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Agriculture Practice

The 2040 fertilizer industry: How could industry trends affect demand?

Historically, the fertilizer market has experienced slow and steady growth; however, demand shifts could change the picture by 2040.

This article is a collaborative effort by Madison Pearsall, Owen Stockdale, and Tom Brennan, with Julia Kalanik and Victor Guzik, representing views from McKinsey's Agriculture Practice.

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The global fertilizer industry could face some big changes ahead. Historically, volumes have grown steadily over the past decade at about 1 percent per annum, with the commodity fertilizer market reaching $145 billion as of 2023.[1] However, by 2040, several interconnected shifts across the agricultural sector could disrupt this slow and steady growth.

In a business-as-usual scenario, we anticipate demand to grow at approximately 2.1 percent per annum through 2027 to account for the growing global population and increased caloric needs, with capacity growing at about 2.5 percent per annum. However, "business as usual" may not be how things shake out. In the future, new factors such as technology, climate change, changing consumer preferences, and more could cause meaningful demand shifts.

In this article, we highlight a number of different drivers that could potentially impact demand in the next 15 years, comparing them to projected business-as-usual volumes. The impacts laid out in this analysis are not additive across drivers. Each scenario looks at one driver in isolation: actual 2040 volumes will take into account drivers outside the scope of this analysis as well as second order effects, including changing farmer economics. Understanding these different trends and their potential effects can help stakeholders in the fertilizer industry ask strategic questions to prepare for what's ahead.

Potential drivers of demand swings

Historically, volume growth in the fertilizer market has been propelled by steadily increasing global application rates to support expanding crop production (see sidebar, "The fertilizer industry today"). The main reason for this steady growth is that farmers' purchasing behaviors have been relatively inelastic, except during periods of significant price spikes (plus or minus 50 percent). This is because farmers view fertilizers as table stakes to achieve high yields, with farmers in the United States, the European Union, and Brazil spending as much as 25 to 40 percent of their annual budgets on fertilizers—more than any other input.[2]

Steady underlying drivers of population growth and improving calories per capita are expected to continue fueling future growth. However, we have identified several potential disruptors that could cause sizable swings to projected 2040 volume

[1] Based on McKinsey analysis of data from the International Fertilizer Association and World Bank.
[2] Based on McKinsey analysis of data from the USDA Economic Research Service and the European Commission's Farm Accountancy Data Network.

The fertilizer industry today

Fertilizers provide essential nutrients required for crop growth.[1] Fertilizers come in two main types: commodity fertilizers and specialty fertilizers.

The commodity fertilizer market (representing about $145 billion globally) includes products such as urea, diammonium phosphate, and potassium chloride that provide crops with three key nutrients: nitrogen (N), phosphorus (P), and potassium (K). Each nutrient is critical for multiple biological functions in crops and is required in varying concentrations depending on the crop type and expected yield. Nitrogen is critical for protein synthesis and chlorophyll production, phosphorus aids energy transfer systems, and potassium is needed for water retention and enzyme functionality.

