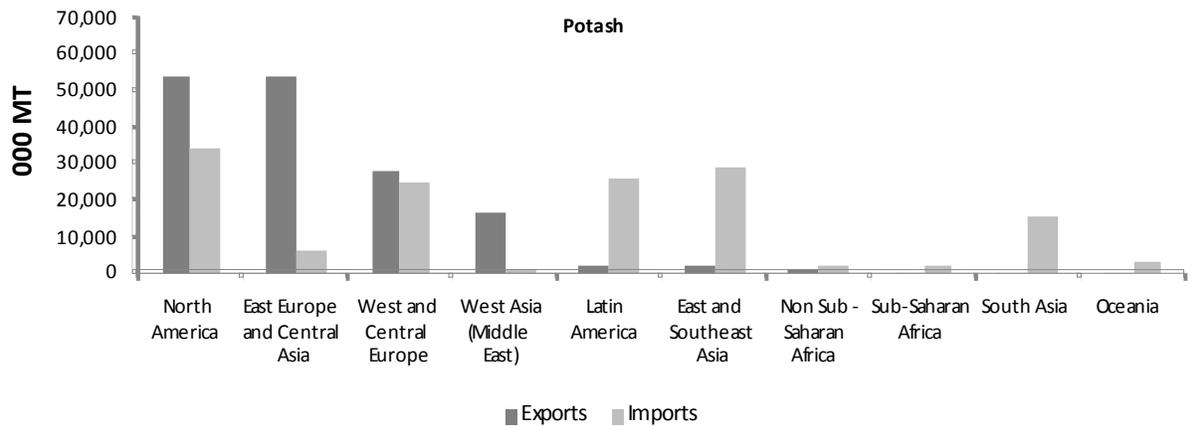
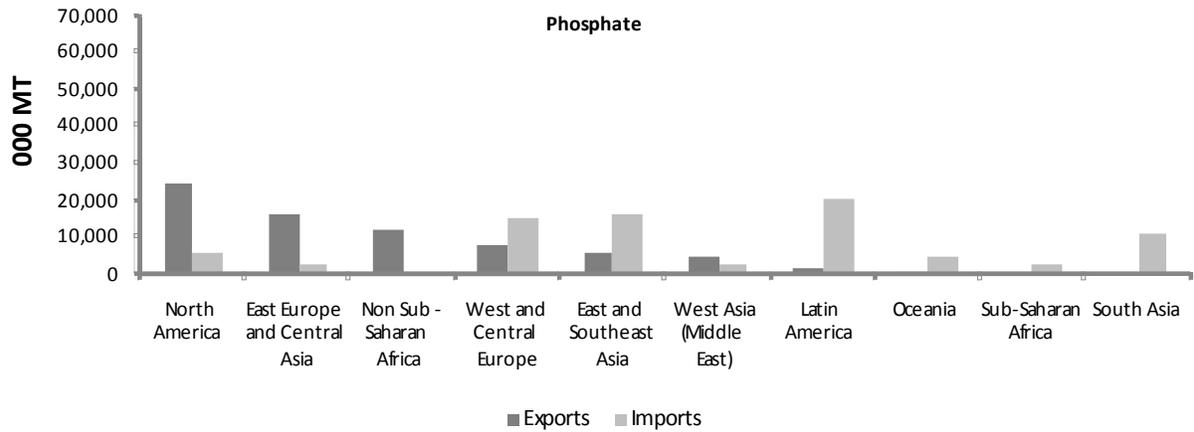
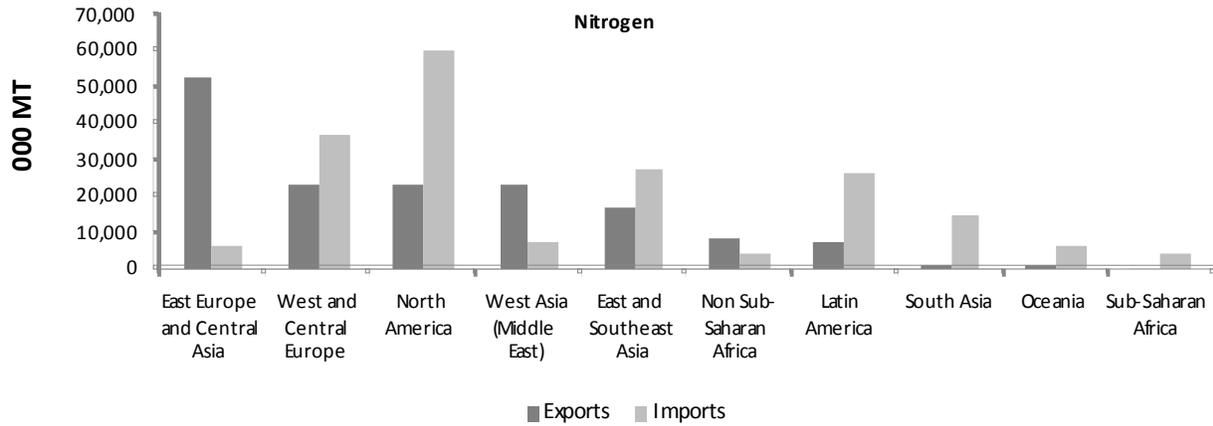
Source: FAOSTAT online database.

Figure 7 shows aggregate fertilizer exports and imports by both macronutrient and region. Although East Europe and Central Asia is the fourth largest producer of nitrogen in the world, it only accounted for one-third of the total exports during 2002–2007. Within this region, Russia and Ukraine registered the

highest export levels, with 18 percent and 8 percent, respectively, of the world's exports. Other regions that export a relatively large amount of nitrogen include West and Central Europe (in particular, the Netherlands, Lithuania, Germany, and Norway), North America (both the United States and Canada), and West Asia (Saudi Arabia and Qatar), each representing 15 percent of total exports. Of these, only North America is also among the top producers of nitrogen. In addition, North America (United States) is the main importer of nitrogen, with 31 percent (30 percent) of the global imports during 2002–2007, followed by West and Central Europe (France, Germany, the United Kingdom, Italy, and Spain), with 19 percent; East and Southeast Asia (Thailand, China, and Vietnam), with 14 percent; and Latin America (Brazil and Mexico), with 14 percent. Note also that North America exhibited a higher negative trade balance (exports minus imports) during the period (36 million MT).

In the case of phosphate, North America—and in particular the United States—is the main exporter, with 33 percent of the global exports in 2002–2007, followed by East Europe and Central Asia (Russia), with 22 percent. Non-sub-Saharan Africa (Morocco and Tunisia) is also an important supplier of phosphate, with 17 percent of total exports; however, this region is not among the top producers. Latin America, in turn, is the main importer of phosphate, with 25 percent of world imports and with net imports of 19 million MT. Brazil is by far the main importer (and consumer) in the region, with 12 percent of total imports. Other regions that import large amounts of phosphate include East and Southeast Asia (China), with 20 percent; West and Central Europe (France and Italy), with 19 percent; and South Asia (India and Pakistan), with 14 percent.

Figure 7. Fertilizer exports and imports by macronutrient and region, 2002–2007



Source: FAOSTAT online database.

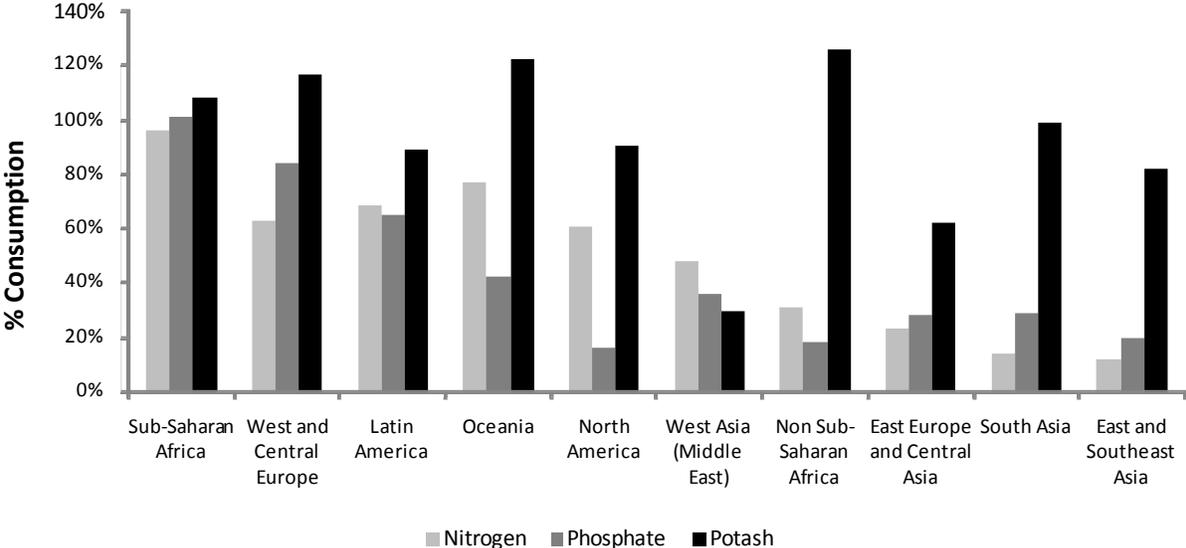
Regarding potash, both North America and East Europe and Central Asia are the main exporters, each accounting for more than 34 percent of the total exports during 2002–2007. In particular, Canada accounted for 34 percent of global exports, Russia for 19 percent, and Belarus for another 14 percent. West and Central Europe (Germany) is the third major supplier of potash, with 18 percent of total exports. As opposed to nitrogen and phosphate, the top producers of potash are also the top exporters, because the production of potash is more concentrated than the production of nitrogen and phosphate (due to the limited number of deposits of potash around the world). In terms of imports, these are more equally distributed among North America (United States), with 24 percent of global imports; East and Southeast Asia (China, Malaysia, Indonesia, and Japan), with 21 percent; Latin America (Brazil), with 18 percent; and West and Central Europe (France, the Netherlands, Italy, and Spain), with 17 percent. Of these regions, only East and Southeast Asia and Latin America exhibit a negative trade balance.

Figure A.3 in the Appendix shows fertilizer exports and imports by both product and region, accessed from the IFA open-access database for 2002–2008. For fertilizers with a high nitrogen content, East Europe and Central Asia is the main supplier of all three main nitrogen fertilizers: ammonia, urea, and ammonium nitrate. Latin America, which does not figure as a top aggregate supplier of nitrogen, is also an important supplier of ammonia, while West Asia is an important supplier of urea. North America, in turn, arises as the main buyer of ammonia and urea; Latin America and East and Southeast Asia are also important buyers of urea. For fertilizers with a high phosphate content, North America is by far the main supplier of DAP/MAP, while Africa (non-sub-Saharan Africa) is the main supplier of phosphoric acid (particularly to South Asia). Latin America is the main buyer of DAP/MAP, followed by South Asia and East and Southeast Asia. Finally, as previously mentioned, North America (Canada) and East Europe and Central Asia are the main suppliers of potash to East and Southeast Asia, North America (United States), Latin America, and West and Central Europe.

The importance of trade in the industry and, in particular, the high dependence of several regions on imported fertilizer are better depicted in Figure 8, which shows the share of aggregate imports over total consumption by macronutrient and region for 2002–2007. Overall, five regions basically rely on imported fertilizers for consumption: sub-Saharan Africa, with a share of imported fertilizer nutrients over consumption of close to 100 percent; West and Central Europe, with a share of 79 percent; Latin America, with 74 percent; Oceania, with 64 percent; and North America, with 58 percent. By macronutrient, in the case of potash, all regions except West Asia show a high dependence on imports,

as expected—the share of imports over consumption is greater than 62 percent in all these regions.⁴ Several regions also exhibit a high dependence on imported nitrogen fertilizers, especially sub-Saharan Africa, Oceania, Latin America, West and Central Europe, and North America, all with shares over consumption of greater than 60 percent. In the case of phosphate, only three regions—sub-Saharan Africa, West and Central Europe, and Latin America—show a considerable dependence on imports, with shares over consumption great than 65 percent.

Figure 8. Fertilizer imports as a percentage of consumption by macronutrient and region, 2002–2007



Source: FAOSTAT online database.

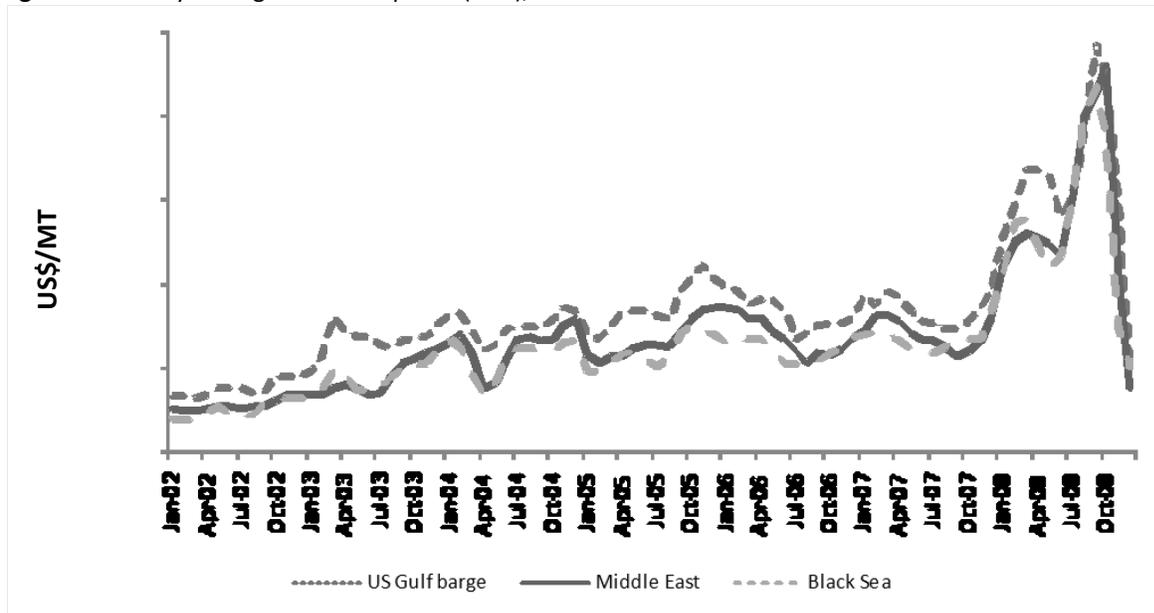
2.4 Prices

Turning to the evolution of fertilizer prices in recent years, Figure 9 shows monthly average freight on board (FOB) prices for ammonia in the U.S. Gulf (barge), the Middle East, and the Black Sea, as compiled by Green Markets for 2002–2008. Several patterns emerge from these data. First, ammonia prices show a cyclical pattern, with apparent peaks at the beginning of every year; prices are also highly correlated across regions. Second, ammonia is more expensive in the United States, as compared with prices in the Middle East and the Black Sea (on average, US\$60–\$80 more per MT). On this matter, Huang (2007) argued that rising natural gas prices in the United States in recent years resulted in lower ammonia

⁴ In some cases, these shares are over 100 percent due to potential data aggregation errors in the database when reporting potash consumption and imports.

production, lower production capacity (and number of plants), and higher prices. Third, ammonia prices have shown an upward trend since 2002, drastically increasing during most of 2008 to reach \$860–\$970 per MT in September 2008 (compared with \$230–\$290 per MT in September 2007). Prices then collapsed to \$150–\$200 per MT toward the end of 2008, similar to the price spike and collapse of commodity and oil prices during the recent financial crisis.

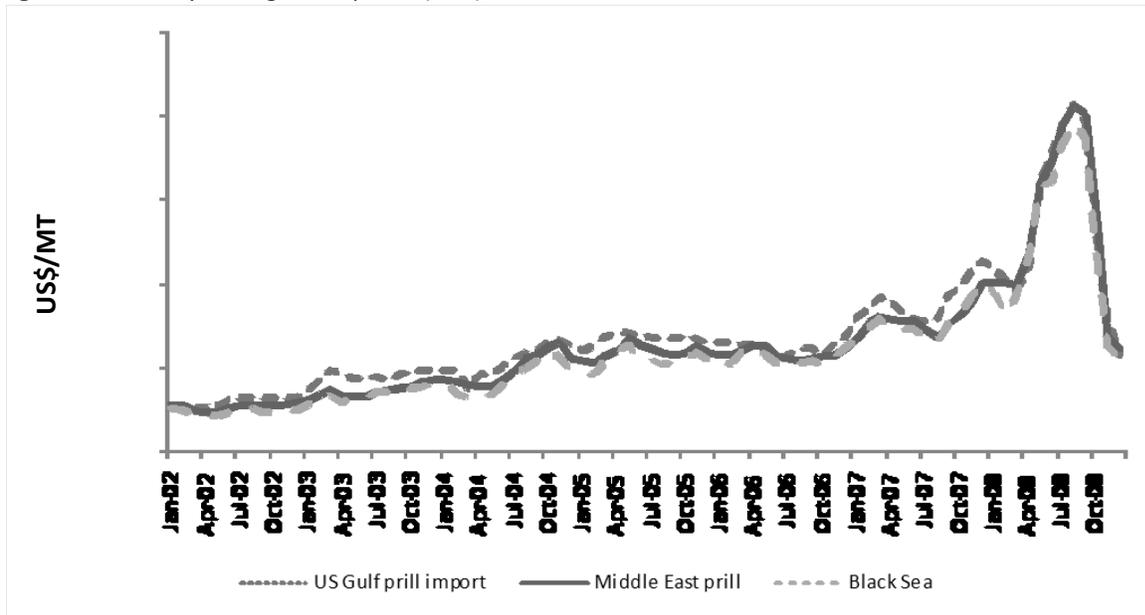
Figure 9. Monthly average ammonia prices (FOB), 2002–2008



Source: Green Markets.

A similar pattern emerges when analyzing monthly average FOB prices for prilled urea in the three regions. As shown in Figure 10, although prices are highly correlated across regions, their cyclical pattern is less clear than is the pattern for ammonia prices. Prices are also higher in the United States relative to the Middle East and the Black Sea (on average, \$32–\$52 more per MT). Furthermore, urea prices have shown an upward trend in recent years, as well as a price spike and collapse in 2008. By August 2008, urea prices reached \$785–\$830 per MT (compared with \$260–\$320 per MT in August 2007), whereas by December 2008, prices ranged from \$225–\$250 per MT.

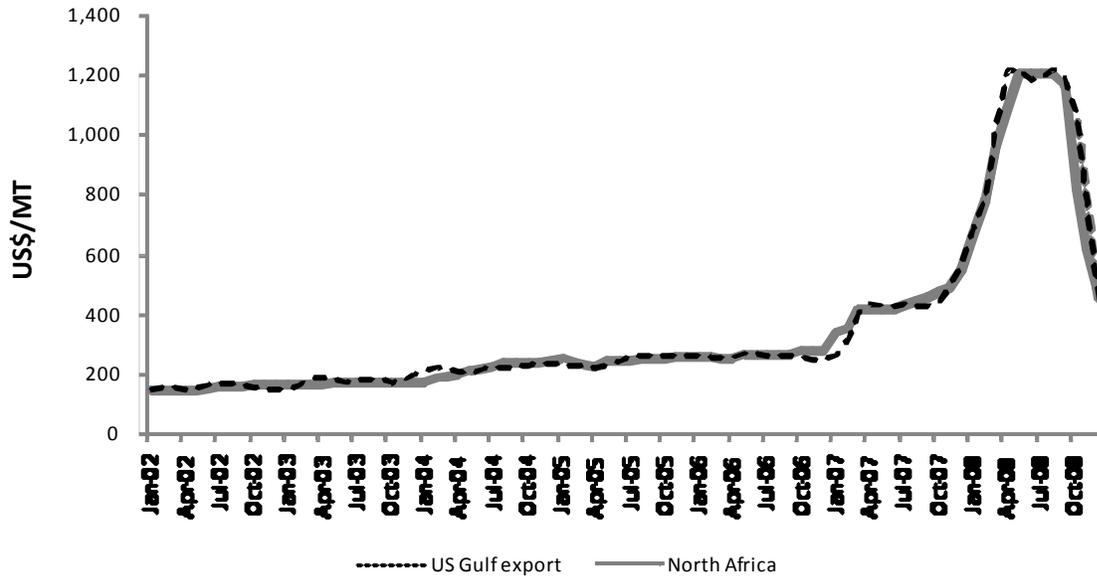
Figure 10. Monthly average urea prices (FOB), 2002–2008



Source: Green Markets.

For DAP, Figure 11 reports average monthly prices in the U.S. Gulf and North Africa. Prices in the United States are similar to those in North Africa and have also shown an upward trend in recent years. Similar to ammonia and urea, DAP prices also drastically increased at the beginning of 2008, reaching more than \$1,200 per MT in August (compared with \$440 per MT in August 2007); prices then declined to around \$450–\$470 per MT by December 2008.