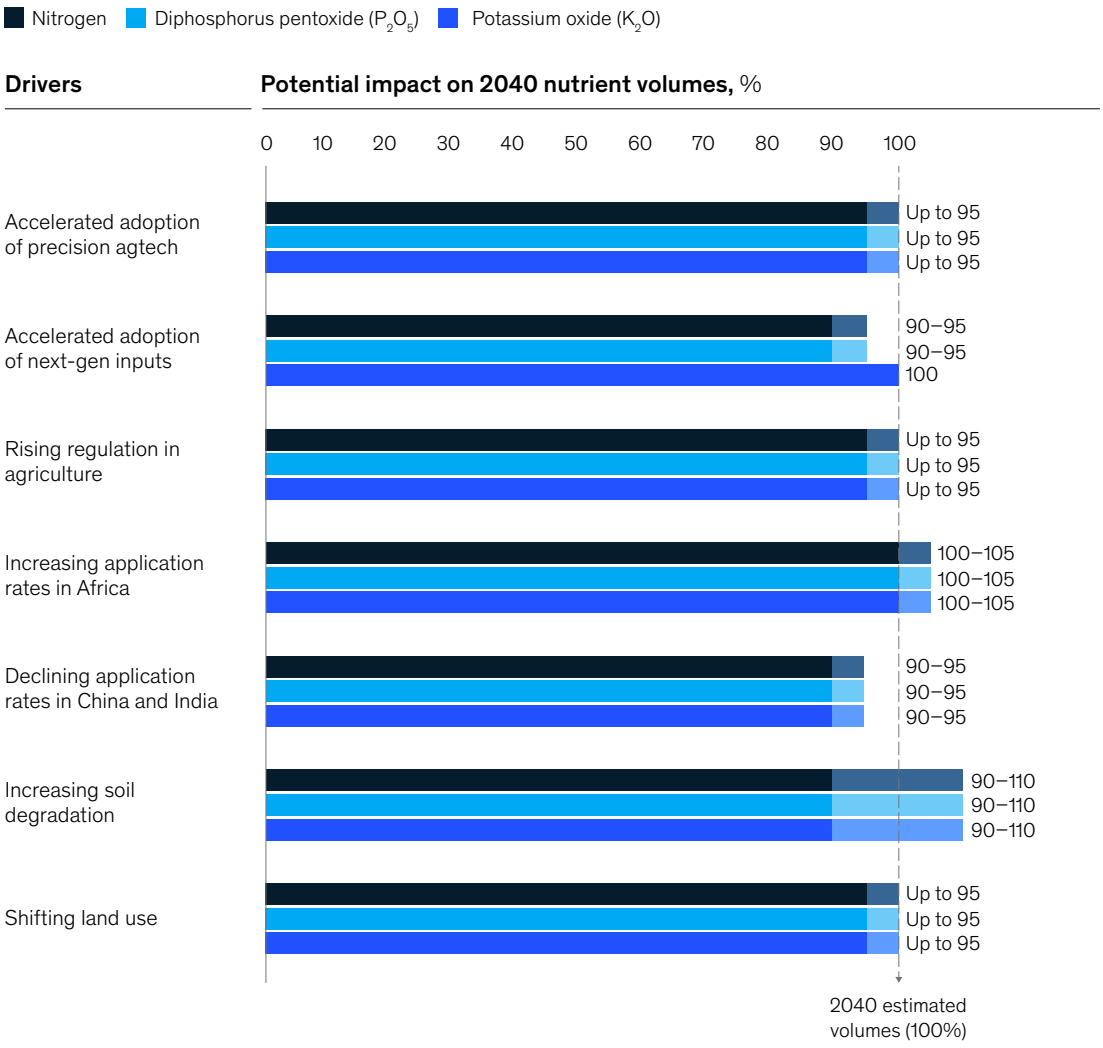
Specialty fertilizers include slow- and controlled-release coatings, chelated and non-chelated micronutrients, and various biostimulants. These products deliver the same N, P, and K nutrients to crops as commodities, but they do so with higher efficiency. Today, the specialty fertilizer market represents about $25 billion.

Leading players in the industry have built their market positions by securing affordable feedstocks—such as ammonia from low-cost natural gas (for N) and high-quality mined ore deposits (for P and K)—to make production more cost-effective.

[1] *Global fertilizer markets and policies: A joint FAO/WTO mapping exercise*, The Food and Agriculture Organization of the United Nations and the World Trade Organization, November 15, 2022.

Exhibit 1

Seven demand drivers have the potential to affect 2040 global volumes.



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demand under business-as-usual projections (exhibit). While in reality these drivers will not materialize in isolation, we analyze them one by one to size the relative impact of each.