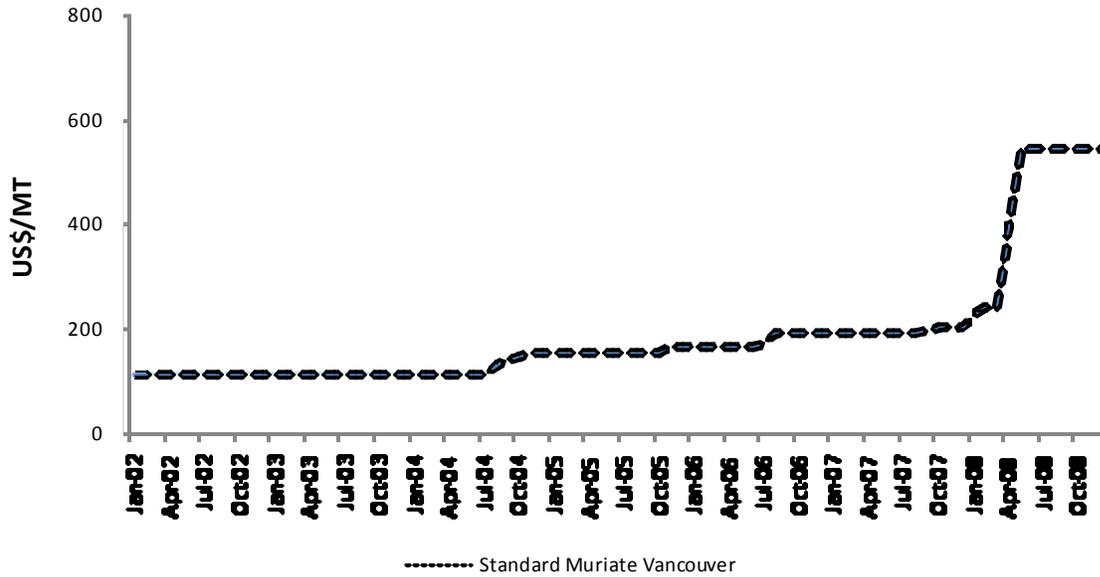
Figure 11. Monthly average DAP prices (FOB), 2002–2008



Source: Green Markets.

Figure 12 reports monthly average FOB prices for potash (standard muriate) in Vancouver. Although it is not possible to compare these prices with prices in other regions, it is interesting to observe that there is less fluctuation in potash prices than in other fertilizer products. Gregory and Bumb (2006) sustained that the high concentration of the potash industry, together with overcapacity in mining, prevent cyclical movements in potash prices. However, discrete increases in prices can still be observed over time, including the drastic increase to \$546 per MT during the second quarter of 2008 (compared with \$230 at the beginning of the year). As opposed to the prices of other fertilizer products, potash prices did not decrease until 2009, and even when they did decrease, it was to levels still above those prior to the financial crisis.

Figure 12. Monthly average potash prices (FOB), 2002–2008



Source: Green Markets.

Overall, fertilizer prices have shown an upward trend in recent years, with a spike and collapse in 2008 during the financial crisis. Potash prices are the exception, exhibiting a drastic increase in 2008 without a subsequent crash. According to Gregory and Bumb (2006), fertilizer prices are subject to large fluctuations over time, because in this industry, prices are easier to adjust than quantities. However, it is unclear whether the observed price variations result from demand-and-supply adjustments, from market power exertion in this highly concentrated industry, or from a combination of both factors. For example, market power exertion may allow producers to take full advantage of price spikes in raw materials (such as natural gas for the production of ammonia and urea) and grains to the detriment of farmers' wealth. Formally uncovering market power exertion in the industry is beyond the scope of the present study. However, we later examine the effects of local and regional market concentration on urea prices by looking at a panel of countries.

3 Developing Countries' Situations

This section examines the fertilizer market situation in three key developing regions: sub-Saharan Africa, Latin America, and South Asia. The situation in each region is analyzed in terms of production and industry structure, consumption, and trade. Whereas South Asia is both a major fertilizer producer and consumer, sub-Saharan Africa exhibits the lowest levels of production and consumption in the world. Latin America is an important consumer but a small-sized producer.⁵

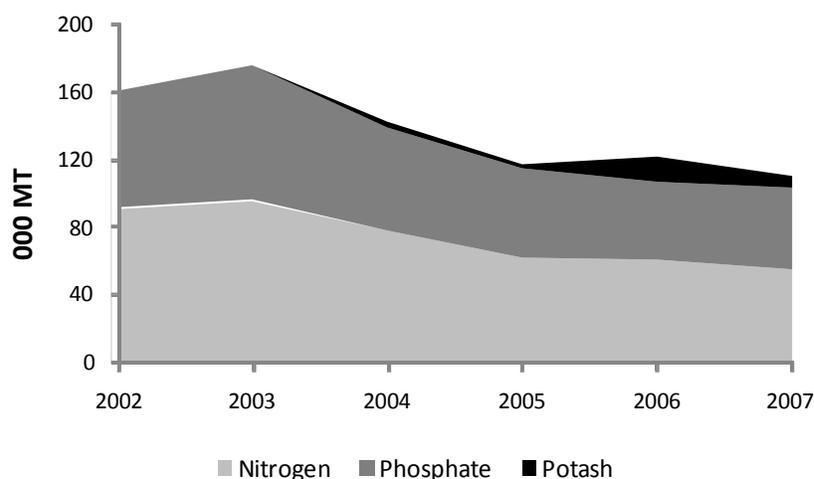
3.1 Sub-Saharan Africa

3.1.1 Production

As opposed to the global pattern, fertilizer production in sub-Saharan Africa (SSA) has shown a downward trend in recent years. Total production in the region decreased at an annual rate of 7.3 percent from 2002 to 2007, totaling 111,000 MT of nutrients at the end of the period (versus 161,000 MT in 2002), representing less than 0.1 percent of global fertilizer production in 2007. As shown in Figure 13, the fertilizer produced in SSA is basically nitrogen and phosphate fertilizer; of the total 829,000 MT of nutrients produced during this period, nitrogen accounted for 54 percent and phosphate for 43 percent. The production of both nitrogen and phosphate decreased in recent years (at 9.5 percent and 7.2 percent, respectively, per year); this decrease was observed in all producing countries in the region except Nigeria.

⁵ The International Fertilizer Development Center (IFDC) publishes, on a regular basis, a compilation of data primarily reflecting the fertilizer situation in different regions, including Africa, Latin America, and Asia. This section partly relies on the same sources of information used by IFDC for these regional reports, putting special emphasis on the industry level of concentration at the regional and country level.

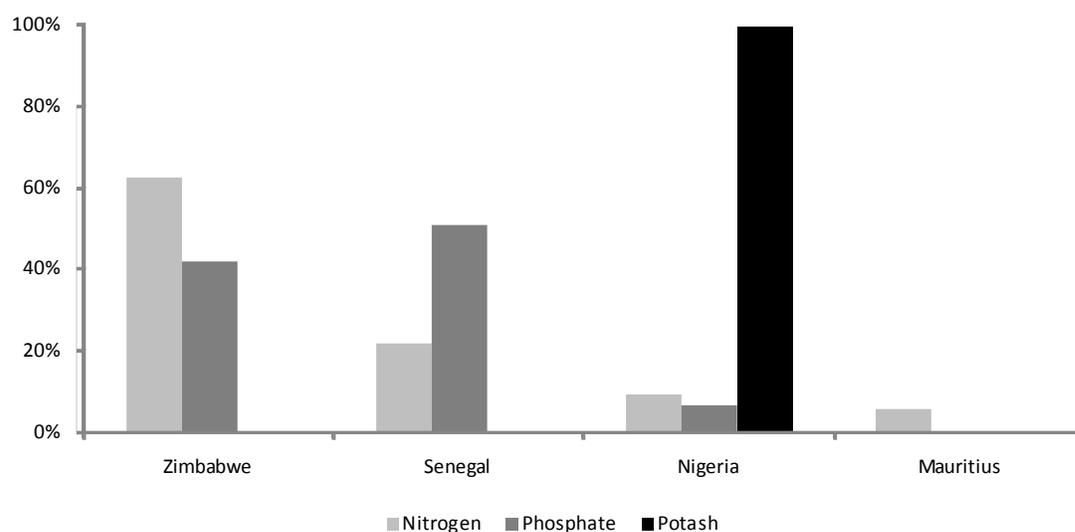
Figure 13.Sub-Saharan Africa: Production of fertilizer by macronutrient, 2002–2007



Source: FAOSTAT online database.

Looking at the distribution by country (Figure 14), the production of nutrients in the region is basically concentrated among four countries: Zimbabwe, Senegal, Nigeria, and Mauritius. Nitrogen is mainly produced in Zimbabwe, which accounted for more than 62 percent of regional production in 2002–2007, followed by Senegal, with 22 percent; Nigeria, with 10 percent; and Mauritius, with the remaining 6 percent. Senegal and Zimbabwe are also the main producers of phosphate, with 51 percent and 42 percent, respectively, of total production. The other producer of phosphate is Nigeria, which has 7 percent of the production share. Potash is produced mainly in Nigeria, though in limited amounts. As is the case with the global market, the concentration of fertilizer production in a few countries is probably due to the limited availability of raw materials in certain areas.

Figure 14. Sub-Saharan Africa: Distribution of fertilizer production by macronutrient and country, 2002–2007



Source: FAOSTAT online database.

A more detailed analysis by product uses data from the IFDC’s Worldwide Fertilizer Capacity Listings by Plant for fertilizer year 2008/09 (Table 2). This listing confirms the high concentration levels of production capacity among a few countries. With the opening of a major nitrogen plant in Port Harcourt in 2008, Nigeria has become the main producer of ammonia and urea in the region. Zimbabwe still controls all of the production capacity for ammonium nitrate (AN), the other main nitrogen fertilizer produced in SSA, and is the second main producer of ammonia. Senegal is by far the largest producer of both phosphoric acid and DAP/MAP. Finally, Ivory Coast is the main producer of complex fertilizers (NPK). The other important producers of NPK are Senegal and Zimbabwe. This region’s contribution to world production capacity is limited; for most products, the contribution of the region’s top five countries to world production capacity is less than 1 percent. The lack of adequate infrastructure in SSA could account for the region’s limited amount of investment and production capacity.

Table 2. Sub-Saharan Africa: Concentration of fertilizer production capacity, 2008/09

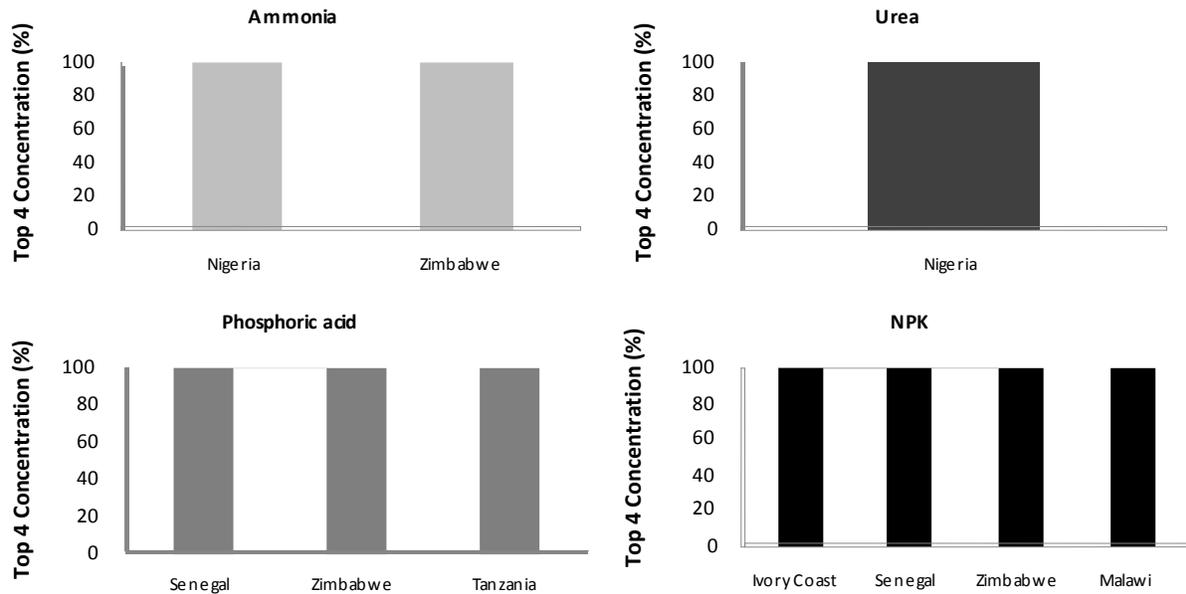
Fertilizer	Top Five Countries (% of region)	Top Five Capacity (000 MT)	Top Five Share (% of Region)	Top Five Share (% of World)
Ammonia	Nigeria (82), Zimbabwe (18)	443	100.0	0.3
Urea	Nigeria (100)	500	100.0	0.3
AN	Zimbabwe (100)	250	100.0	0.4
DAP/MAP	Senegal (100)	120	100.0	0.3
Phosphoric acid	Senegal (90.8), Zimbabwe (5.5), Tanzania (3.7)	727	100.0	1.6
NPK	Ivory Coast (41.2), Senegal (27.8), Zimbabwe (25.8), Malawi (5.2)	970	100.0	1.0

Source: IFDC 2009.

Note: Based on capacity for operative plants in 2008/09.

The level of concentration of producers within each country is also extremely high, probably due to economies of scale in production (as well as to the limited amounts produced in this region as compared with other regions). Figure 15 shows the top-4 concentration ratio within each producing country for the main fertilizer products produced in the region (ammonia, urea, phosphoric acid, and NPK). In all cases, the top four firms in each country control all of the country's production capacity. To be more specific, no more than four firms are operating in any of the producing countries in SSA; in most cases, there is only one firm operating (for example, Notore Chemical Industries Ltd. in Nigeria for ammonia and urea, Sable Chemical Industries Ltd. in Zimbabwe for ammonia, Industries Chimiques in Senegal for phosphoric acid and NPK, and Yara International in Ivory Coast for NPK).

Figure 15.Sub-Saharan Africa: Concentration of fertilizer production capacity for selected products by country, 2008/09



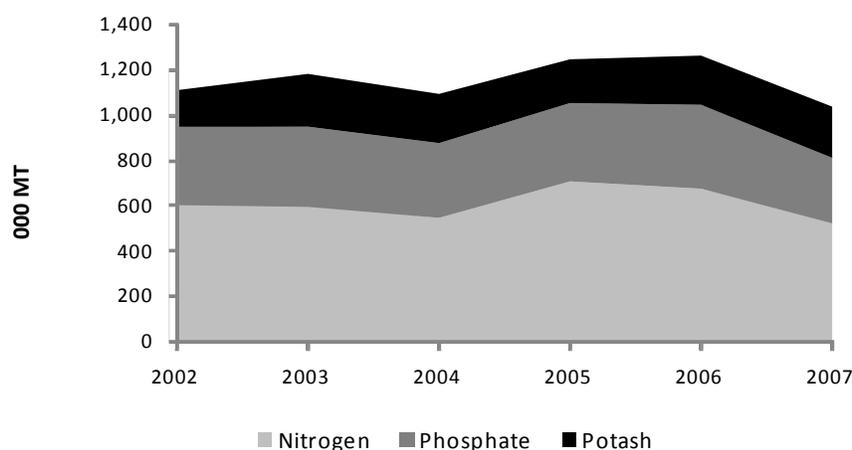
Source: IFDC 2009.

Note: Based on capacity for operative plants in 2008/09.

3.1.2 Consumption

Fertilizer consumption in SSA has fluctuated in recent years, ultimately decreasing to 1,041,000 MT of nutrients in 2007, as compared with 1,113,000 MT in 2002. This is equivalent to an average decrease of 1.3 percent per year. The amount of nutrients consumed in the region is approximately 10 times the amount produced, though this amount still represents less than 0.8 percent of world consumption. Figure 16 shows that nitrogen accounts for more than half of the total consumption in the region. More specifically, from 2002 to 2007, nitrogen accounted for 53 percent of the almost 7 million MT of nutrients consumed in SSA, phosphate accounted for 29 percent, and potash accounted for the remaining 18 percent. In terms of growth, although the consumption of potash increased at an annual rate of 6.9 percent during this period, the consumption of nitrogen and phosphate decreased at an annual rate of 2.8 percent and 3.4 percent, respectively.

Figure 16. Sub-Saharan Africa: Consumption of fertilizer by macronutrient, 2002–2007

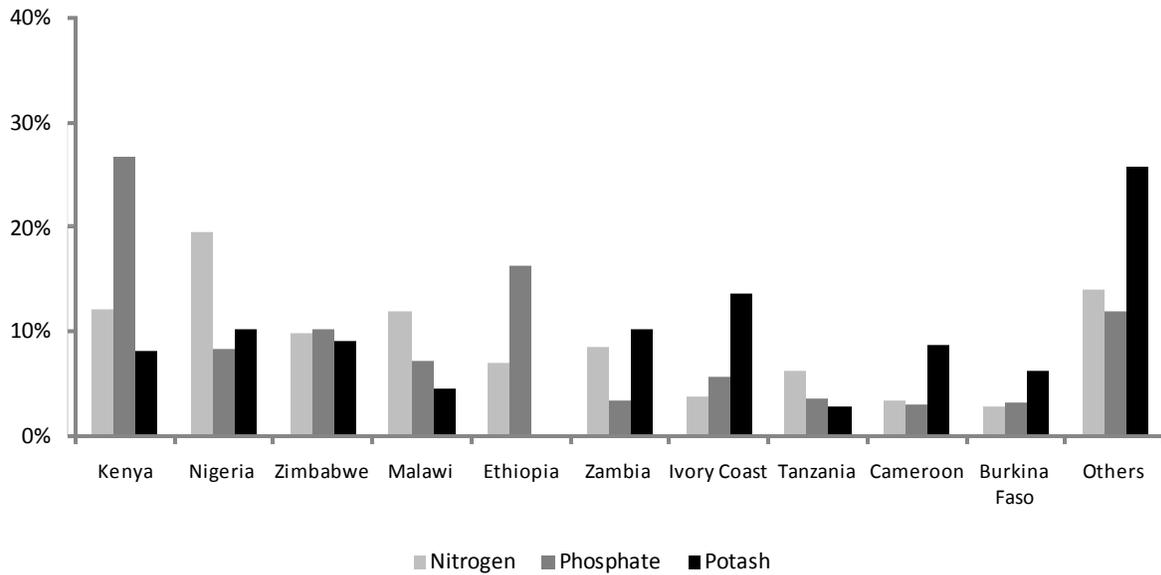


Source: FAOSTAT online database.

An analysis of the distribution by country reveals that overall, Kenya is the region's main consumer, with 16 percent of total regional consumption for 2002–2007; it is closely followed by Nigeria (15 percent). Since 1990, Kenya's fertilizer policy has focused on favoring free markets by decontrolling prices and liberalizing imports and distribution. As documented by Ariga and Jayne (2009), this focus has resulted in a dramatic increase in consumption in the country through better access to input providers and the reduction of marketing margins. Nigeria, in contrast, has focused since 1999 on providing fertilizer subsidies to farmers through public retailers under the Federal Market Stabilization Program (FMSP). Although consumption increased during the first years of the program, in recent years, it has followed an irregular pattern and has been subject to several criticisms (Gregory 2008).

By macronutrient, Nigeria is the main consumer of nitrogen, with 20 percent of the regional consumption (see Figure 17). Other important consumers of nitrogen are Kenya and Malawi, each with shares of 12 percent, and Zimbabwe, with a share of 10 percent. Kenya, in turn, is the region's main consumer of phosphate, with 27 percent of total consumption, and is followed by Ethiopia, with 16 percent, and Zimbabwe, with 10 percent. The consumption of potash is more widely distributed across the region. Ivory Coast is the top potash consumer, with a share of 14 percent, followed by Zambia (10 percent), Nigeria (10 percent), Zimbabwe (9 percent), Cameroon (9 percent), and Kenya (8 percent).

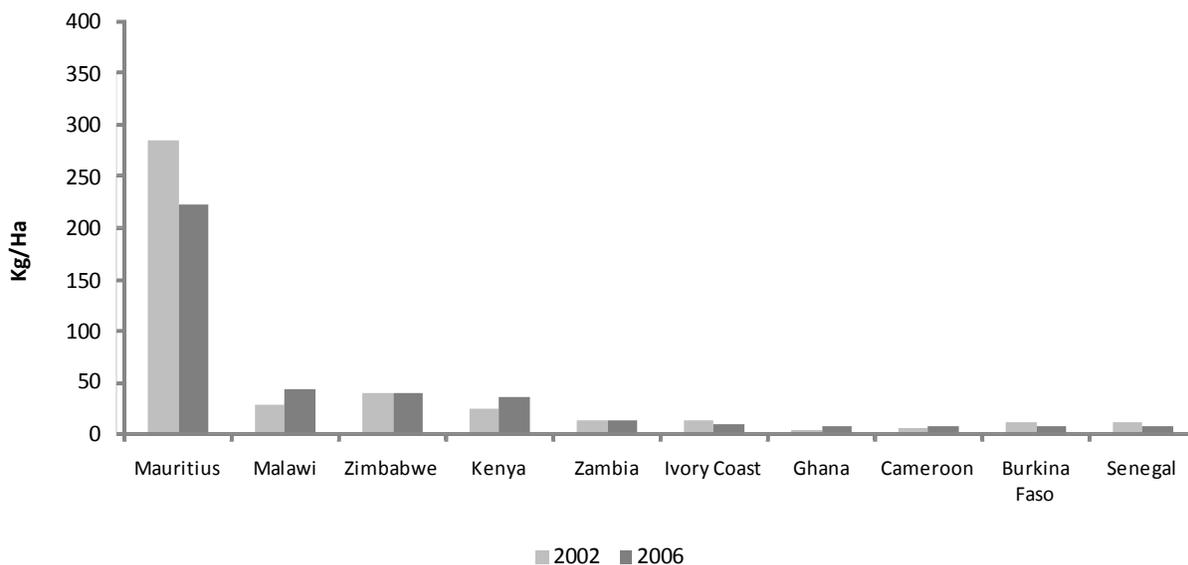
Figure 17. Sub-Saharan Africa: Distribution of fertilizer consumption by macronutrient and country, 2002–2007



Source: FAOSTAT online database.

If we normalize the amount of nutrients consumed by the number of hectares of temporary and permanent cropland in each country, we find that not all countries in the region with a high level of consumption are also among those with higher application rates (for example, Nigeria, Ethiopia, and Tanzania). Using WRI data (Figure 18), we observe that Mauritius has by far the highest fertilizer use intensity in SSA, although the country’s use intensity decreased from 286 kg/Ha in 2002 to 223 kg/Ha in 2006. Other countries with application rates above the regional average of 10kg/Ha (but still well below the average of 179 kg/Ha for developing countries) include Malawi (43 kg/Ha in 2006), Zimbabwe (40 kg/Ha), Kenya (35 kg/Ha), and Zambia (14 kg/Ha). In general, application rates in the region are extremely low; in several countries, these rates decreased during 2002–2006.

Figure 18. Sub-Saharan Africa: Countries with higher fertilizer use intensity, 2002 and 2006



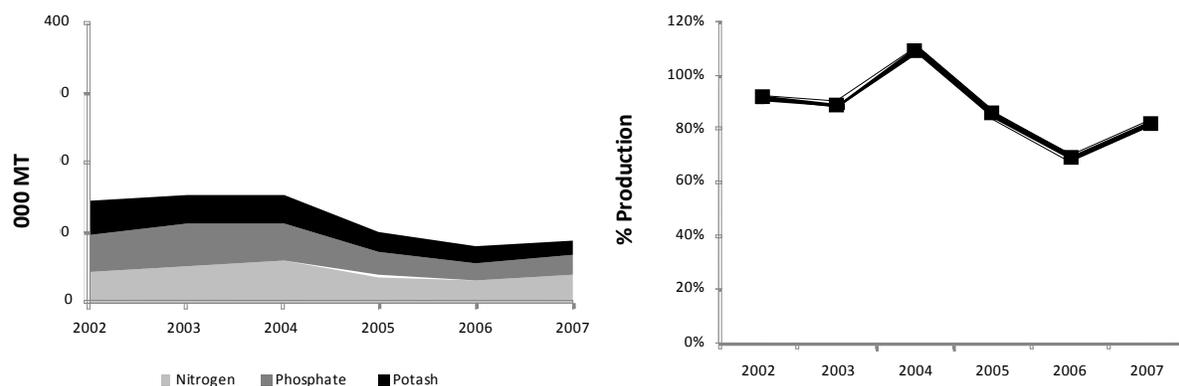
Source: World Resources Institute (WRI), EarthTrends Searchable Database Results.

Note: Fertilizer use intensity is the amount of fertilizer (nutrients) consumed by agriculture per hectare of temporary and permanent cropland. In the case of Burkina Faso, the fertilizer use intensity for 2002 corresponds to 2003.

3.1.3 Trade

Total exports in sub-Saharan Africa have shown a larger downward trend than production in recent years (Figure 19), decreasing at an annual rate of 9.4 percent from 2002 to 2007 (compared with a decrease of 7.3 percent for production). In 2007, total exports in the region totaled 91,000 MT of nutrients, compared with 149,000 MT in 2002. Although not reported, the decrease in exports was observed in most of the top exporting countries in the region, specifically Ivory Coast, Senegal, and Mauritius. By macronutrient, nitrogen exports, which accounted for about 45 percent of the region's total exports, decreased at an annual rate of 2.4 percent, while phosphate exports, which represented 33 percent of total exports, decreased at an annual rate of 11.1 percent. The sales abroad of potash, which is exported in much lesser quantities than nitrogen and phosphate, also decreased at an annual rate of 16.3 percent. From 2002 to 2007, SSA exported a total of 739,000 MT of nutrients, representing less than 0.2 percent of total global exports.

Figure 19. Sub-Saharan Africa: Exports of fertilizer in levels and as a percentage of production by macronutrient, 2002–2007



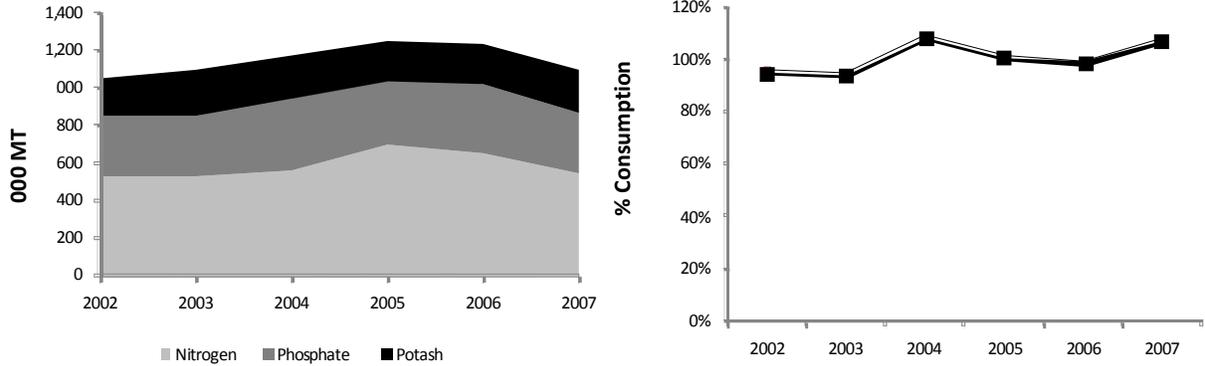
Source: FAOSTAT online database.

Figure 19 also reveals that almost all the nutrients produced in SSA have been oriented toward foreign markets, though this pattern has become less clear in recent years. The percentage of total nutrients exported, relative to the total amount produced, decreased by 10 percent—from 92 percent in 2002 to 82 percent in 2007. By macronutrient, whereas the fraction of nitrogen produced for export increased during 2002–2007, the fraction of phosphate produced for export decreased considerably. In all countries, the small amounts of potash produced were exported.

Imports have also fluctuated in recent years, though they ultimately increased to 1,113,000 MT of nutrients in 2007, compared with 1,056,000 MT in 2002 (Figure 20). This increase is equivalent to an average annual increase of 1 percent. Total imports in the region are approximately 10 times the amount exported, mirroring the trend for consumption and production, even though they account for less than 1.7 percent of world imports. Among the top importers in SSA, only Zambia and, to a lesser extent, Ethiopia have shown an increase in imports in recent years. Figure 20 also shows that nitrogen, the main macronutrient consumed in the region, represented nearly half of the almost 7 million MT of nutrients imported during 2002–2007; phosphate accounted for 30 percent, and potash accounted for the remaining 20 percent. In terms of growth, the imports of nitrogen increased at an annual rate of 0.3 percent, whereas the imports of phosphate and potash increased at annual rates of 1 percent and 3.1 percent, respectively.

As indicated previously, SSA relies heavily on imported fertilizer for consumption. The share of imported nutrients over consumption fluctuated at around 100 percent for 2002–2007. This fluctuation has been the case for all three macronutrients consumed in the region.

Figure 20. Sub-Saharan Africa: Imports of fertilizer in levels and as a percentage of consumption by macronutrient, 2002–2007



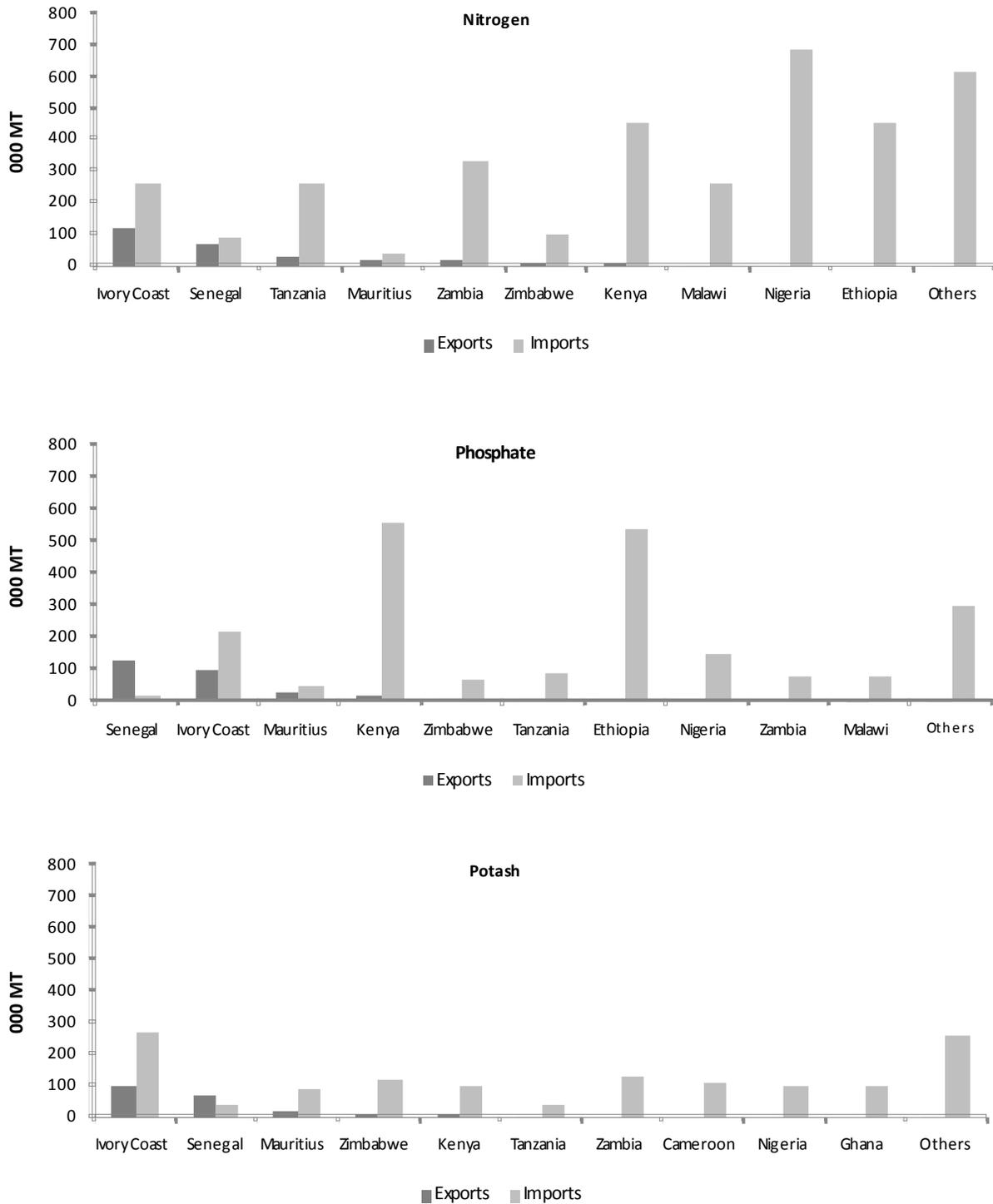
Source: FAOSTAT online database.

An analysis of trade flows by country indicates that Ivory Coast and Senegal are by far the main exporters of nutrients in the region, with 42 percent and 36 percent, respectively, of total exports. The main destination of Ivory Coast’s exports is Burkina Faso; for Senegal, the main destinations are Mali and India. Mauritius ranks third, with 8 percent of total exports (mainly to France). Imports, on the other hand, are more equally distributed among Kenya, which has 16 percent of total imports (mainly from Russia, Finland, and the United States); Ethiopia, with 14 percent (from Lithuania, Jordan, Qatar, and Russia); Nigeria, with 13 percent (from Belgium and Ukraine); Ivory Coast, with 11 percent (from Russia and Belarus); and Zambia, with 8 percent (from South Africa).

Figure 21 provides a closer look at aggregate exports and imports by both macronutrient and country for 2002–2007. Ivory Coast and Senegal were the main exporters of all three macronutrients.⁶ Ivory Coast accounted for 43 percent, 36 percent, and 48 percent of nitrogen, phosphate, and potash exports, respectively; Senegal represented 24 percent, 48 percent, and 35 percent of the respective exports. Tanzania is the third main exporter of nitrogen, with a share of 10 percent, while Mauritius is the third exporter of phosphate and potash, with respective shares of 7 percent and 10 percent.

⁶ As previously indicated, although Senegal is among the top producers of macronutrients in SSA (especially phosphate and nitrogen), Ivory Coast produces and exports complex fertilizers, which contain all three macronutrients.

Figure 21. Sub-Saharan Africa: Fertilizer exports and imports by macronutrient and country, 2002–2007



Source: FAOSTAT online database.

In the case of imports, the top consumers of each macronutrient in the region are also the top importers. Nigeria is the main importer of nitrogen, with 19 percent of total purchases from abroad, followed by Kenya and Ethiopia, each with shares of 13 percent. Kenya, in turn, is the main importer of phosphate, with 27 percent of total imports, but is closely followed by Ethiopia, which has a 26 percent share; Ivory Coast ranks third, with a share of 10 percent. In addition, Ivory Coast is the top importer of potash, with 20 percent of total imports. Zambia and Zimbabwe are the other main importers of potash, with shares of 10 percent and 9 percent, respectively.

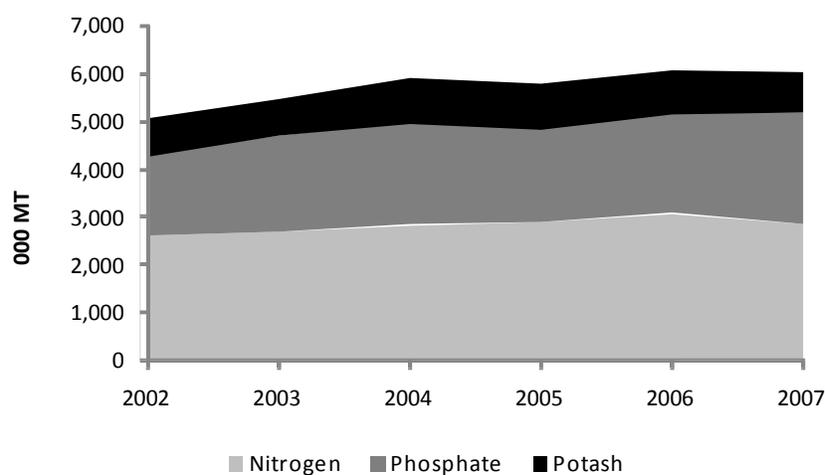
Another pattern that becomes clearer from Figure 21 is the large trade deficit exhibited by almost all countries in SSA. Senegal is the only country among the top trading countries that registered a positive trade balance for phosphate and potash during the period of analysis. Overall, Senegal reported a trade surplus of 127,000 MT of nutrients, whereas countries like Kenya, Ethiopia, Nigeria, Zambia, and Ivory Coast registered trade deficits of 0.4–1.1 million MT. It follows that in addition to the region's low levels of production and consumption, there is also a high dependence on foreign suppliers as compared with other developing countries.

3.2 Latin America

3.2.1 Production

Fertilizer production in Latin America showed an upward trend during 2002–2007. Total production in the region increased at an annual rate of 3.5 percent during this period, reaching more than 6 million MT of nutrients in 2007 (3.5 percent of world production). Nitrogen is the main macronutrient produced in Latin America, followed by phosphate and potash (see Figure 22). From 2002 to 2007, a total of 34 million MT of nutrients was produced; nitrogen accounted for half of this production, phosphate accounted for 35 percent, and potash accounted for the remaining 15 percent. The production of phosphate, however, has increased at an annual rate of 7 percent in recent years, whereas the production of nitrogen and potash only increased at an annual rate of 1.6 percent. The higher production of phosphate in the region is explained by the important increase in production in Brazil, which, along with Mexico, is the main producing country in the region.

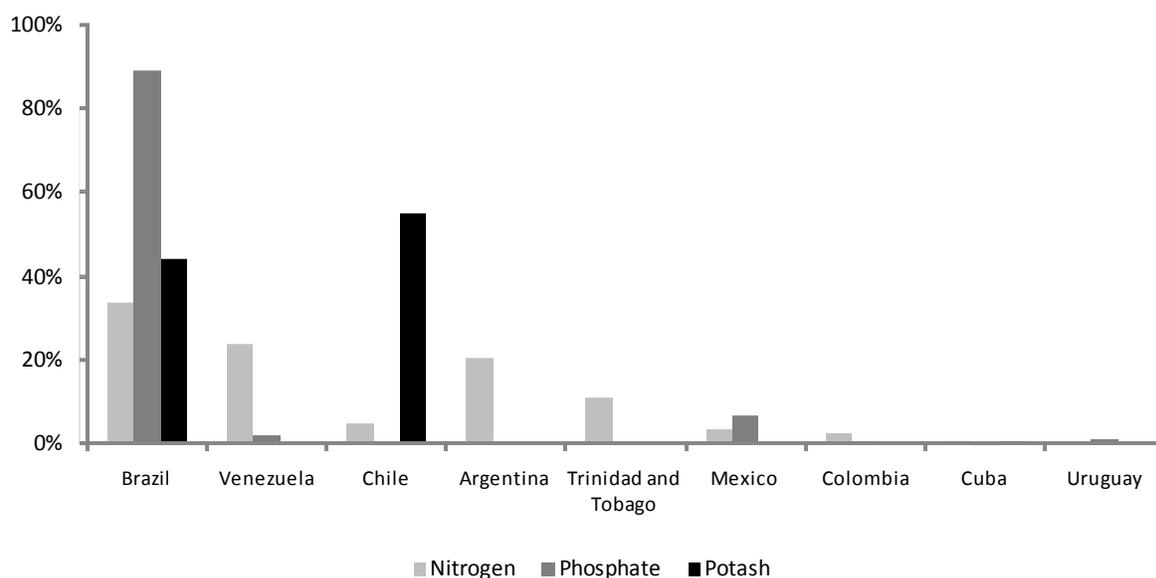
Figure 22. Latin America: Production of fertilizer by macronutrient, 2002–2007



Source: FAOSTAT online database.

Regarding the distribution by country (Figure 23), the region's production of nutrients is concentrated among a few countries, particularly in the case of phosphate and potash. Brazil is by far the main producer of phosphate, representing almost 90 percent of the regional production during 2002–2007, followed by Mexico, which has a share of 7 percent. Chile is the main producer of potash, with 55 percent of regional production, followed by Brazil, with 44 percent. Brazil is also the main producer of nitrogen in Latin America, with 34 percent of regional total production; other important producers of nitrogen include Venezuela (24 percent), Argentina (20 percent), and Trinidad and Tobago (11 percent).

Figure 23. Latin America: Distribution of fertilizer production by macronutrient and country, 2002–2007



Source: FAOSTAT online database.

An analysis by product of the region’s production capacity, using data from IFDC for fertilizer year 2008/09, also reveals high concentration levels in the industry. As seen in Table 3, the top five countries control more than 90 percent of the regional production capacity for each product. Brazil, the main producer of macronutrients in the region, is the top producer of AN, DAP/MAP, phosphoric acid, and complex fertilizers (NPK) and is the second main producer of urea and potash. Trinidad and Tobago is the main producer of ammonia (most of which is supplied to the United States), Venezuela is the top producer of urea, and Chile controls almost two-thirds of the production capacity for potash in Latin America. In addition, the region’s contribution to world production capacity lies between 4 and 6 percent for most of the products.