Accelerated adoption of precision agtech: Up to a 5 percent decrease in 2040 volumes

Precision agriculture uses data analytics (including machine learning and AI), geospatial data, and various sensors to optimize the application of fertilizers, ensuring crops receive the exact nutrients they need, when they need them, and where they need them. Precision agriculture techniques include on-field soil sensors, variable-rate fertilizer and pesticide application, and sprayer section controls. Today, 20 to 30 percent of farmers globally have adopted precision agriculture hardware, and an additional 5 percent of farmers anticipate adopting it in the next two years.[3] This technology has the potential to reduce overall fertilizer volumes by up to 5 percent, driving increased application efficiency without compromising on yields and reducing input costs for farmers.

[3] McKinsey Global Farmer Survey 2024.

Next-gen inputs, particularly biological alternatives such as biostimulants, have the potential to offset commodity fertilizer usage.

Accelerated adoption of next-gen inputs: A 5 to 10 percent decrease in 2040 volumes

Next-gen inputs, particularly biological alternatives such as biostimulants, have the potential to offset commodity fertilizer usage. Biostimulants include products such as nitrogen-fixing biologicals, beneficial bacteria and fungi, organic acids (for example, humic and fulvic acid), protein hydrolystates (for example, amino acids), and seaweed extracts and botanicals. Biostimulants have the potential to increase the availability of nutrients to crops, with the aspiration of higher yields and lower environmental costs. They also can play a role in reducing emissions, particularly compared to nitrogen fertilizers, given that they do not require ammonia production in their manufacturing and have lower on-farm emissions profiles. Today, many farmers are trialing biostimulants in combination with their traditional-fertilizer protocol. Approximately 20 percent of farmers globally have already adopted biostimulants, and an additional 6 percent anticipate adopting them in the next two years.[4] In the United States, nitrogen-fixing biologicals are the most commonly adopted of all biostimulant products[5] because these products are designed to directly offset synthetic N fertilizer needs. As adoption of these products continues to rise and their impact is proved, there is a potential to reduce 2040 volumes by 5 to 10 percent if farmers offset their commodity fertilizer needs with biologicals.

Rising regulation in agriculture: Up to a 5 percent decrease in 2040 volumes

Agriculture contributes approximately 15 percent to global emissions, with N fertilizers alone accounting for approximately 3 percent of this total due to manufacturing and on-farm emissions.[6] Around the world, organizations in the public and private sectors are increasingly focusing on environmental sustainability and the reduction of greenhouse gas emissions. For example, the EU Green Deal sets targets for reducing fertilizer use and increasing organic farmland, although McKinsey analysis suggests progress toward these targets is lagging behind. Industry players, particularly consumer packaged goods (CPG) companies, are setting Scope 3 emission targets to make their supply chains more sustainable. This includes increased attention on the volume and types of fertilizer applied, as well as greater emphasis on regenerative agriculture practices. Such commitments from CPG companies can have cascading effects down to the farmer level, even without government regulation. Enhanced regulations aimed at decarbonizing agriculture could reduce fertilizer volumes by up to 5 percent.

Increasing application rates in Africa: Up to a 5 percent increase in 2040 volumes

As farmers in Africa gain better access to fertilizers and other agricultural inputs—through both increased farmer profitability and improving

[4] Ibid.
[5] "Year #2: Tracking grower perceptions of biostimulant products in North America," Stratus Ag Research, 2023.
[6] "The net-zero transition: What it would cost, what it could bring," McKinsey Global Institute, January 2022.

global supply chains—there is an opportunity for application rates in Africa to grow toward global averages. Today, the average combined application rate across N, P, and K nutrients in Africa (Morocco and South Africa) is about 120 kilograms (kg) per hectare, compared with about 135 kg per hectare globally. If farmers in Africa were to apply fertilizer more in line with the global application rate, which is still lower than that of Brazil, the European Union, or the United States, this would increase global fertilizer volumes by up to 5 percent in 2040.