Table 3. Latin America: Concentration of fertilizer production capacity, 2008/09

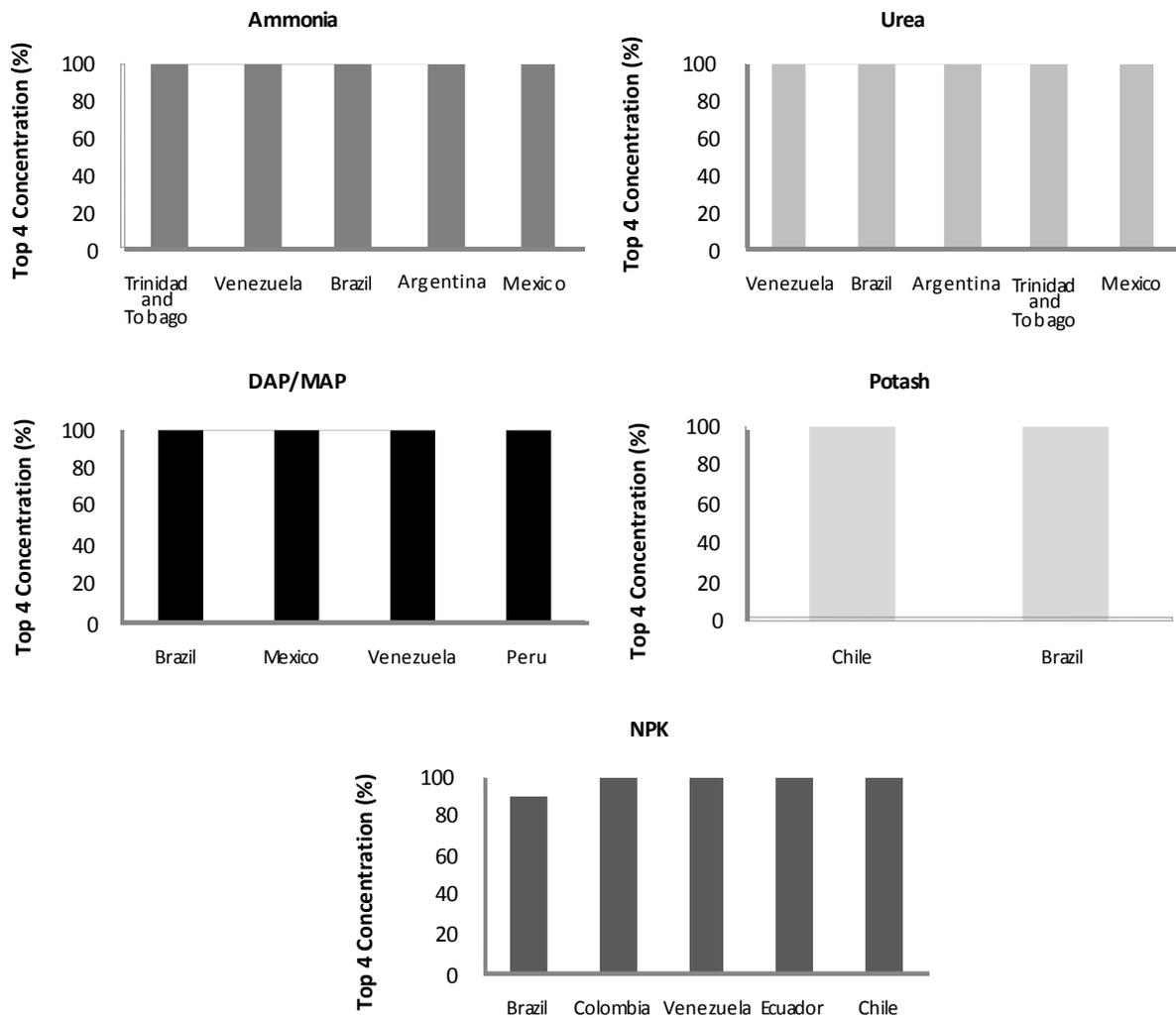
Fertilizer	Top Five countries (% of region)	Top Five Capacity (000 MT)	Top Five Share (% of Region)	Top Five Share (% of World)
Ammonia	Trinidad and Tobago (48.3), Venezuela (17.5), Brazil (15.2), Argentina (8.1), Mexico (8.1)	10,739	97.0	6.5
Urea	Venezuela (36.8), Brazil (28.8), Argentina (19.6), Trinidad and Tobago (10.7), Mexico (3.2)	6,635	100.0	4.2
AN	Brazil (44.7), Chile (22.2), Cuba (13), Mexico (6.8), Colombia (5.1)	3,357	92.0	5.5
DAP/MAP	Brazil (70), Mexico (17.4), Venezuela (6.6), Peru (6)	1,669	100.0	4.8
Phosphoric acid	Brazil (79.3), Mexico (14.8), Venezuela (4.3), Bolivia (1.6)	1,923	100.0	4.2
Potash	Chile (64.7), Brazil (34.9), Colombia (0.4)	1,462	100.0	2.8
NPK	Brazil (55.4), Colombia (18.9), Venezuela (8.3), Ecuador (7.1), Chile (3)	3,676	92.0	3.9

Source: IFDC 2009.

Note: Based on capacity for operative plants in 2008/09.

The industry also exhibits high levels of concentration within each main producing country in the region. As seen in Figure 24, in all cases except the production of NPK in Brazil, the top four firms in each country account for all of the country's production capacity. Overall, most of these country-specific markets comprise fewer than four firms; in several cases, there is only one firm operating in the country (for example, Petroquímica in Venezuela for ammonia, urea, DAP/MAP, and NPK, Petroquímica Cosoleacaque in Mexico for ammonia, Sociedad Química y Minera in Chile for potash and NPK, Companhia Vale do Rio Doce in Brazil for potash, and Fertilizantes Terminales in Ecuador for NPK). This pattern could also reflect the importance of economies of scale in the production process of fertilizer products.

Figure 24. Latin America: Concentration of fertilizer production capacity for selected products by country, 2008/09



Source: IFDC 2009.

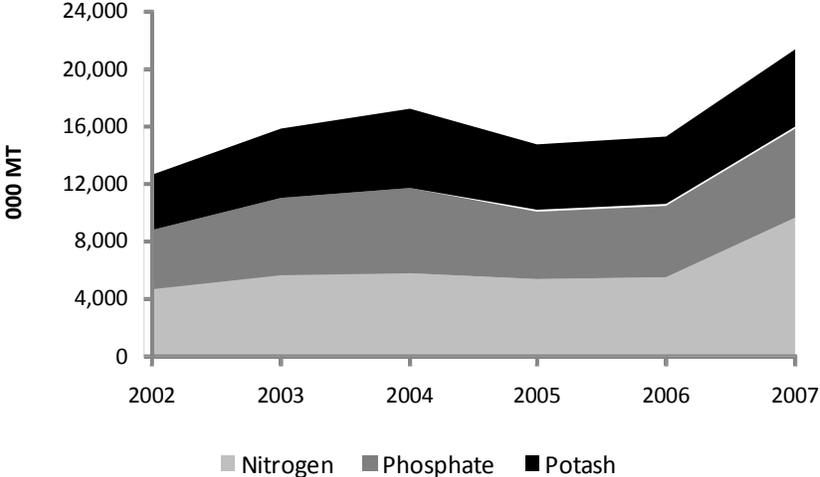
Note: Based on capacity for operative plants in 2008/09.

3.2.2 Consumption

The consumption of fertilizer in Latin America has seen an important increase in recent years. From 2002 to 2007, regional consumption increased at an annual rate of 11.1 percent, more than 2.5 times the growth rate of global consumption in the same period. By 2007, total consumption in the region totaled 21 million MT of nutrients, equivalent to 12 percent of world consumption and 3.5 times the

amount produced by the region in that year. As revealed by Figure 25, nitrogen, phosphate, and potash are generally consumed in almost similar proportions. Of the 97 million MT of nutrients consumed during 2002–2007, nitrogen represented 38 percent of this amount, phosphate 32 percent, and potash the remaining 30 percent. In terms of growth, the consumption of nitrogen increased at an annual rate of 15 percent, while the consumption of phosphate and potash increased at annual rates of 9 percent and 7.6 percent, respectively. The significant increase in the consumption of nitrogen toward the end of the period can be explained by the increase registered by Ecuador, which, in addition to Brazil, is one of the top consumers in the region.

Figure 25. Latin America: Consumption of fertilizer by macronutrient, 2002–2007

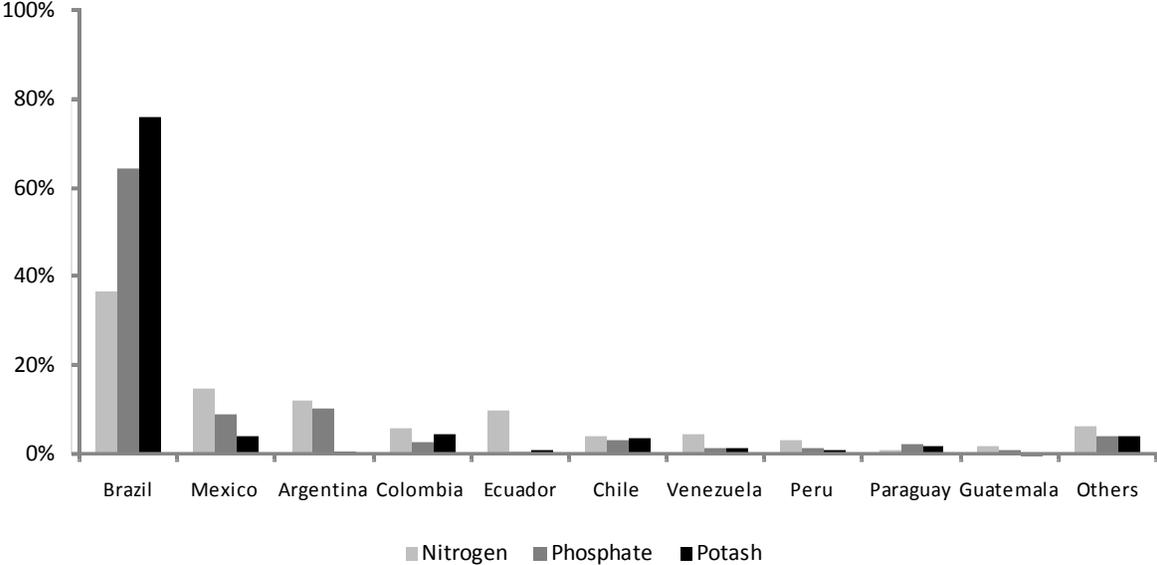


Source: FAOSTAT online database.

As was the case with production, Brazil is by far the main consumer of fertilizer, with around 57 percent of regional consumption in recent years (Figure 26). In fact, Brazil is one of the biggest consumers of fertilizer in the world; during 2002–2007, it consumed more than 55 million MT of nutrients, which is almost three times the amount it produced during that period and is equivalent to 5.6 percent of global consumption. The second major consumer of fertilizer in Latin America is Mexico, with a regional share of 9.8 percent, followed by Argentina (8.1 percent), Colombia (4.4 percent), and Ecuador (4.4 percent). This means that the top five consumers in the region account for 84 percent of total consumption. (Note that Argentina and Mexico are also among the main producers.) By macronutrient, Brazil is the top consumer of all three macronutrients, and alone it accounts for 37 percent of the consumption of nitrogen in the region, 65 percent of phosphate, and 76 percent of potash. Other important consumers of nitrogen are Mexico, with 15 percent of total consumption; Argentina, with 12 percent; and Ecuador,

with 10 percent. Argentina and Mexico are also important consumers of phosphate, with 10 percent and 9 percent, respectively, of regional consumption. In the case of potash, Colombia and Mexico are the second and third main consumers; however, together they only account for 9 percent of the total amount consumed.

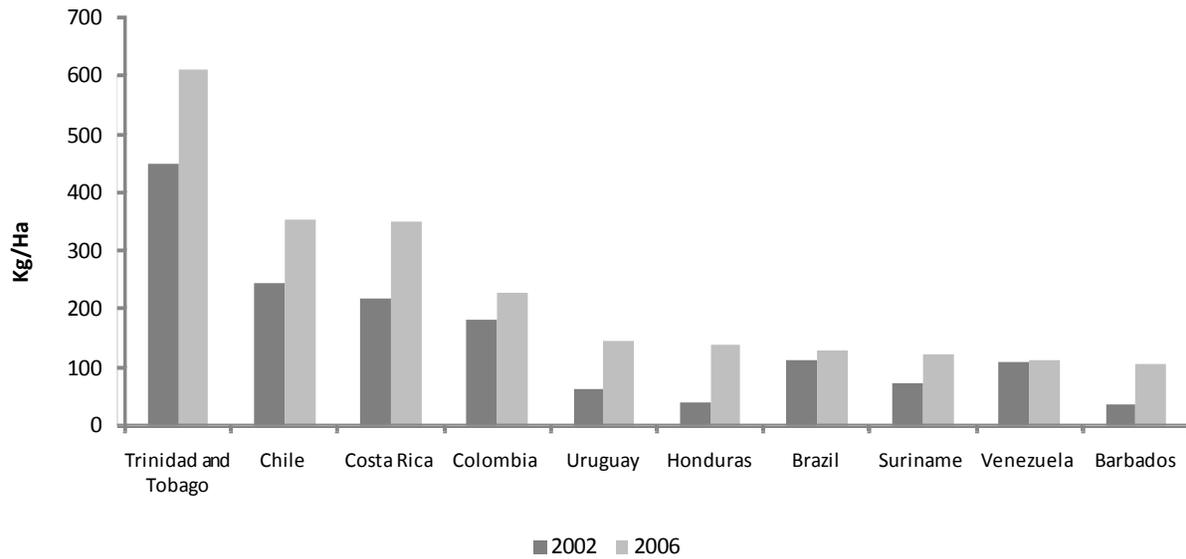
Figure 26. Latin America: Distribution of fertilizer consumption by macronutrient and country, 2002–2007



Source: FAOSTAT online database.

Turning to fertilizer application rates, calculations from WRI for 2002 and 2006 show that several patterns have emerged (Figure 27). First, the top 10 countries with the highest fertilizer use intensity in the region exhibited application rates of above 100 kg/Ha (as of 2006); of those countries, 8 were above the region’s average of 118 kg/Ha and 4 were above the average of 179 kg/Ha for developing countries. Trinidad and Tobago had the highest fertilizer use intensity in Latin America, with an application rate of 615 kg/Ha in 2006, followed by Chile and Costa Rica, with application rates of 356 and 351 kg/Ha, respectively. Second, all of the countries in the region increased their use of fertilizer per hectare of temporary and permanent cropland during 2002–2006. Some countries, such as Uruguay, Honduras, and Barbados, even doubled or tripled their intensity of use during this period. Finally, as was the case in sub-Saharan Africa, countries with a high level of consumption of nutrients in the region did not necessarily exhibit higher application rates (for example, Mexico, Argentina, and Ecuador).

Figure 27. Latin America: Countries with higher fertilizer use intensity, 2002 and 2006



Source: World Resources Institute (WRI), EarthTrends Searchable Database Results.

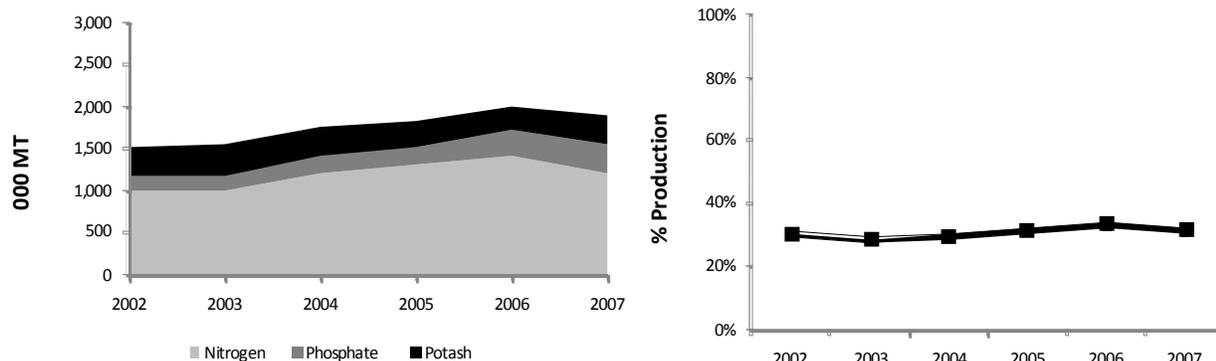
Note: Fertilizer use intensity is the amount of fertilizer (nutrients) consumed by agriculture per hectare of temporary and permanent cropland. In the case of Honduras, the fertilizer use intensity for 2002 corresponds to 2003.

3.2.3 Trade

In recent years, fertilizer exports in Latin America have increased at a higher rate than production, though exports still represent less than 2.8 percent of total global exports. During 2002–2007, exports increased at an average annual rate of 4 percent (compared with 3.5 percent in production), totaling 1.9 million MT of nutrients in 2007. In particular, Brazil, Venezuela, and Trinidad and Tobago, which are among the top exporting countries in the region, registered an important increase in their sales abroad. As with production, nitrogen is the main macronutrient exported (see Figure 28). Of the total 10.7 million MT of nutrients exported during 2002–2007, nitrogen accounted for 68 percent. Potash was the second main macronutrient exported in the region, with 19 percent of the total sales, while phosphate accounted for the remaining 13 percent. Phosphate exports, however, have increased at an annual rate of 12.1 percent in recent years, while nitrogen exports have increased at a rate of 4 percent and potash exports have decreased at a rate of 0.5 percent.⁷

⁷ All of the top exporters of phosphate in Latin America reported a considerable increase in their exports, particularly Brazil and Uruguay, which mainly sell their products to nearby countries in the region.

Figure 28. Latin America: Exports of fertilizer in levels and as a percentage of production by macronutrient, 2002–2007

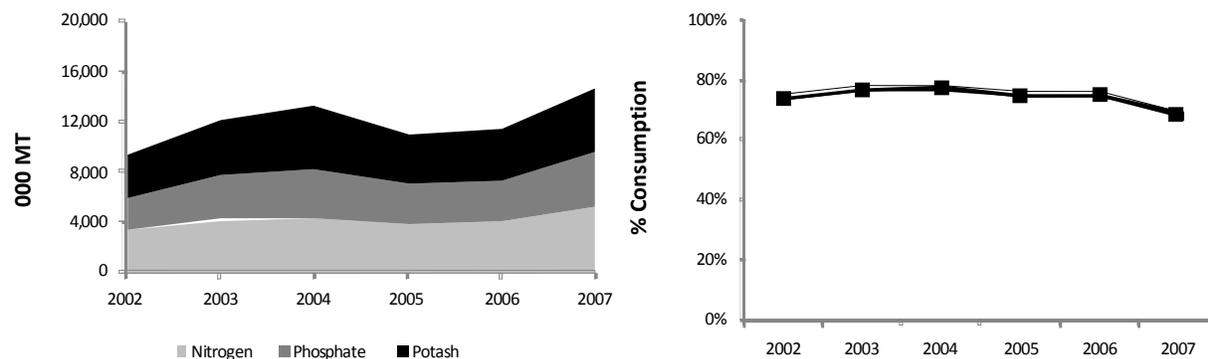


Source: FAOSTAT online database.

Compared with sub-Saharan Africa, where basically all of the relatively small amounts of nutrients produced were oriented toward foreign markets, in Latin America, the percentage of total nutrients exported, relative to the amount produced, has fluctuated around 30 percent in recent years. By macronutrient, the percentage of nitrogen and phosphate exports over production increased by 5 percent and 3 percent, respectively, during 2002–2007, whereas the percentage of potash exports decreased by 4 percent during the same period. As of 2007, roughly 43 percent of the nitrogen produced was exported—15 percent in the case of phosphate and 41 percent in the case of potash.

Fertilizer imports, in turn, have increased at a much faster rate than exports (Figure 29). Between 2002 and 2007, regional imports increased at an average annual rate of 9.5 percent. By 2007, total imports in Latin America added up to 14.8 million MT of nutrients, which is equivalent to 19.5 percent of global imports and is almost 8 times the amount exported by the region in that year. As previously indicated, Latin America (in particular, Brazil) is one of the top importers worldwide. In addition to Brazil, the region’s other major importers have registered an important increase in their imports in recent years, especially Argentina. Figure 29 further shows that both nitrogen and potash are imported in similar proportions, whereas phosphate is imported in lower quantities. Of the 72 million MT of nutrients imported during 2002–2007, nitrogen and potash each accounted for 36 percent and phosphate for the remaining 28 percent. It is worth noting that imports of all three macronutrients have increased at significant rates in recent years. Phosphate purchases increased at an annual rate of 11 percent, nitrogen purchases at a rate of 10 percent, and potash purchases at a rate of 8 percent.

Figure 29. Latin America: Imports of fertilizer in levels and as a percentage of consumption by macronutrient, 2002–2007



Source: FAOSTAT online database.

Relative to consumption, fertilizer imports have increased at a slightly lower rate, which is also reflected in Figure 29 by examining the share of imports over consumption. Although the share of imports decreased during 2002–2007, more than two-thirds of the nutrients consumed in each country in Latin America are imported. This indicates that the region continues to rely on foreign markets for the provision of most fertilizers. By macronutrient, the percentage of nitrogen imports over consumption decreased from 70 percent in 2002 to 56 percent in 2007 (due to a much higher increase in consumption in recent years), while the percentage of potash and phosphate imports over consumption increased from 89 percent to 93 percent and 63 percent to 68 percent, respectively, during that same period.

Turning to trade flows by country, Venezuela is the region’s main exporter, with a share of 26 percent of total exports during 2002–2007. The main destinations of Venezuelan exports are the United States and Mexico. Other countries that export considerable amounts of nutrients include Chile, with a share of 22 percent (mainly to Mexico, Brazil, and Peru); Trinidad and Tobago, with a share of 17 percent (to the United States); Brazil, with a share of 16 percent (to Paraguay); and Argentina, with a share of 11 percent (to Uruguay, Brazil, and Chile). In the case of imports, Brazil accounts for 55 percent of the total purchases from abroad, followed by Mexico, with a share of 12 percent, and Argentina, with a share of 8 percent. The other Latin American countries account for less than 5 percent each of total regional imports. Brazil is actually the second largest importer of fertilizer in the world, with a global share of

around 10 percent; Brazil buys fertilizer mainly from Russia, Canada, and Belarus.⁸ The United States and Russia are the main suppliers of fertilizer for Mexico and Argentina.

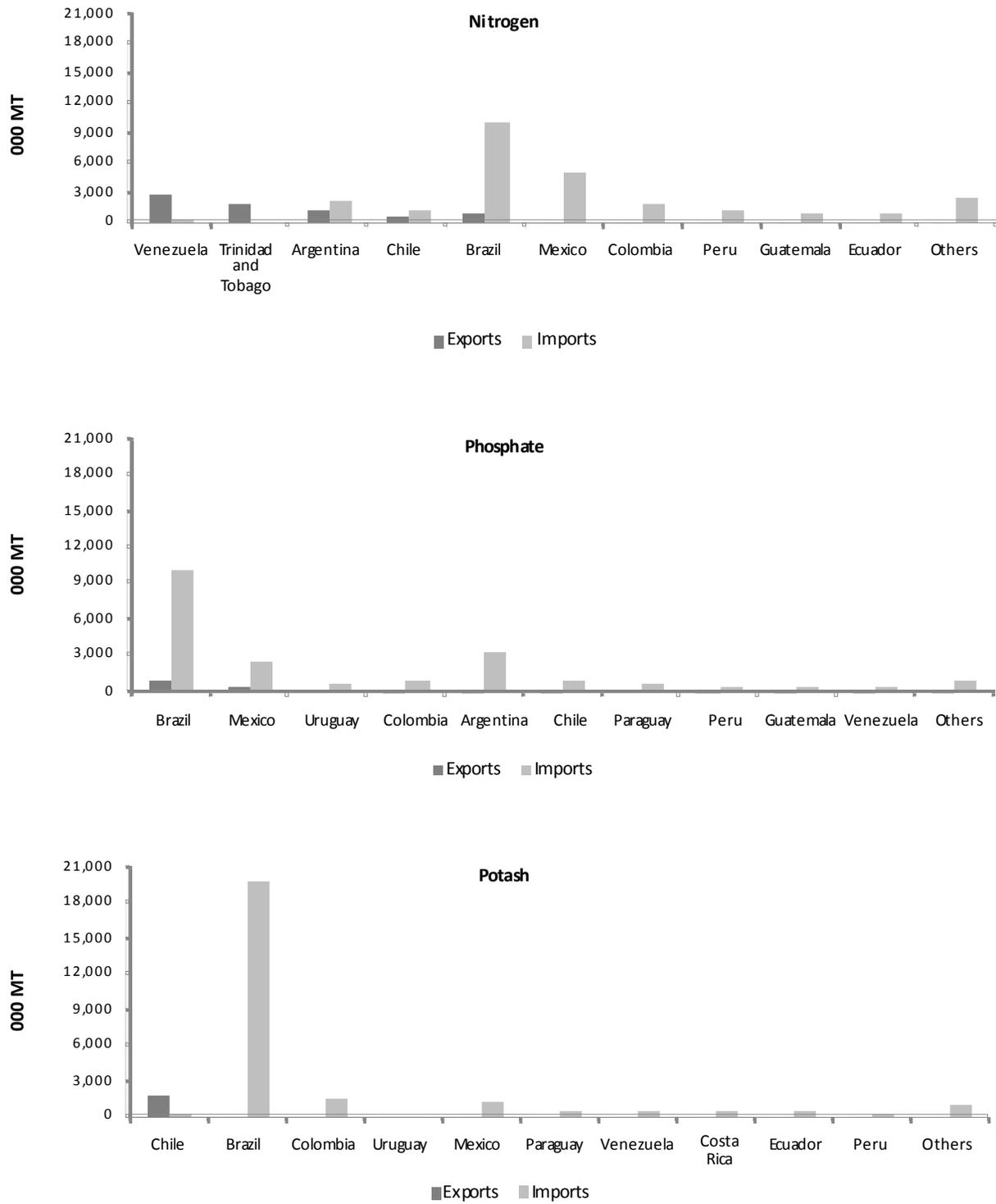
Figure 30 shows aggregate exports and imports by macronutrient and country for 2002–2007. Venezuela, the second major producer of nitrogen in the region, is the top exporter of this macronutrient, with 38 percent of total sales. The second main exporter of nitrogen is Trinidad and Tobago, with a share of 26 percent, while Argentina is third, with a share of 15 percent. Brazil, in turn, is the top exporter (and producer) of phosphate, with 63 percent of the regional exports; Mexico accounts for another 21 percent of exports, while Uruguay is third, with a share of 8 percent. Finally, Chile is by far the main exporter of potash, with 90 percent of the exports.

Regarding imports, as with consumption, Brazil is the top importer of all three macronutrients, accounting for 39 percent of the total nitrogen imports, 49 percent of phosphate, and 77 percent of potash. Other important buyers of nitrogen are Mexico, with a regional share of 19 percent, and Argentina, with 8 percent. Argentina and Mexico are also important buyers of phosphate, with 16 percent and 11 percent, respectively, of regional purchases. Colombia and Mexico are the second and third main importers of potash, although together they account for less than 10 percent of the total amount imported.

Similar to sub-Saharan Africa, the negative trade balance is recurrent across most of the countries in Latin America, as indicated in Figure 30. The only exceptions are Venezuela and Trinidad and Tobago, which are net exporters of nitrogen, and Chile, which is a net exporter of potash. In general, Venezuela and Trinidad and Tobago reported trade surpluses of 1.7 and 1.8 million MT of nutrients, respectively, for 2002–2007, while Chile registered a trade deficit of 76,000 MT. In Brazil, the total trade imbalance totaled 38 million MT; in Mexico, the trade deficit totaled 8 million MT; while in Argentina, the deficit added up to more than 4 million MT. Regardless of the higher levels of production in recent years, even higher levels of consumption make several Latin American countries highly dependent on foreign suppliers.

⁸ The top importer of fertilizer is the United States, with a global share of 23 percent.

Figure 30. Latin America: Fertilizer exports and imports by macronutrient and country, 2002–2007



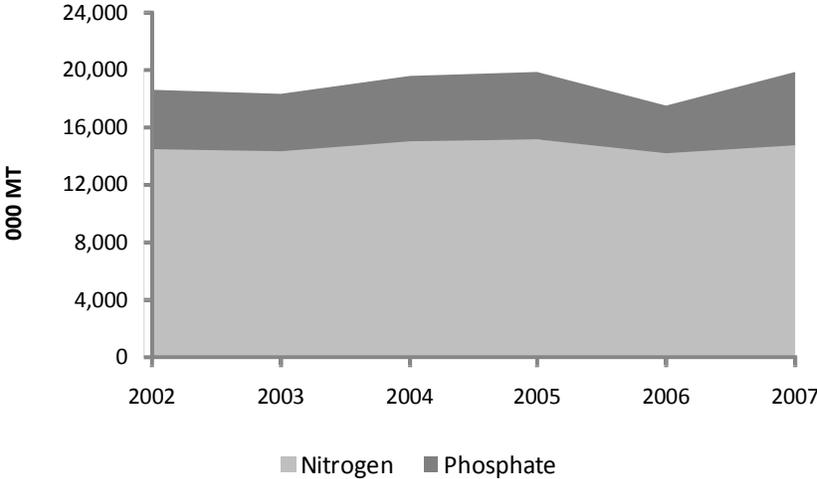
Source: FAOSTAT online database.

3.3 South Asia

3.3.1 Production

Fertilizer production in South Asia has also increased in recent years, though to a lesser extent than in Latin America. During 2002–2007, production in the region increased at an annual rate of 1.3 percent, totaling almost 20 million MT of nutrients in 2007 (11.4 percent of world production). As shown in Figure 31, the region basically produces nitrogen and phosphate. Of the 114 million MT of nutrients produced during 2002–2007, nitrogen accounted for approximately 78 percent and phosphate for another 22 percent. However, although the production of phosphate increased at an annual rate of 3.8 percent during this period, the production of nitrogen only increased at an annual rate of 0.5 percent. Note also that in 2006, there was a sharp decrease in fertilizer production (in particular, phosphate) due to the closure of several plants in India, the main producing country in the region and one of the top producers in the world.

Figure 31.South Asia: Production of fertilizer by macronutrient, 2002–2007

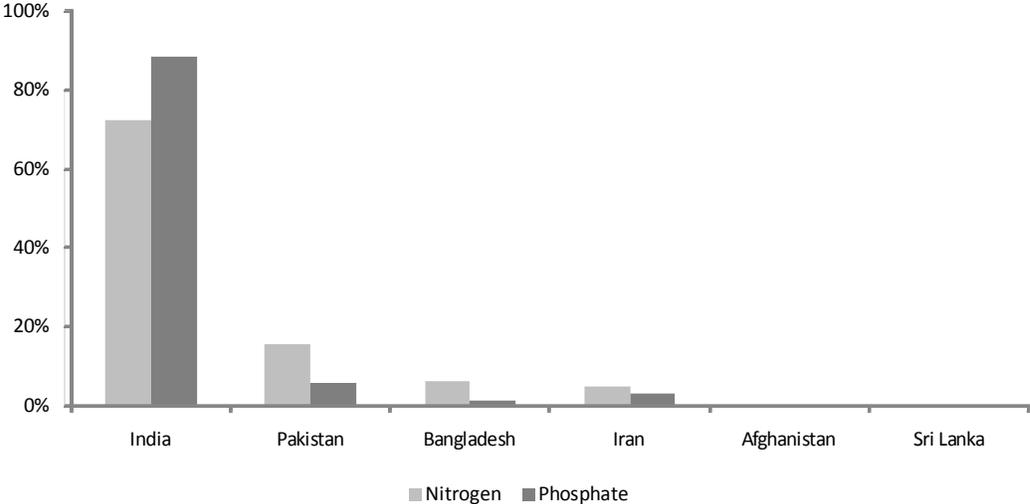


Source: FAOSTAT online database.

From Figure 32, we clearly observe that India is by far the region’s main producer of nutrients. During 2002–2007, India accounted for 73 percent of the production of nitrogen and 89 percent of the production of phosphate. Compared with the two regions previously examined, the production in India alone of both nitrogen and phosphate is three times the production in all Latin America and more than

100 times the production in all sub-Saharan Africa. The second main producer in South Asia is Pakistan, with 16 percent of the regional production of nitrogen and 6 percent of the production of phosphate. Other important producers are Bangladesh and Iran, with 6 percent and 5 percent, respectively, of the share in nitrogen and 2 percent and 3 percent, respectively, of the share in phosphate.

Figure 32.South Asia: Distribution of fertilizer production by macronutrient and country, 2002–2007



Source: FAOSTAT online database.

An analysis by product using IFDC data for fertilizer year 2008/09 confirms the high levels of concentration of the industry and, in particular, the importance of India in the region (and in the world). Table 4 shows that India controls more than 71 percent of South Asia’s production capacity for all main fertilizer products, including urea, ammonia, complex fertilizers (NPK), and DAP/MAP. Iran, in turn, controls most of the production capacity for AN and phosphoric acid; however, the contribution of Iran (and the region) to the world production capacity for these two products is limited (less than 1 percent). In contrast, the contribution of South Asia to the world production capacity for urea, ammonia, NPK, and DAP/MAP ranges from 8 to 18 percent.

Table 4. South Asia: Concentration of fertilizer production capacity, 2008–2009

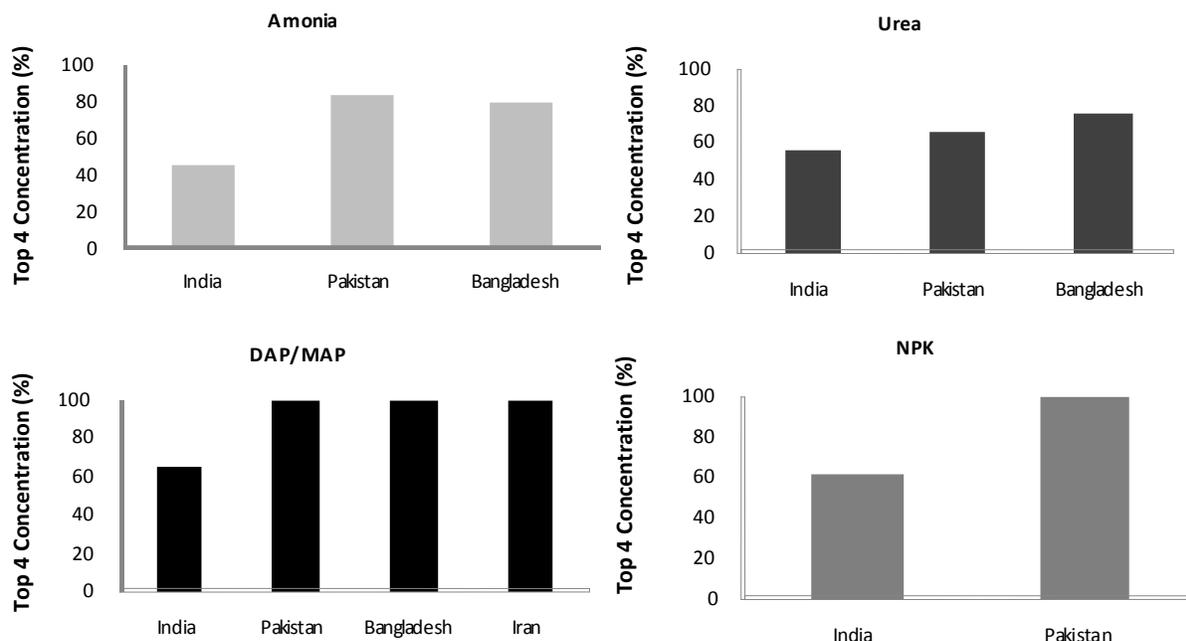
Fertilizer	Top Five Countries (% of region)	Top Five Capacity (000 MT)	Top Five Share (% of Region)	Top Five Share (% of World)
Ammonia	India (74.6), Pakistan (15.2), Bangladesh (9.8)	19,783	100.0	11.9
Urea	India (71.7), Pakistan (18), Bangladesh (9.9), Afghanistan (0.4)	29,146	100.0	18.2
AN	Iran (88.5), India (11.5)	243	100.0	0.4
DAP/MAP	India (79.4), Pakistan (10.9), Bangladesh (4.8), Iran (4.8)	4,991	100.0	14.4
Phosphoric acid	Iran (100)	280	100.0	0.6
NPK	India (95), Pakistan (5)	8,058	100.0	8.6

Source: IFDC 2009.

Note: Based on capacity for operative plants in 2008/09.

The level of concentration within each main producing country is also high, though not as strong as the levels exhibited by countries in Latin America and sub-Saharan Africa. This difference is most likely due to the larger size of the industry in South Asia, which allows for more market participants. Except for the production of ammonia in India, in all cases, the top four firms in each country account for more than 56 percent of the country's production capacity (Figure 33). In general, all countries other than India show high concentration levels, reaching top-4 concentration ratios of 100 percent in some cases. However, there are several situations in which fewer than four firms operate in a country, as well as cases in which only one firm is operating, such as Chittagong Urea Fertilizer Ltd. in Bangladesh for DAP/MAP. And yet in India, the number of operating firms is small, especially for the production of DAP/MAP and NPK.

Figure 33. South Asia: Concentration of fertilizer production capacity for selected products by country, 2008/09



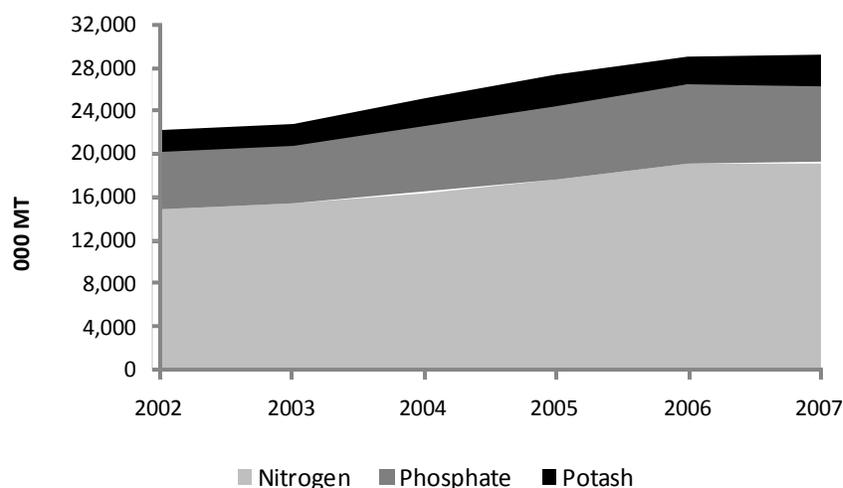
Source: IFDC 2009.

Note: Based on capacity for operative plants in 2008/09.

3.3.2 Consumption

The consumption of fertilizer in South Asia has shown an upward trend in recent years. During 2002–2007, total consumption increased at an average annual rate of 5.7 percent, reaching more than 29 million MT of nutrients in 2007. This amount represented 16.5 percent of the global consumption in that year, indicating that the region is not only an important producer of fertilizer in the world but also one of the major consumers (in particular, India). In addition, South Asia consumes roughly 1.5 times the amount of fertilizer that it produces. Figure 34 shows that two-thirds of the total amount of nutrients consumed in recent years (103 million MT out of a total of 156 million MT during 2002–2007) corresponded to nitrogen; phosphate accounted for an additional 24 percent and potash for the remaining 10 percent. In terms of growth, the consumption of potash increased at an annual rate of 9.5 percent during 2002–2007, while the consumption of phosphate and nitrogen increased at annual rates of 5.6 percent and 5.2 percent, respectively.

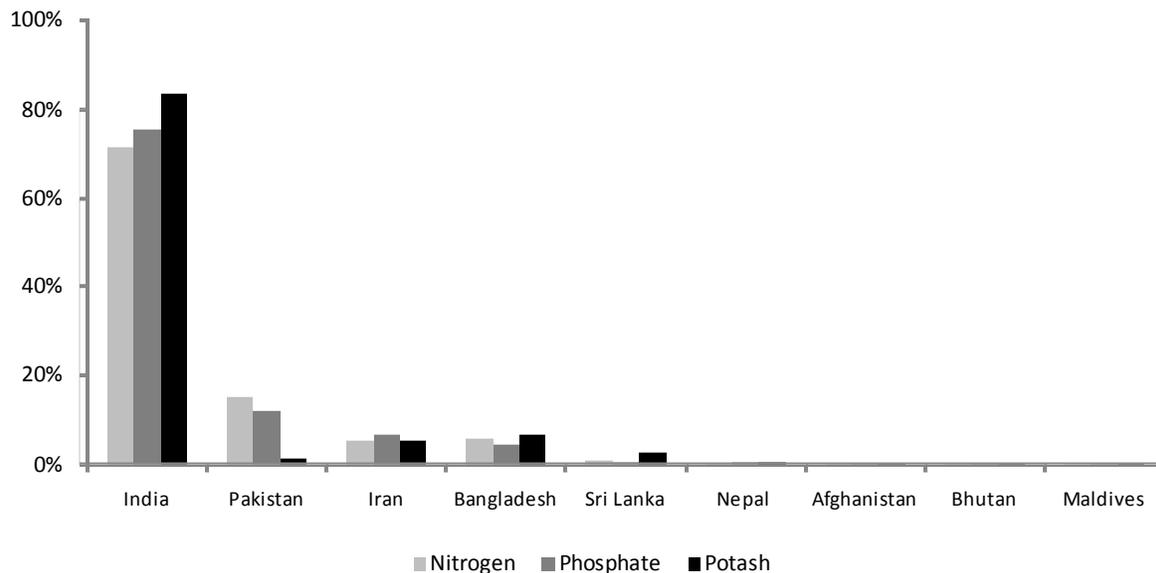
Figure 34.South Asia: Consumption of fertilizer by macronutrient, 2002–2007



Source: FAOSTAT online database.

By country, as with production, India is by far the main consumer of nutrients in the region and one of the top consumers in the world (see Figure 35). During 2002–2007, India consumed 116 million MT of nutrients, which represented 74 percent of regional consumption and 12 percent of global consumption. This amount is more than two times the amount consumed by Brazil, another major fertilizer consumer. India is actually the third largest fertilizer consumer in the world, after China and the United States. The other main consumers of nutrients in South Asia are also the top producers: Pakistan (13 percent of regional consumption), Iran (6 percent), and Bangladesh (6 percent). By macronutrient, India is clearly the main consumer of all three macronutrients, accounting for 72 percent of the total amount of nitrogen consumed, 76 percent of phosphate, and 84 percent of potash. Pakistan is the second largest consumer of nitrogen and phosphate in the region, with shares of 15 percent and 12 percent, respectively, while Bangladesh is the second largest consumer of potash, with a share of 7 percent.

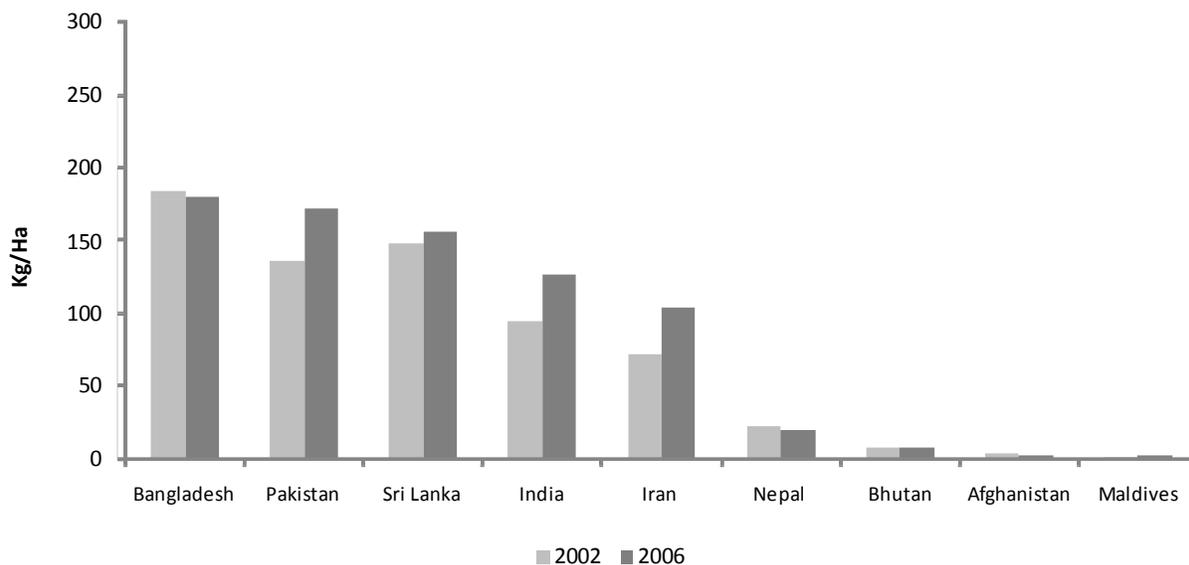
Figure 35. South Asia: Distribution of fertilizer consumption by macronutrient and country, 2002–2007



Source: FAOSTAT online database.