Declining application rates in China and India: A 5 to 10 percent decrease in 2040 volumes

China and India have historically applied more fertilizers than the rest of the world. This is due to a number of factors, including the larger share of small shareholder farmers, who tend to overapply fertilizers due to lack of other inputs, such as high-tech machinery; a need to feed a growing domestic population; and subsidies for fertilizer use. For example, nitrogen-use efficiency in China is about 40 percentage points less than in the United States,[7] and excess phosphorus use is about 21 percent in India and 30 percent in China, compared with only about 6 percent in the United States.[8] As a result, China's and India's application rates are about 30 kg per hectare higher for N and P and about ten kg per hectare higher for K than the world average. China, in particular, has made strides to reduce overuse of fertilizers with the 2015 Five Year Plan, successfully reducing fertilizer consumption about 12 percent by 2020.[9] If China and India moved to reduce application rates to be more in line with global averages, it could lead to a reduction in fertilizer volumes by 5 to 10 percent.

Increasing soil degradation: A change in 2040 volumes ranging from a 10 percent decrease to a 10 percent increase

Soil degradation caused by aridity, salinization, erosion, and increasing organic carbon levels could disrupt the efficiency with which nutrients are delivered to crops within the soil matrix and put downward pressure on crop yields. This could affect fertilizer use in varying ways. To offset declining soil health, farmers may need to apply more nutrients to uphold yields, increasing the demand for fertilizers by more than 10 percent. However, increasing soil degradation could have the opposite effect, reducing the overall yield potential of soils such that applying more nutrients alone will not be able to offset other degradation factors. If so, soil degradation could actually result in a decrease in 2040 volumes of more than 10 percent because applying additional fertilizer with no yield benefits would be unprofitable for farmers.

Shifting land use: Up to a 5 percent decrease in 2040 volumes

As global demand for food, livestock, and fuel grows and as rising global temperatures shift global weather patterns, land use is expected to shift, causing a projected decline in overall fertilizer volumes. Major drivers include a decline in overall yield potential, which most often cannot be overcome with higher application rates. It is possible that diets could shift away from animal proteins, resulting in lower animal feed requirements, and increasing demand for biofuels could create higher demand for bioenergy crops.[10]

Potential drivers of supply swings

While the focus of this analysis is on demand disruptions, markets will undoubtedly be further shaped by a number of critical supply side drivers. In particular, we anticipate seeing the following: increased raw material volatility; shifting global supply chains, especially as blue and green ammonia[11] production rises; increased sustainability pressures on manufacturers; shifting geopolitics affecting global trade; and an increased push toward self-sufficiency in some regions, especially Brazil, China, and India. These trends will all increase global competition, putting increased importance on each participant's position on the cost curve to protect margins.

[7] "Nitrogen use efficiency, 2014," Our World in Data, 2014.
[8] "Share of global excess phosphorus from croplands," Our World in Data, 2014.
[9] "China's agricultural policy digest: Edition #3," AGRA, November 22, 2022.
[10] To learn more about McKinsey's perspective on the land use transition, see "Striking the balance: Catalyzing a sustainable land-use transition," McKinsey, November 7, 2023.
[11] Blue ammonia is made through conventional production means combined with carbon capture to lower emissions. Green ammonia is produced through water electrolysis and can theoretically be emissions-free when combined with renewable energy sources.

Strategic considerations for industry players

Because these trends have potential to cause sizable swings in demand, leaders in crop nutrition should consider some questions to best position their businesses in a changing world:

- How do players continue to protect their position on the cost curve, especially players on the right of the cost curve? How could potential demand shortfalls affect plans to build incremental capacity?
- How do players innovate their product and service portfolios to lock in volumes in a competitive environment (for example, expanding into specialty fertilizers or partnering with precision agriculture players to offer agronomic services)?
- How do players enhance their go-to-market strategy with data and analytics to be hypertargeted in markets where growth is anticipated (for example, Africa)?
- How do players invest in sustainability to protect profits in a regulation- and sustainability-conscious future? How will soil health play into the future environmental landscape?
- How do players optimize procurement in a world of changing inputs (for example, blue and green ammonia) and shifting geopolitics?

Madison Pearsall is a partner in McKinsey's Chicago office, where **Julia Kalanik** is a consultant; **Owen Stockdale** is a senior partner in the Minneapolis office; **Tom Brennan** is a partner in the Philadelphia office; and **Victor Guzik** is a consultant in the Boston office.