An analysis of fertilizer use intensity in the region, using data from WRI for 2002 and 2006, reveals that, on average, application rates in South Asia are lower than in Latin America and in developing regions in general. The average application rate in South Asia was 86 kg/Ha (as of 2006), compared with 118 kg/Ha among Latin countries and 179 kg/Ha among developing countries. As shown in Figure 36, only Bangladesh has an application rate above the average for developing countries (180 kg/Ha). Fertilizer use intensity in other main consumer countries, such as India, Pakistan, Iran, and Sri Lanka, range from 104 to 173 kg/Ha. It is interesting to see, then, that although the region is an important global consumer, the intensity of use is still small compared with other regions. It also worth noting, however, that all countries with the highest fertilizer use intensity in the region, except Bangladesh, increased their application rates during 2002–2006. Iran, for example, increased its application rate by 43 percent (from 72 to 104 kg/Ha), India by 35 percent (from 95 to 128 kg/Ha), and Pakistan by 27 percent (from 137 to 173 kg/Ha).

Figure 36. South Asia: Fertilizer use intensity by country, 2002 and 2006



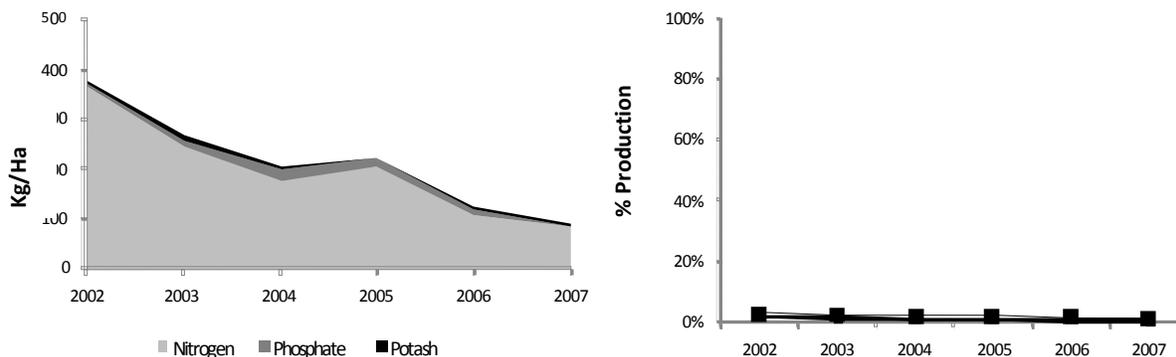
Source: World Resources Institute (WRI), EarthTrends Searchable Database Results.

Note: Fertilizer use intensity is the amount of fertilizer (nutrients) consumed by agriculture per hectare of temporary and permanent cropland. In the case of Bhutan, the fertilizer use intensity for 2002 corresponds to 2005.

3.3.3 Trade

Contrary to the increase in fertilizer production, South Asian exports have considerably decreased in recent years to levels similar to those seen in SSA. During 2002–2007, total regional exports decreased at an average annual rate of 24.4 percent, totaling 94,000 MT of nutrients in 2007 (compared with 91,000 MT in SSA), representing less than 0.3 percent of global exports during this period. The decrease in exports was observed in all of the region’s top exporting countries except India. Figure 37 shows a dramatic decrease in nitrogen exports, the main nutrient exported in the region. Of the 1.3 million MT of nutrients exported during 2002–2007, nitrogen accounted for 93 percent; however, nitrogen sales abroad decreased at an annual rate of 25.3 percent. Phosphate sales, which represented 5 percent of regional exports, decreased at a rate of 5.4 percent, while potash sales, which accounted for the other 3 percent of exports, decreased at a rate of 6.8 percent.

Figure 37. South Asia: Exports of fertilizer in levels and as a percentage of production by macronutrient, 2002–2007

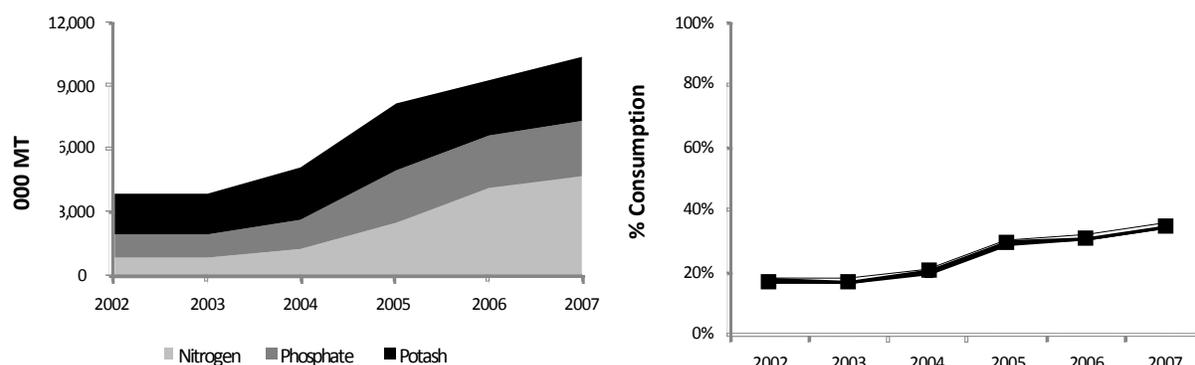


Source: FAOSTAT online database.

From Figure 37, it is also clear that most of the fertilizer production in South Asia is oriented toward local demand. The percentage of total nutrients exported, relative to the amount produced, has fluctuated around 1 percent in recent years. In other words, for every metric ton of nutrients produced in a certain country in the region, only 10 kg are sold in foreign markets, which is the case for all three macronutrients.

In contrast, fertilizer imports have seen a significant increase in recent years (Figure 38). Although consumption in the region increased at an average annual rate of 5.7 percent during 2002–2007, imports increased four times faster (at a rate of 21.4 percent). By 2007, total imports in South Asia added to 10.4 million MT of nutrients, equivalent to 13.7 percent of global purchases and more than 31 times the amount exported by the region in that same year. India, the main buyer in the region and one of the top importers in the world, more than tripled its imports during the period of analysis. The other major importers in the region also registered an increase in their purchases from abroad, though at lower levels than in India. Figure 38 also shows that nitrogen, the main macronutrient consumed in South Asia, has displaced potash as the top nutrient imported. In recent years, nitrogen imports have increased at an annual rate of 39.9 percent, while phosphate purchases have increased by 17.3 percent and potash purchases by 10.1 percent. If we examine the amount of nutrients imported during 2002–2007 (41 million MT), nitrogen and potash accounted for 36 percent each of total purchases and phosphate for the remaining 28 percent; however, in 2007, nitrogen accounted for 46 percent of the purchases, potash for 29 percent, and phosphate for 25 percent.

Figure 38. South Asia: Imports of fertilizer in levels and as a percentage of consumption by macronutrient, 2002–2007



Source: FAOSTAT online database.

The higher dynamism of imports, relative to consumption, is further reflected by the region's higher dependence on imported fertilizer. Figure 38, which also compares the amount of nutrients imported relative to the amount consumed, shows that this share almost doubled during 2002–2007 (from 18 to 35 percent). By macronutrient, the percentage of nitrogen imports over consumption increased from 6 percent to 24 percent; the share of phosphate increased from 22 percent to 37 percent and that of potash from 97 percent to 100 percent.

Regarding trade flows by country, Bangladesh is the main exporter of fertilizer in South Asia, with 68 percent of the total exports; Iran ranks second, with 16 percent. India, which is the main producer (and consumer) in the region and one of the top producers in the world, ranks third, with 11 percent of regional exports.⁹ The main destination of Bangladesh's exports is India; Iran exports primarily to Afghanistan, Pakistan, and Iraq; and India, to Nepal, the United Arab Emirates, Bangladesh, and the United Kingdom. In the case of imports, India is the top importer, with roughly two-thirds of the regional purchases (64 percent), which is not surprising, considering that India is the third major importer in the world after the United States and Brazil (and the second major consumer after China). India's imports are mainly from the United States and China. Other major importers of nutrients in the region include Pakistan, with 13 percent of imports (mainly from China, Russia, and Australia); Iran, with 10 percent (from Lebanon); and Bangladesh, with 9 percent (from China).

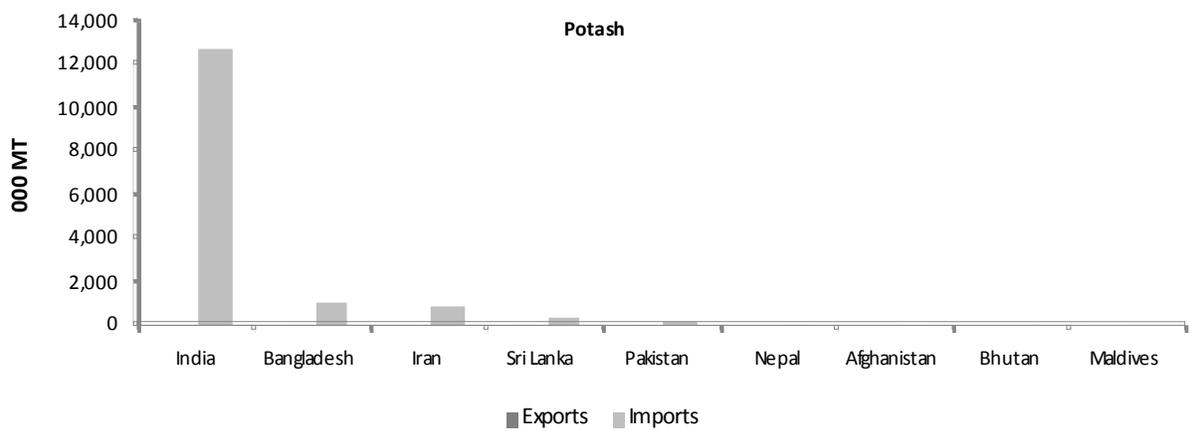
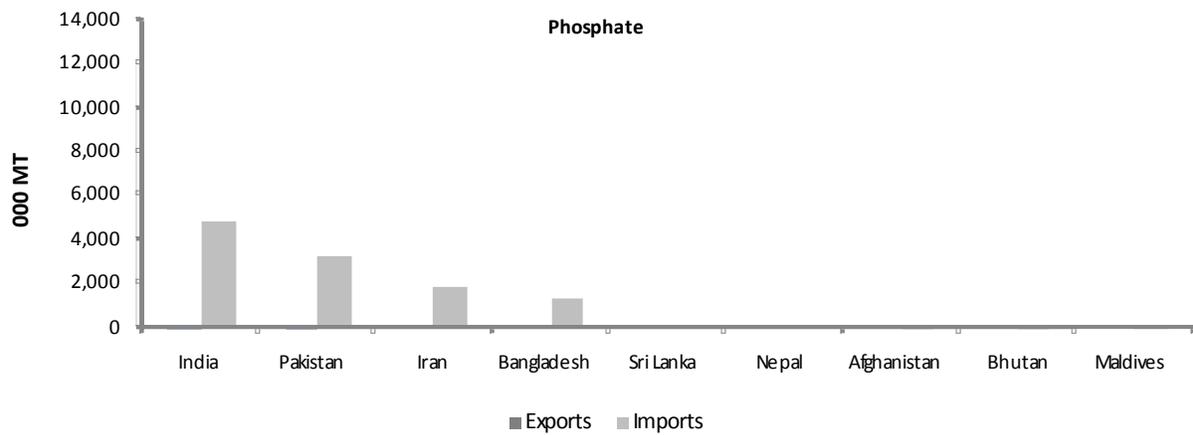
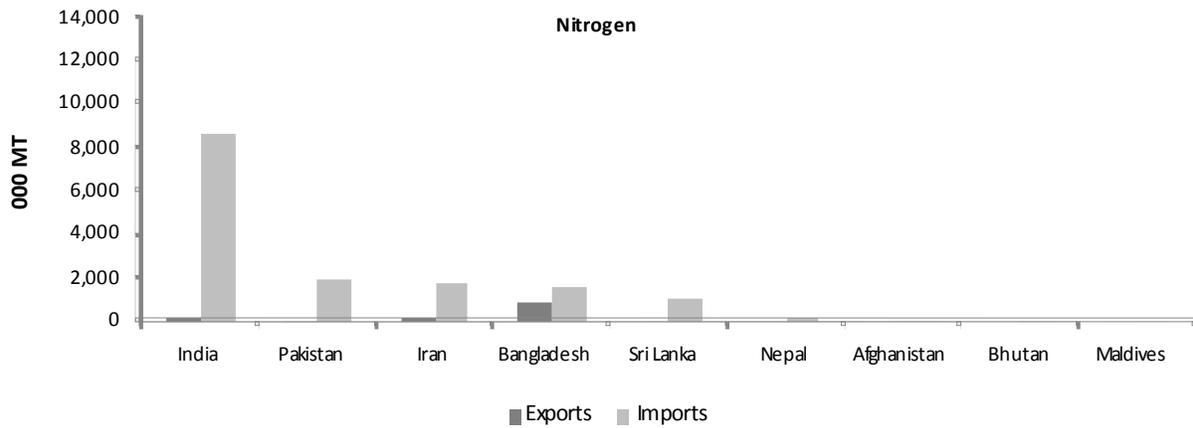
⁹ This also confirms that the vast majority of India's production is oriented toward local markets.

Figure 39 provides a more detailed look at aggregate exports and imports by both macronutrient and country for 2002–2007. Bangladesh is by far the top exporter of nitrogen, the main macronutrient sold in the region, with 74 percent of the total sales; it is followed by Iran, with a share of 17 percent. India, in turn, accounts for around two-thirds of the small amounts of phosphate and potash exported, while Pakistan accounts for the other third of both macronutrients.

Turning to imports, as with consumption, India is the top importer of all three macronutrients, accounting for 58 percent of nitrogen purchases, 43 percent of phosphate, and 85 percent of potash. Other important buyers of both nitrogen and phosphate are Pakistan, with regional shares of 13 percent of nitrogen and 28 percent of phosphate; Iran, with shares of 11 percent and 16 percent, respectively; and Bangladesh, with respective shares of 10 percent and 11 percent, respectively. Bangladesh and Iran are the second and third main importers of potash, with 7 percent and 5 percent, respectively, of regional purchases.

Similar to the other regions analyzed (SSA and Latin America), South Asian countries exhibit an important fertilizer trade deficit. However, in this case, the negative balance is recurrent across all countries without exception. In India, for example, the trade deficit totaled 26 million MT of nutrients; in Pakistan, the deficit totaled 5 million MT; while in Iran and Bangladesh, the deficit was 4 and 3 million MT, respectively. Despite the high levels of fertilizer production in the region, plus the fact that almost all of the production is oriented toward local markets, the even higher and increasing levels of consumption have made South Asian countries more dependent on foreign suppliers.

Figure 39. South Asia: Fertilizer exports and imports by macronutrient and country, 2002–2007



Source: FAOSTAT online database.

3.4 Summary

Several important patterns emerge across the regions examined. First, regardless of the different levels of fertilizer production across regions, production is concentrated among few countries within each region and among few firms within each major producing country. As previously indicated, this statistic could be explained by the limited geographic availability of raw materials and by the probable economies of scale in production. Second, the three regions are not major fertilizer exporters, though this is due to different reasons within each region. In South Asia, most of the production goes toward satisfying the high (and increasing) local demand; in Latin America and SSA, part or most of the production is oriented toward foreign markets, though the amount of nutrients produced is relatively low compared with other regions. Third, despite the different amounts of nutrients consumed (and produced) in each region, the majority of countries in all three regions show an important dependence (or increasing dependence, in the case of South Asian countries) on external markets for the provision of fertilizer.

Table 5 summarizes the level and observed variation in fertilizer production, consumption, and trade flows across the regions for 2002–2007. Latin America is the only region that reported an increase in all variables in recent years, especially in its consumption and imports of nutrients. SSA showed only a marginal increase in its imports and is still the region with the lowest levels of production, consumption, and trade flows in the world. South Asia, in turn, reported the highest variation in trade flows, relative to the other regions; however, although imports increased considerably, exports decreased by an even higher magnitude.

Table 5. Comparison of fertilizer production, consumption, and trade across regions, 2002–2007

Region	Production		Consumption		Exports		Imports	
	Level	Variation	Level	Variation	Level	Variation	Level	Variation
SSA	Lowest	–	Lowest	–	Lowest	–	Lowest	+
Latin America	Low	+	Medium/High	+	Low	+	High	+
South Asia	High	+	High	+	Low	–	Medium/High	+

Source: FAOSTAT online database.

Notes: Level is relative to other regions in the world. Variation is for the period 2002–2007.

4 Prices and Market Concentration: The Case of Urea

This section formally examines the relationship between urea prices and market structure, using data from a panel of countries. The panel nature of our dataset permits us to exploit differences in market structure across countries and time in order to determine whether there is a positive correlation between prices and market concentration. A regression analysis at the country level allows us to examine this information while controlling for other factors that may drive urea prices.

4.1 The Model

Consider the following dynamic price model:

$$\begin{aligned}\ln p_{ijt} &= \alpha \ln p_{ijt-1} + \beta mktstructure_{ijt} + X_{ijt} \delta + \varepsilon_{ijt} \\ \varepsilon_{ijt} &= c_i + u_{ijt} \\ E[c_i] &= E[u_{ijt}] = E[c_i u_{ijt}] = 0,\end{aligned}\tag{1}$$

where p_{ijt} is the price of urea in country i from region j at year t ; $mktstructure_{ijt}$ is a measure of market concentration; X_{ijt} is a vector of controls; and ε_{ijt} is the disturbance term, which has two orthogonal components—a country specific effect c_i and an idiosyncratic shock u_{ijt} . The model is dynamic in that current price realizations are influenced by past ones. Our parameter of interest is β , which captures the effect of market concentration on prices.

Several econometric issues arise from estimating equation (1). The time-invariant country-specific effect c_i accounts for any differences across countries, which could drive fertilizer prices in a market and which are not well captured by the vector of controls. To the extent that this effect might be correlated to some of the explanatory variables, particularly with market structure, consistent estimation of the parameters in equation (1) requires the elimination of c_i .

Taking first differences of equation (1), we get

$$\Delta \ln p_{ijt} = \alpha \Delta \ln p_{ijt-1} + \beta \Delta mktstructure_{ijt} + \Delta X_{ijt} \delta + \Delta u_{ijt}. \quad (2)$$

This equation models (annual) changes in log price as a function of changes in lagged log price, market structure, and other explanatory variables. Naturally, any time-invariant controls drop from the equation. First differencing, however, does not completely account for the potential endogeneity of market structure. More specifically, performance can feed back into structure, causing a contemporaneous correlation between market structure and the error term in equation (2).

Furthermore, as a function of outputs or revenues, market structure is correlated with the determinants of price that are, at best, measured with error; therefore, market concentration is likely to be correlated with the error term. In addition, by construction, $\Delta \ln p_{ijt-1}$ is not strictly exogenous in equation (2).

Due to the lack of appropriate instruments for market structure, we can follow Anderson and Hsiao (1981) and use as an instrument the second lag of market structure, $mktstructure_{ijt-2}$.¹⁰ This instrument is valid under the assumption that u_{ijt} is uncorrelated with $mktstructure_{ijs}$ for $s < t$ —that is, market structure only has a contemporaneous effect on prices. Similarly, for $\Delta \ln p_{ijt-1}$, a natural candidate instrument is $\ln p_{ijt-2}$, because it is mathematically related to $\Delta \ln p_{ijt-1} = \ln p_{ijt-1} - \ln p_{ijt-2}$ but not to the error term $\Delta u_{ijt} = u_{ijt} - u_{ijt-1}$ (as long as the u_{ijt} are not serially correlated).

To improve efficiency, we can use deeper lags of market structure and the log of price as additional instruments. To the extent that this introduces more information, it should improve efficiency; however, in standard two-stage least squares (2SLS), the deeper the lags used, the smaller the sample size. Arellano and Bond (1991) offered an alternative generalized method of moments (GMM) procedure, originally proposed by Holtz-Eakin, Newey, and Rosen (1988), that eliminates the trade-off between lag and sample depth and makes it practical to include all valid lags of the untransformed variables as instruments.¹¹ As pointed out by Roodman (2006), after differencing, the disturbances are also far from

¹⁰ The lack of valid external instruments is also the reason following a first-difference approach is more appropriate than following a fixed-effects approach—the former permits the use of lags of the potential endogenous variables as instruments. See Woodbridge (2002) for a more detailed discussion on this matter.

¹¹ For further details on the procedure, see also Roodman (2006).

identically and independently distributed, far enough to distort estimation of equation (2). The Arellano-Bond GMM procedure addresses this problem by modeling the error structure more realistically, which makes the estimation more efficient and better behaved.

Next, we describe the data used in the regression analysis, as well as the estimation results. For comparison purposes, we estimate equation (2) by ordinary least squares (OLS), Anderson-Hsiao's 2SLS procedure, and Arellano-Bond's difference GMM approach.

4.2 Data and Results

Table A.1 in the Appendix summarizes the sources of information consulted in constructing the variables in the regression analysis. The two main variables of interest are price and market structure. The price data are annual urea prices paid by farmers. These data are obtained from the online Fertilizer Archives of the Food and Agriculture Organization (FAO), which encompass 1961–2002. The prices for each country were reported in local currency per MT and were then converted into U.S. dollars per MT, using the real exchange rate series (base year 2005) from the Economic Research Service (ERS) of the United States Department of Agriculture (USDA). To measure market structure, we use annual data on urea production capacity by company and country from the Tennessee Valley Authority for 1970–1995 and from the International Fertilizer Development Center (IFDC) for 1996 onward.¹²

Given the different year ranges of these two datasets and that not all countries listed in the urea capacity listing appear in the price database or report information for a sufficient number of years, we end up with an unbalanced panel of 38 countries for 1970–2002. We thus drop all countries that did not report prices for at least 70 percent of the sample period. Whenever possible, we also apply linear extrapolation to recover some of the missing values.

For the estimations, we consider three continuous measures of market concentration: the number of firms, the top-4 concentration ratio (CR4), and the Herfindahl-Hirschman index (HHI). The CR4 is simply the sum of the market shares of the four largest firms competing in a market, while the HHI is the sum

¹² We use production capacity instead of production because we are not aware of cross-country data on fertilizer production for a sufficiently large period of time. To the extent that annual production is correlated with capacity, this should not pose an issue for our empirical exercise.

of the squared market shares of each firm operating in the market. Both the CR4 and the HHI range from 0 to 1; increases in these indices generally indicate a decrease in competition and an increase in market power, whereas decreases indicate the opposite. The main difference between the two indices is that the HHI gives more weight to larger firms. To measure market share, in turn, we consider both production capacity in MT (q) and number of plants (p). Thus, we end up with two alternative top-4 concentration ratios, $CR4_q$ and $CR4_p$, as well as two alternative measures of HHI, HHI_q and HHI_p .

Given that some countries rely on imported fertilizer for consumption more than others, as is clear from the previous analysis, we account for market concentration at both the country and the regional level (excluding the country) and use a weighted average of both. Because we are interested in examining the relationship between prices and concentration and because several countries import part or most of their urea, it is reasonable to also account for the level of competition at their neighboring countries, assuming that countries will prefer to buy fertilizer from nearby countries. This assumption seems reasonable given the high transportation costs in the industry. Formally, we allow for the following two different measures of market structure:

$$mktstructure_{ijt} = w_{it} \times mktstructure_{it} + (1 - w_{it}) \times mktstructure_{j\neq it} \quad (\text{Measure 1})$$

$$mktstructure_{ijt} = I(w_{it} \geq 0.5) \times mktstructure_{it} + (1 - I(w_{it} \geq 0.5)) \times mktstructure_{j\neq it}, \quad (\text{Measure 2})$$

where $mktstructure_{it}$ is the market structure in country i at year t , $mktstructure_{j\neq it}$ is the market structure in region j excluding country i , w_{it} is the share of total consumption from local production or $w_{it} = 1 - imports_{it} / consumption_{it}$, and $I(\cdot)$ is an indicator function. Measure (1) is a weighted average of market concentration at the country and regional level, which uses as weights the relative amount of urea consumed both from local production and imports; measure (2) uses the level of concentration either at the country level or at the regional level, depending on whether most of the urea consumed is from local production or imports.¹³

¹³ Unfortunately, due to data limitations, we are not able to also account for potential differences across countries in the level of competition regarding the distribution of fertilizer. However, if there is market power exertion among producers, particularly in highly concentrated markets, we should still expect a positive correlation between prices and concentration.

As noted earlier, we estimate equation (2) by OLS, 2SLS (Anderson-Hsiao), and GMM (Arellano-Bond). As control variables, we include the share of imported urea over total consumption and whether the country is the top producer of urea in the region (or among the top four producers). The former variable is intended to capture any extra costs (for example, additional transaction costs) associated with importing urea, while the latter variable is intended to account for possible economies of scale in production. We also interact both variables, provided that the country is an important producer of urea while still importing a considerable amount of the urea it consumes. Similarly, we add regional and year dummies to capture any differences in pricing trends across areas and over time.

The full estimation results are presented in Tables A.2–A.6 in the Appendix. The standard errors reported are robust. Each table corresponds to a different measure of market concentration used in the regression analysis: number of firms; CR4 based on production capacity; CR4 based on number of plants; HHI based on production capacity; and HHI based on number of plants. Similarly, Model 1 corresponds to the specifications in which we include a dummy variable for whether the country is the top producer in the region, whereas Model 2 corresponds to the specifications in which we instead use a dummy variable if the country is among the top four producers in the region. For ease of presentation, estimates of the regional and time-fixed effects are omitted.

Turning to the power of the instruments, in the case of the Anderson-Hsiao 2SLS procedure, which uses as instruments the second lags of the change in log prices and market structure, we report both the LM and Wald versions of the Kleibergen and Paap (2006) rk statistic for underidentification and weak identification. Whereas in some cases the LM underidentification test rejects at the 5 (or 10) percent level of significance the null hypothesis that the excluded instruments are not correlated with the presumably endogenous regressors (the first lag of the change in log prices and the change in market structure), the F weak-identification test suggests that the instruments are only weakly correlated with the endogenous explanatory variables. In the case of the Arellano-Bond difference GMM procedure, which uses a broader set of lagged variables as instruments, the Hansen J statistic test for overidentifying restrictions never rejects the null hypothesis that the instruments, as a group, are exogenous. In addition, the Arellano-Bond test for an autoregressive process of order 2 in first differences does not reject at a 5 percent level of significance the null hypothesis of no autocorrelation (in levels).

The estimation results generally show a positive correlation between urea prices and market concentration, after controlling for other factors. Table 6 summarizes the effect of the different measures of market concentration considered on prices under the different model specifications and estimation procedures applied. Two issues are worth noting regarding the sign, magnitude, and significance of the estimated coefficients for market structure. First, as expected, in most cases, the coefficients for the CR4 and HHI have positive signs, though they are not always significant. This suggests that the higher the level of concentration in a market, the higher the prices. In particular, the Arellano-Bond estimates, which are both consistent and efficient, indicate that a 10 percentage point increase in CR4 based on the number of plants results in a 9.8 percent (significant) increase in urea prices under Model 1 and an 11.6 percent increase under Model 2. A similar increase in CR4 based on production capacity, in turn, increases prices by 8.2 percent under Model 2. Similarly, a 10 percentage point increase in HHI based on the number of plants results in a 10–16.4 percent increase in prices under Model 1 and a 9.2–16.5 percent increase under Model 2.¹⁴ Second, the number of companies in a market does not have an economically and statistically significant (negative) impact on prices. It appears that simply observing the number of firms in a market is not sufficient to examine market power in the industry.¹⁵

With respect to control variables, urea prices of the previous year seem to have an important positive effect on current prices, which also confirms the dynamic nature of prices. A 10 percent increase in prices in the previous year results in a 6–10 percent increase in prices in the next year (see Tables A.2–A.6). The share of imported urea over total consumption in a year also has a significant positive effect on prices, especially under Model 1, which seems reasonable considering that this variable is intended to capture any extra costs associated with importing fertilizer. The other controls, however, do not appear to play a major role in determining urea prices.

¹⁴ Note that the Anderson-Hsiao 2SLS estimates predict a much higher impact of market concentration on urea prices; however, these estimates are not statistically significant. Recall that the instruments for the market concentration measures are weakly correlated with these variables under this estimation procedure.

¹⁵ Compared with the top-4 concentration ratio and the HHI, the number of competitors in a market is a less accurate measure of concentration (and market power) because it implicitly assumes that all firms have an equal market share.

Table 6. Effect of market concentration on urea prices

	OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Number of companies						
Measure 1	-0.021	-0.021	0.084	0.090	0.001	0.002
Measure 2	-0.001	-0.001	-0.020	-0.020	-0.004	-0.003
Top-4 ratio on production capacity						
Measure 1	1.072*	0.978*	2.246	2.874	0.032	0.316
Measure 2	0.154	0.119	3.485	2.819	0.718	0.817*
Top-4 ratio on number of plants						
Measure 1	0.200	0.167	5.567	5.596	-1.013	-0.858
Measure 2	0.187	0.162	3.742	3.329	0.976**	1.155**
HHI on production capacity						
Measure 1	1.840*	1.816*	4.812	4.499	0.979	1.058
Measure 2	0.151	0.118	3.490	2.871	0.672	0.558
HHI on number of plants						
Measure 1	1.606**	1.580**	4.198	3.897	1.642*	1.654*
Measure 2	0.135	0.104	3.569	2.864	0.998**	0.921**
Main producer and share imports/consumption	✓		✓		✓	
Among top-4 producers and share imports/consumption		✓		✓		✓
Regional fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Full regressions reported in Tables A.2–A.6.

Measure 1 corresponds to the weighted average of the measure of market concentration at the country and regional levels. Measure 2 is the measure of market concentration at either the country or regional level, depending on whether most of the urea consumed is from local production or imports.

Overall, these results provide some evidence that urea prices tend to be higher in less competitive markets, with all else being equal.¹⁶ In other words, even though the fertilizer industry is already highly concentrated, in further concentrated markets, prices are even higher due to the greater market power enjoyed by firms. It seems that the market power effects outweigh the cost-efficiency effects (related to economies of scale in production) of increased concentration in the fertilizer industry. As stated earlier,

¹⁶ Although not reported, we obtain similar results when averaging market concentration measures at the country level and at the main producing country in the region (instead of the regional level). Details are available upon request.

formally uncovering market power exertion in the industry (as well as cost-efficiency effects) is beyond the scope of the present study, due to data limitations.¹⁷

¹⁷ For a detailed study on this matter in a specific market, refer to Kim et al. (2002), who examined market power and cost-efficiency effects of market concentration in the U.S. nitrogen fertilizer industry for 1976–2000 and found that the former effects are greater than the latter.

5 Concluding Remarks

This study has provided a detailed overview of the current market situation in the fertilizer industry at the global level and in three key developing regions: sub-Saharan Africa, Latin America, and South Asia. The market situation was analyzed in terms of production, consumption, trade, and prices, with special emphasis given to the level of concentration in the industry. We also performed a regression analysis to formally examine the impact of market concentration on fertilizer (urea) prices. Several important patterns and results emerged from the study.

At the global level, it is clear that the fertilizer industry is a highly concentrated market with high and increasing levels of trade. A small number of countries control most of the production capacity for the main nitrogen, phosphate, and potash fertilizers. More specifically, except for ammonium nitrate (AN), the top five countries control more than half of the world's production capacity for all major fertilizer products. Similarly, except for China, the industry shows a high level of concentration among firms within each main producing country. In most cases, the top four firms control more than 50 percent of the country's production capacity. Although the availability of raw materials explains the geographical pattern of global production, economies of scale in production might explain the industry structure at the country level. The importance of trade in the industry is evident from the increasing dependence of several regions on imported fertilizers (as well as from the increasing share of exports over production in another few regions). Fertilizer prices in major international markets have, in turn, shown an upward trend in recent years.

Despite the different levels of production and consumption across the three regions analyzed, the market situation in each region shows high concentration levels in production, as well as a significant or increasing dependence on external markets for the provision of fertilizer. Production is concentrated among few countries within each region and among few firms within each major producing country. All regions have also increased their imports of fertilizer in recent years. Whereas South Asia is both a major global fertilizer producer and consumer (though most of its production is oriented toward satisfying its high and increasing local demand), sub-Saharan Africa is by far the smallest producer and consumer in the world. Latin America is an important (and increasing) consumer, though still a small-sized producer.

The regression analysis for the urea industry, which uses data from a panel of countries, suggests that fertilizer prices are higher in more concentrated markets. It seems that despite the high levels of concentration in the industry, in further concentrated markets, prices are even higher because of the apparently greater market power enjoyed by firms. Due to economies of scale in production (and procurement), although increased concentration may result in cost efficiencies, it may also result in market power exertion (and tacit collusion) among firms. In this input market, the market power effects apparently outweigh the cost-efficiency effects.

The results from this study, besides noting the high levels of concentration in the industry and the increasing dependence of several regions on imported fertilizer, intend to motivate further research on the associated effects of higher market concentration on prices. In particular, future research should thoroughly examine the extent of market power exertion in major fertilizer markets, using a more detailed dataset. It is generally argued that the high levels of concentration in the fertilizer industry result from a high requirement of raw materials that are not available worldwide, as well as from economies of scale in production. However, not much has been said about potential market power exertion in this highly concentrated industry. The estimation results seem to point in this direction. Market power exertion may allow producers to take full advantage of price spikes in raw materials (for example, natural gas for the production of ammonia and urea) and grains, to the detriment of farmers' wealth.¹⁸ Moreover, given the high and increasing dependence of most developing regions on external markets for the provision of fertilizer, linking the analysis of market power exertion to other studies that identify supply-side constraints at the regional and country level becomes crucial for adequate policymaking regarding the development of input markets in these regions. In addition to the lack of competition across suppliers and distributors within the country or region, as well as poor dealer networks, lack of infrastructure and market information, and high financing costs, farmers in developing regions may also be facing high input prices (unless subsidized) because of market power exertion by major producers in the world.

¹⁸ According to Integer Research, a leading consultant in global commodity markets based in London, major fertilizer producers have achieved record profits in recent years, with total revenues of more than US\$50 billion.

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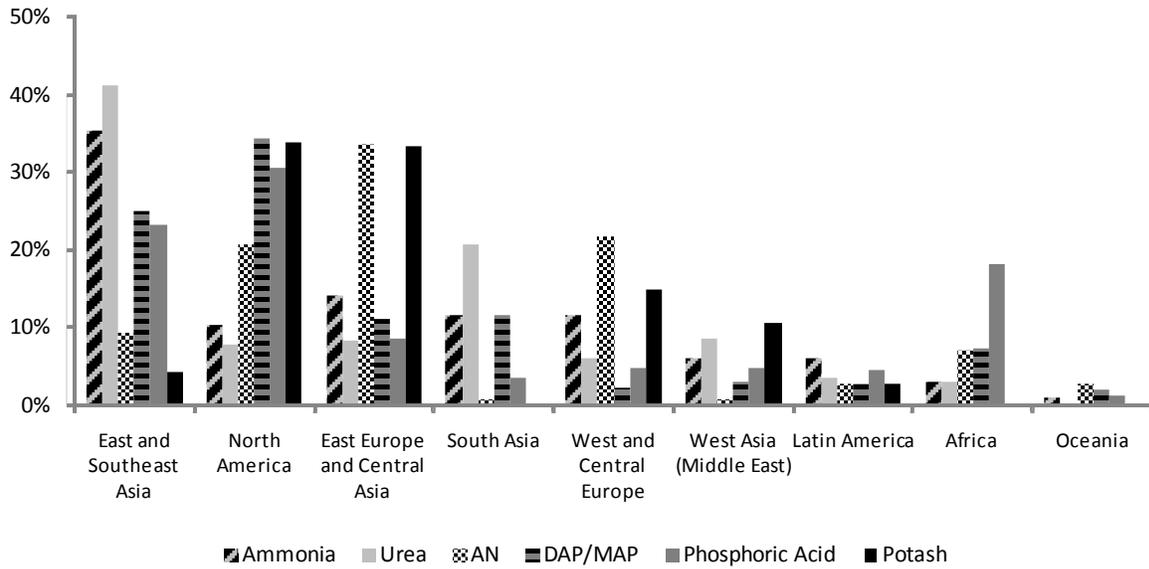
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Appendix: Supplementary Tables and Figures

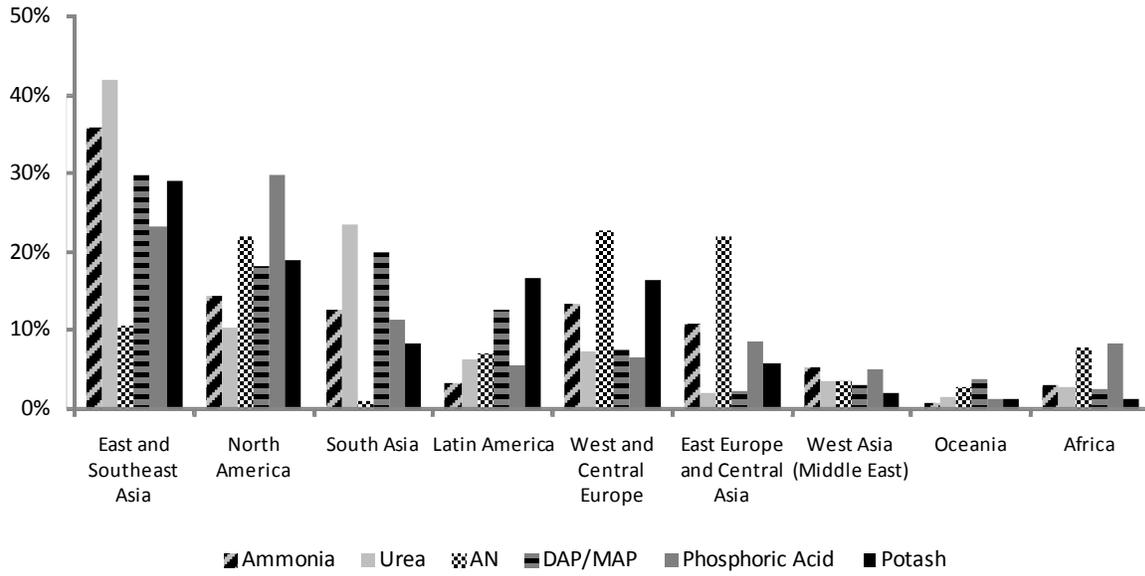
Figure A.1. Distribution of global fertilizer production by product and region, 2002–2008



Source: IFA online statistics.

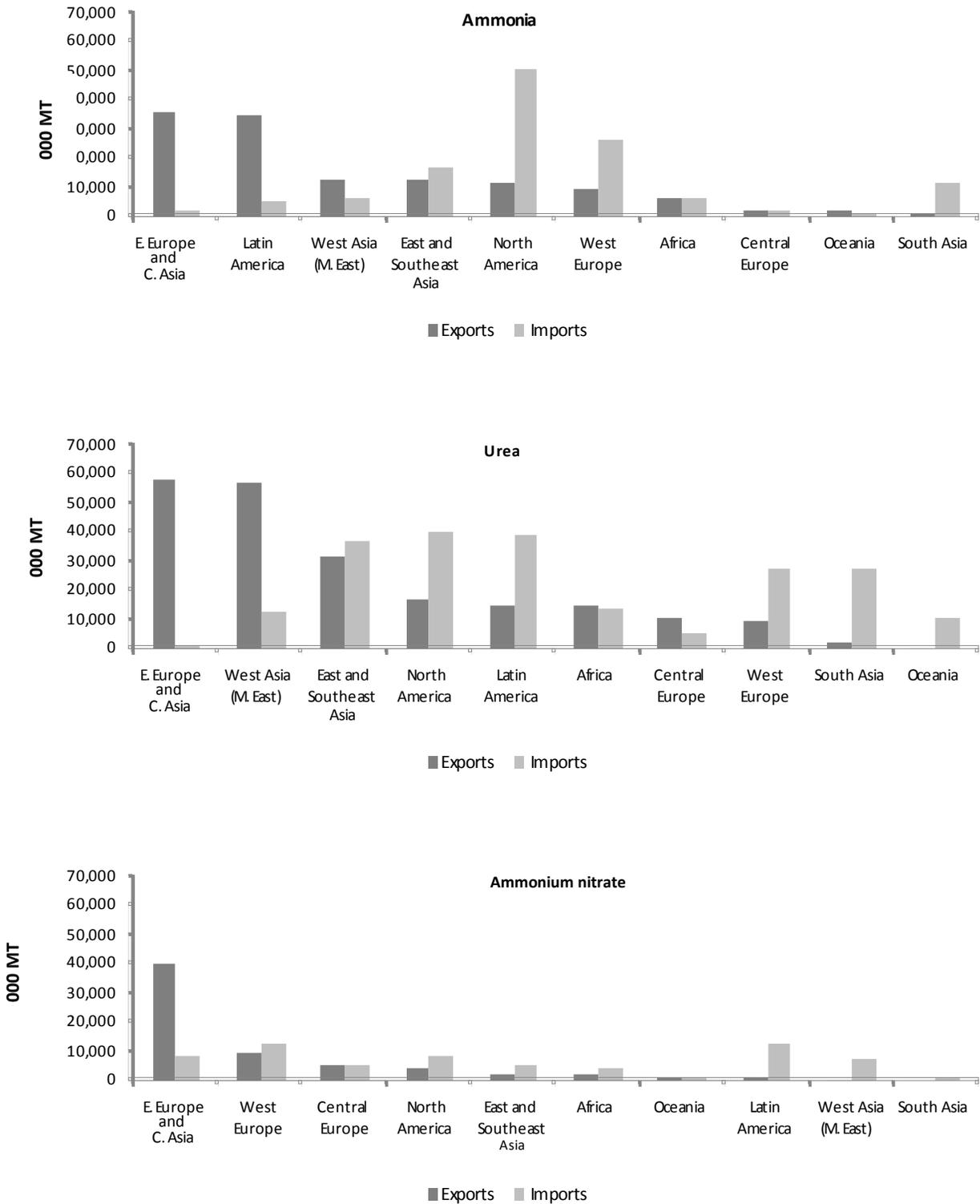
Notes: AN: ammonium nitrate; DAP/MAP: diammonium and mono-ammonium phosphate.

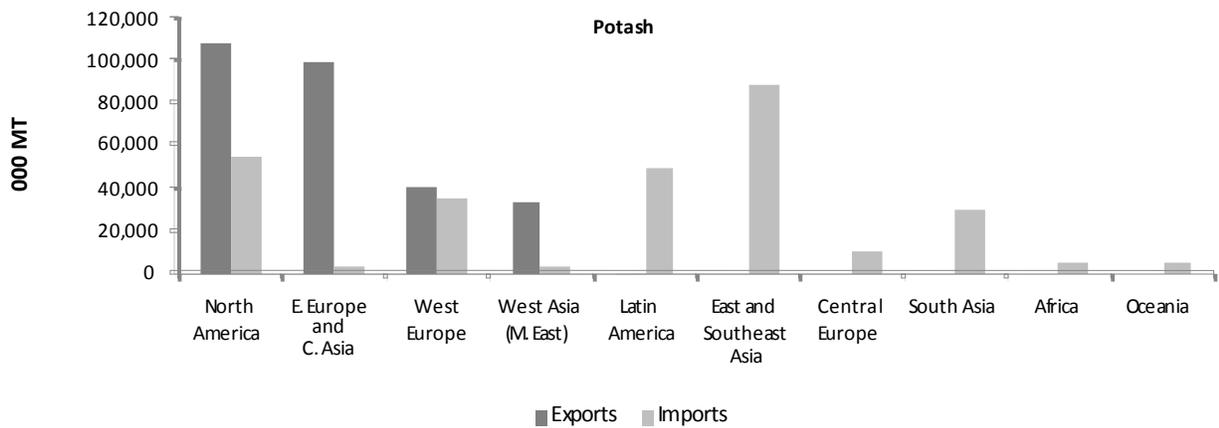
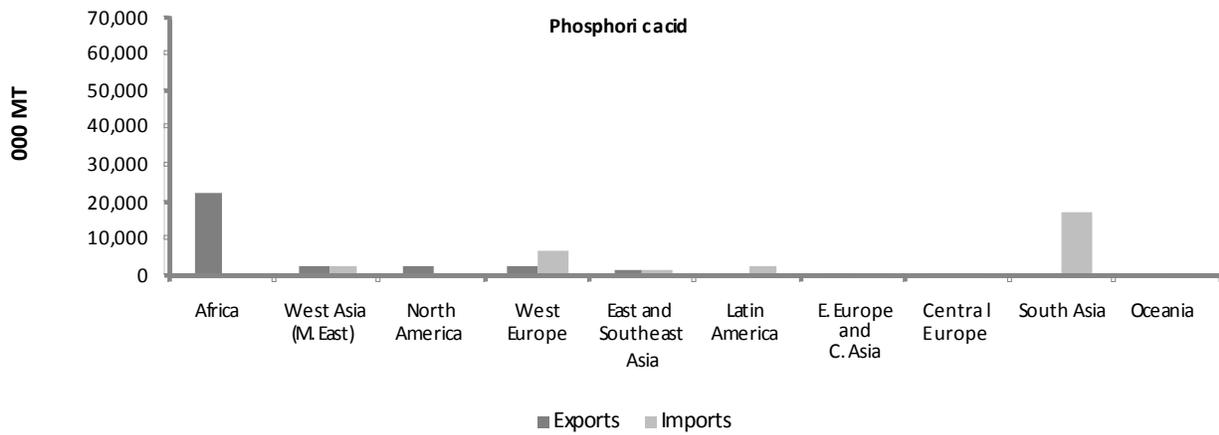
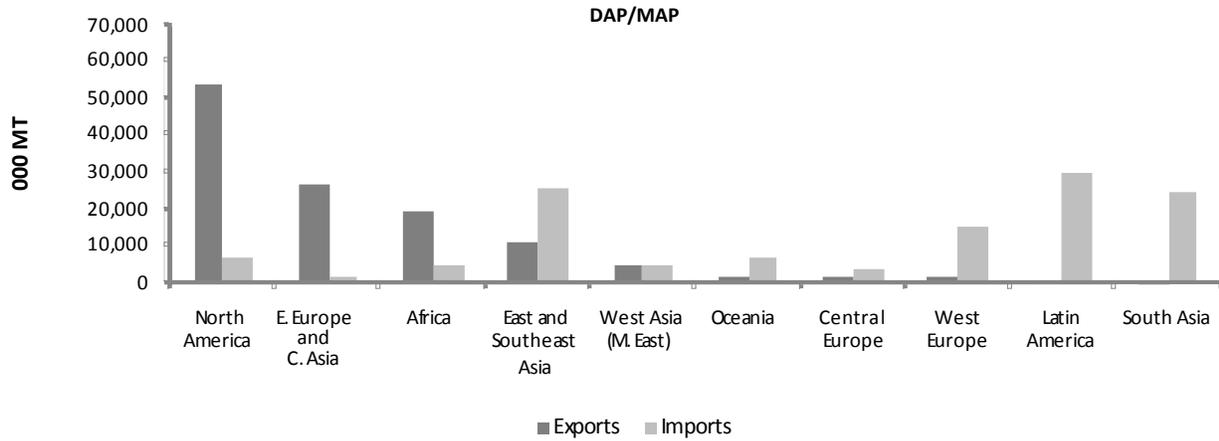
Figure A.2. Distribution of global fertilizer consumption by product and region, 2002–2008



Source: IFA online statistics.

Figure A.3. Fertilizer exports and imports by product and region, 2002–2008





Source: IFA online statistics.

Table A.1. Sources of information for the regression analysis

Source	Variables
Food and Agriculture Organization (FAO), Fertilizer Archives http://faostat.fao.org/	Prices, imports over consumption
Tennessee Valley Authority (TVA), 1970–1995; International Fertilizer and Development Center (IFDC), 1996 onward	Production capacity, number of plants, number of companies, HHI and top-4 index based on capacity and number of plants, by country and region
U.S. Department of Agriculture (USDA), Economic Research Service http://www.ers.usda.gov/Data/ExchangeRates/	Real exchange rate

Table A.2. Log of urea price regressions, using number of companies as the measure of market concentration

	Model 1						Model 2					
	OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM		OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM	
	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2
Log of price _{t-1}	-0.070 (0.092)	-0.069 (0.092)	0.907** (0.389)	0.889** (0.384)	0.754*** (0.064)	0.756*** (0.064)	-0.069 (0.092)	-0.068 (0.092)	0.901** (0.382)	0.891** (0.382)	0.749*** (0.064)	0.752*** (0.064)
Number of companies	-0.021 (0.016)	-0.001 (0.001)	0.084 (0.106)	-0.020 (0.027)	0.001 (0.004)	-0.004 (0.004)	-0.021 (0.142)	-0.001 (0.001)	0.090 (0.106)	-0.020 (0.026)	0.002 (0.004)	-0.003 (0.004)
If main producer	0.035 (0.084)	0.051 (0.087)	-0.064 (0.134)	0.123 (0.312)	0.062 (0.218)	0.042 (0.222)						
If among top-4 producers							0.012 (0.071)	0.006 (0.069)	-0.069 (0.116)	0.154 (0.276)	0.004 (0.181)	0.011 (0.190)
Share M/C	0.167* (0.085)	0.205* (0.108)	0.258** (0.104)	1.165 (1.198)	0.240** (0.105)	0.402* (0.210)	0.131 (0.087)	0.162 (0.110)	0.187** (0.094)	1.158 (1.247)	0.168 (0.119)	0.296 (0.244)
Main producer x share M/C	-0.097 (0.109)	-0.114 (0.114)	-0.085 (0.139)	-0.456 (0.531)	-0.194 (0.283)	-0.244 (0.298)						
Top-4 producers x share M/C							0.100 (0.142)	0.087 (0.143)	0.244 (0.190)	-0.217 (0.696)	0.173 (0.200)	0.174 (0.241)
Constant	0.144*** (0.054)	0.139*** (0.054)	-0.171 (0.166)	-0.320 (0.213)			0.140*** (0.053)	0.136*** (0.052)	-0.160 (0.166)	-0.316 (0.213)		
<i>Underidentification test:</i>												
Kleibergen-Paap rk LM statistic (Chi-sq P-val)			14.0 (0.00)	0.7 (0.41)					14.3 (0.00)	0.8 (0.39)		
<i>Weak identification test:</i>												
Kleibergen-Paap rk Wald F statistic			7.13	0.32					7.30	0.36		
<i>Arellano-Bond AR test:</i>												
AR(1) z statistic (Pr > z)					-2.5 (0.01)	-2.5 (0.01)					-2.5 (0.01)	-2.5 (0.01)
AR(2) z statistic (Pr > z)					-1.7 (0.08)	-1.7 (0.09)					-1.7 (0.08)	-1.7 (0.08)
<i>Test of overidentifying restrictions:</i>												
Hansen J statistic (Prob > chi-sq)					4.2 (1.00)	3.5 (1.00)					2.7 (1.00)	4.2 (1.00)
# observations	828	828	827	801	828	828	828	828	827	801	828	828

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. M = imports; C = consumption. Robust standard errors reported in parentheses. Meas. 1 corresponds to the weighted average of the measure of market concentration at the country and regional level; Meas. 2 is the measure of market concentration at either the country or regional level, depending on whether most of the urea consumed is from local production or imported. All regressions include regional and year fixed effects.

Table A.3. Log of urea price regressions, using top-4 concentration ratio based on production capacity as the measure of market concentration

	Model 1						Model 2					
	OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM		OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM	
	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2
Log of price _{t-1}	-0.075 (0.110)	-0.072 (0.110)	0.994** (0.452)	0.927* (0.514)	0.659*** (0.056)	0.666*** (0.063)	-0.074 (0.111)	-0.071 (0.110)	0.984** (0.441)	0.963** (0.487)	0.660*** (0.056)	0.665*** (0.063)
Top-4 concentration ratio	1.072* (0.583)	0.154 (0.104)	2.246 (4.447)	3.485 (5.340)	0.032 (1.537)	0.718 (0.442)	0.978* (0.583)	0.119 (0.095)	2.874 (4.665)	2.819 (3.652)	0.316 (1.497)	0.817* (0.446)
If main producer	0.033 (0.089)	0.055 (0.097)	-0.128 (0.136)	0.435 (0.903)	0.059 (0.215)	0.213 (0.233)						
If among top-4 producers							-0.031 (0.075)	0.006 (0.079)	-0.106 (0.099)	0.189 (0.381)	-0.094 (0.203)	-0.005 (0.208)
Share M/C	0.183* (0.105)	0.294** (0.149)	0.239** (0.121)	2.859 (4.013)	0.215* (0.120)	0.778** (0.355)	0.127 (0.106)	0.227 (0.147)	0.131 (0.102)	2.575 (3.177)	0.162 (0.138)	0.877** (0.415)
Main producer x share M/C	-0.118 (0.120)	-0.144 (0.130)	-0.124 (0.204)	-1.234 (1.858)	-0.229 (0.280)	-0.466 (0.318)						
Top-4 producers x share M/C							0.144 (0.177)	0.090 (0.176)	0.318 (0.254)	-1.219 (2.090)	0.091 (0.215)	-0.261 (0.322)
Constant	0.099** (0.050)	0.297*** (0.070)	-0.116 (0.092)	-0.142 (0.135)			0.086* (0.050)	0.296*** (0.070)	-0.127 (0.092)	-0.101 (0.116)		
<i>Underidentification test:</i>												
Kleibergen-Paap rk LM statistic (Chi-sq P-val)			5.3 (0.02)	0.6 (0.44)					4.9 (0.03)	1.0 (0.31)		
<i>Weak identification test:</i>												
Kleibergen-Paap rk Wald F statistic			2.62	0.28					2.41	0.48		
<i>Arellano-Bond AR test:</i>												
AR(1) z statistic (Pr > z)					-2.0 (0.05)	-2.1 (0.03)					-2.0 (0.05)	-2.1 (0.03)
AR(2) z statistic (Pr > z)					-1.6 (0.12)	-1.5 (0.13)					-1.5 (0.12)	-1.5 (0.13)
<i>Test of overidentifying restrictions:</i>												
Hansen J statistic (Prob > chi-sq)					0.0 (1.00)	0.0 (1.00)					0.0 (1.00)	0.0 (1.00)
# observations	694	694	685	669	694	694	694	694	685	669	694	694

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. M = imports; C = consumption. Robust standard errors reported in parentheses. Meas. 1 corresponds to the weighted average of the measure of market concentration at the country and regional level; Meas. 2 is the measure of market concentration at either the country or regional level, depending on whether most of the urea consumed is from local production or imported. All regressions include regional and year fixed effects.

Table A.4. Log of urea price regressions, using top-4 concentration ratio based on number of plants as the measure of market concentration

	Model 1						Model 2					
	OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM		OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM	
	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2
Log of price _{t-1}	-0.074 (0.110)	-0.073 (0.110)	0.994** (0.449)	0.940* (0.519)	0.656*** (0.059)	0.668*** (0.062)	-0.073 (0.111)	-0.073 (0.111)	0.989** (0.441)	0.953* (0.497)	0.656*** (0.059)	0.661*** (0.063)
Top-4 concentration ratio	0.200 (0.771)	0.187 (0.119)	5.567 (11.436)	3.742 (5.919)	-1.013 (2.502)	0.976** (0.478)	0.167 (0.788)	0.162 (0.106)	5.596 (11.187)	3.329 (4.900)	-0.858 (2.431)	1.155** (0.483)
If main producer	0.033 (0.089)	0.063 (0.099)	-0.105 (0.140)	0.427 (0.918)	0.020 (0.219)	0.266 (0.243)						
If among top-4 producers							-0.036 (0.071)	-0.026 (0.069)	-0.083 (0.128)	0.140 (0.297)	-0.066 (0.217)	-0.031 (0.222)
Share M/C	0.192* (0.110)	0.330** (0.147)	0.271* (0.140)	3.052 (4.408)	0.209* (0.123)	0.990*** (0.383)	0.140 (0.117)	0.280* (0.143)	0.162 (0.128)	3.030 (4.266)	0.162 (0.148)	1.214*** (0.458)
Main producer x share M/C	-0.101 (0.120)	-0.160 (0.130)	-0.134 (0.216)	-1.329 (2.023)	-0.199 (0.279)	-0.554* (0.331)						
Top-4 producers x share M/C							0.133 (0.206)	0.038 (0.195)	0.304 (0.303)	-1.529 (2.908)	0.087 (0.238)	-0.498 (0.371)
Constant	0.267*** (0.068)	0.279*** (0.070)	-0.133 (0.095)	-0.124 (0.139)			0.267*** (0.068)	0.278*** (0.070)	-0.133 (0.094)	-0.099 (0.141)		
<i>Underidentification test:</i>												
Kleibergen-Paap rk LM statistic (Chi-sq P-val)			3.3 (0.07)	0.6 (0.45)					3.6 (0.06)	0.8 (0.39)		
<i>Weak identification test:</i>												
Kleibergen-Paap rk Wald F statistic			1.55	0.27					1.65	0.35		
<i>Arellano-Bond AR test:</i>												
AR(1) z statistic (Pr > z)					-2.0 (0.05)	-2.1 (0.03)					-2.0 (0.04)	-2.1 (0.04)
AR(2) z statistic (Pr > z)					-1.6 (0.12)	-1.6 (0.12)					-1.5 (0.13)	-1.5 (0.12)
<i>Test of overidentifying restrictions:</i>												
Hansen J statistic (Prob > chi-sq)					0.0 (1.00)	0.0 (1.00)					0.0 (1.00)	0.0 (1.00)
# observations	680	680	671	655	680	680	680	680	671	655	680	680

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. M = imports; C = consumption. Robust standard errors reported in parentheses. Meas. 1 corresponds to the weighted average of the measure of market concentration at the country and regional level; Meas. 2 is the measure of market concentration at either the country or regional level, depending on whether most of the urea consumed is from local production or imported. All regressions include regional and year fixed effects.

Table A.5. Log of urea price regressions, using HHI based on production capacity as the measure of market concentration

	Model 1						Model 2					
	OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM		OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM	
	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2
Log of price _{t-1}	-0.081 (0.109)	-0.075 (0.110)	1.106** (0.485)	1.063** (0.542)	0.743*** (0.065)	0.763*** (0.061)	-0.080 (0.109)	-0.075 (0.110)	1.093** (0.474)	1.108** (0.535)	0.745*** (0.065)	0.761*** (0.061)
HHI	1.840* (1.105)	0.151 (0.153)	4.812 (8.052)	3.490 (6.455)	0.979 (0.950)	0.672 (0.444)	1.816* (1.099)	0.118 (0.152)	4.499 (8.048)	2.871 (4.839)	1.058 (0.943)	0.558 (0.466)
If main producer	0.056 (0.097)	0.068 (0.097)	-0.144 (0.153)	0.610 (1.391)	-0.023 (0.224)	0.190 (0.251)						
If among top-4 producers							-0.017 (0.078)	0.005 (0.075)	-0.028 (0.135)	0.212 (0.532)	-0.149 (0.212)	-0.041 (0.224)
Share M/C	0.189* (0.105)	0.315** (0.146)	0.260** (0.130)	3.115 (5.284)	0.264** (0.126)	0.840** (0.389)	0.145 (0.109)	0.238 (0.145)	0.159 (0.116)	2.697 (4.313)	0.201 (0.146)	0.690 (0.445)
Main producer x share M/C	-0.065 (0.124)	-0.169 (0.128)	-0.095 (0.179)	-1.692 (3.016)	-0.115 (0.291)	-0.476 (0.355)						
Top-4 producers x share M/C							0.126 -0.174	0.109 (0.184)	0.310 (0.254)	-0.931 (2.265)	0.166 (0.235)	0.023 (0.306)
Constant	0.121** (0.050)	0.122** (0.057)	-0.367 (0.267)	-0.203 (0.381)			0.292*** -0.068	0.111** (0.056)	-0.371 (0.267)	-0.198 (0.378)		
<i>Underidentification test:</i>												
Kleibergen-Paap rk LM statistic (Chi-sq P-val)			6.3 (0.01)	0.5 (0.47)					6.3 (0.01)	0.8 (0.36)		
<i>Weak identification test:</i>												
Kleibergen-Paap rk Wald F statistic			2.98	0.25					2.99	0.39		
<i>Arellano-Bond AR test:</i>												
AR(1) z statistic (Pr > z)					-1.8 (0.07)	-2.1 (0.03)					-1.8 (0.07)	-2.1 (0.03)
AR(2) z statistic (Pr > z)					-1.6 (0.10)	-1.7 (0.09)					-1.6 (0.11)	-1.6 (0.10)
<i>Test of overidentifying restrictions:</i>												
Hansen J statistic (Prob > chi-sq)					0.0 (1.00)	0.0 (1.00)					0.0 (1.00)	0.0 (1.00)
# observations	703	703	695	680	703	703	703	703	695	680	703	703

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. M = imports; C = consumption. Robust standard errors reported in parentheses. Meas. 1 corresponds to the weighted average of the measure of market concentration at the country and regional level; Meas. 2 is the measure of market concentration at either the country or regional level, depending on whether most of the urea consumed is from local production or imported. All regressions include regional and year fixed effects.

Table A.6. Log of urea price regressions, using HHI based on number of plants as the measure of market concentration

	Model 1						Model 2					
	OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM		OLS in differences		Anderson-Hsiao 2SLS		Arellano-Bond difference GMM	
	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2	Meas. 1	Meas. 2
Log of price _{t-1}	-0.079 (0.109)	-0.074 (0.110)	1.134** (0.521)	1.082* (0.565)	0.752*** (0.060)	0.782*** (0.062)	-0.078 (0.109)	-0.074 (0.110)	1.120** (0.510)	1.122** (0.544)	0.752*** (0.060)	0.782*** (0.062)
HHI	1.606** (0.667)	0.135 (0.148)	4.198 (6.141)	3.569 (6.726)	1.642* (0.896)	0.998** (0.446)	1.580** (0.659)	0.104 (0.147)	3.897 (6.036)	2.864 (4.829)	1.654* (0.877)	0.921** (0.459)
If main producer	0.057 (0.093)	0.058 (0.094)	-0.131 (0.145)	0.581 (1.378)	0.021 (0.226)	0.257 (0.252)						
If among top-4 producers							-0.025 (0.076)	0.000 (0.076)	-0.065 (0.098)	0.154 (0.449)	-0.141 (0.211)	-0.017 (0.224)
Share M / C	0.184* (0.101)	0.294** (0.126)	0.242* (0.126)	3.077 (5.337)	0.253** (0.123)	1.065*** (0.380)	0.137 (0.103)	0.219* (0.122)	0.140 (0.109)	2.581 (4.143)	0.191 (0.142)	0.966** (0.422)
Main producer x share M/C	-0.073 (0.120)	-0.153 (0.121)	-0.102 (0.183)	-1.648 (3.008)	-0.123 (0.289)	-0.581 (0.356)						
Top-4 producers x share M/C							0.139 (0.172)	0.125 (0.179)	0.325 (0.257)	-0.819 (2.125)	0.161 (0.232)	-0.081 (0.297)
Constant	0.114** (0.051)	0.123** (0.057)	-0.349 (0.250)	-0.193 (0.398)			0.102** (0.052)	0.110** (0.054)	-0.355 (0.250)	-0.195 (0.382)		
<i>Underidentification test:</i>												
Kleibergen-Paap rk LM statistic (Chi-sq P-val)			7.0 (0.01)	0.5 (0.49)					7.1 (0.01)	0.8 (0.38)		
<i>Weak identification test:</i>												
Kleibergen-Paap rk Wald F statistic			3.34	0.22					3.40	0.37		
<i>Arellano-Bond AR test:</i>												
AR(1) z statistic (Pr>z)					-1.9 (0.06)	-2.1 (0.03)					-1.9 (0.05)	-2.1 (0.03)
AR(2) z statistic (Pr>z)					-1.7 (0.10)	-1.7 (0.09)					-1.6 (0.10)	-1.7 (0.09)
<i>Test of overidentifying restrictions:</i>												
Hansen J statistic (Prob > chi-sq)					0.0 (1.00)	0.0 (1.00)					0.0 (1.00)	0.0 (1.00)
# observations	715	715	707	692	715	715	715	715	707	692	715	715

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. M = imports; C = consumption. Robust standard errors reported in parentheses. Meas. 1 corresponds to the weighted average of the measure of market concentration at the country and regional level; Meas. 2 is the measure of market concentration at either the country or regional level, depending on whether most of the urea consumed is from local production or imported. All regressions include regional and year fixed effects.