Chapter 4.4

Nutrient Management

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Since the early 1990s, U.S. commercial fertilizer use, application rates, and management practices have tended to change modestly from year to year, while fertilizer prices have exhibited more variability.

Introduction

The major plant nutrients (nitrogen, phosphorus, and potassium) are critical for maintaining crop yields but have also been associated with the impairment of numerous streams, lakes, and aquifers. For most U.S. crops and in most regions, commercial fertilizer is the major source of plant nutrients, although organic sources—such as legumes, crop residue, and animal wastes—can also provide nutrients required for plant growth. Commercial fertilizer is a major agricultural input; farmers typically spend over $10 billion annually on commercial fertilizer, although fertilizer use and prices vary from year to year. Historically, crop producers have used large amounts of commercial fertilizer and organic nutrients, but the concern over runoff and leaching has prompted the promotion of nutrient management practices that minimize nutrient loss.

The share of acres receiving fertilizer, application rates for primary nutrients (nitrogen, phosphate, and potash), and nutrient management practices on major field crops (corn, soybeans, wheat, and cotton) remained fairly stable over the 1990s. However, fertilizer prices, especially for nitrogen, have been volatile and have risen rapidly in recent years. Despite increased fertilizer prices and growing concern about environmental risks from fertilizer use, the use of nutrient management practices on major crops has changed little since the early 1990s.

Fertilizer Use Nationally and by Region

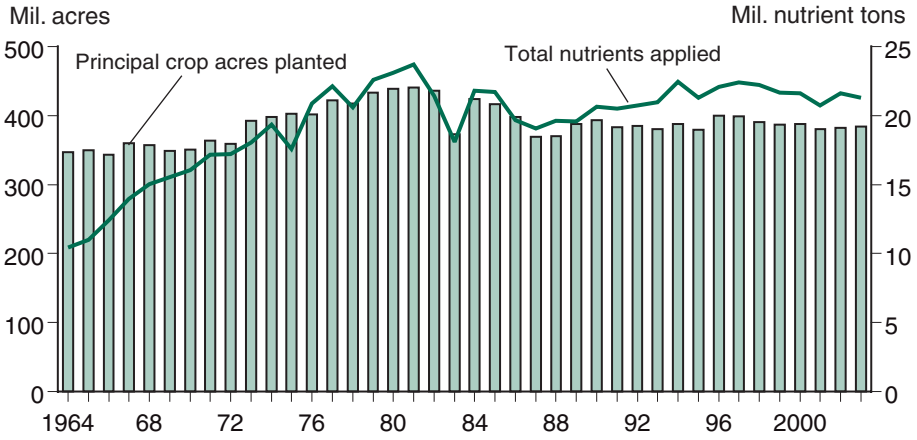
U.S. commercial fertilizer use peaked in 1981 at over 23 million nutrient tons, but has exceeded 22 million tons seldom since then (fig. 4.4.1). The decline in (principal crop) planted acreage since 1998 likely accounts for part of the falloff in fertilizer since then. The mix of crops planted each year also influences aggregate fertilizer use. Corn and wheat acreage, which consumes the most fertilizer among all crops, has dropped since 1998, and fertilizer use on soybeans has only partially offset the falloff.

Consumption of individual nutrients has been variable over the last several years, although annual use through 2003 is below levels reported in the late 1990s (fig. 4.4.2). For example, nitrogen use dropped noticeably in 2001 and remained below 12.5 million tons from 2000 through 2003. Annual phosphate and potash use has demonstrated similar variability over the last several years. The regional distribution of fertilizer use has remained stable,

Contents

Figure 4.4.1

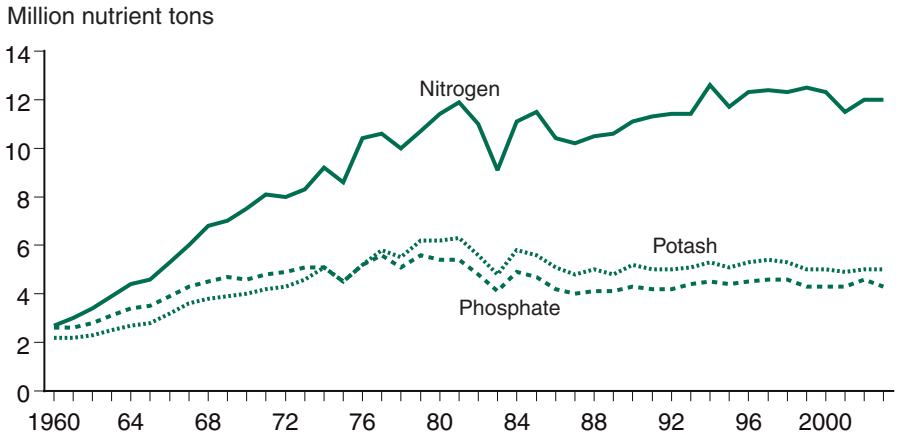
Principal crop acres planted and total nutrient use, 1964-2003



Source: USDA, Economic Research Service.

Figure 4.4.2

Consumption of primary plant nutrients, 1960-2003



Source: USDA, Economic Research Service.

with the Corn Belt, Northern Plains, and Lake States the leading regions because of high concentrations of corn, wheat, and soybean acreage (fig. 4.4.3).

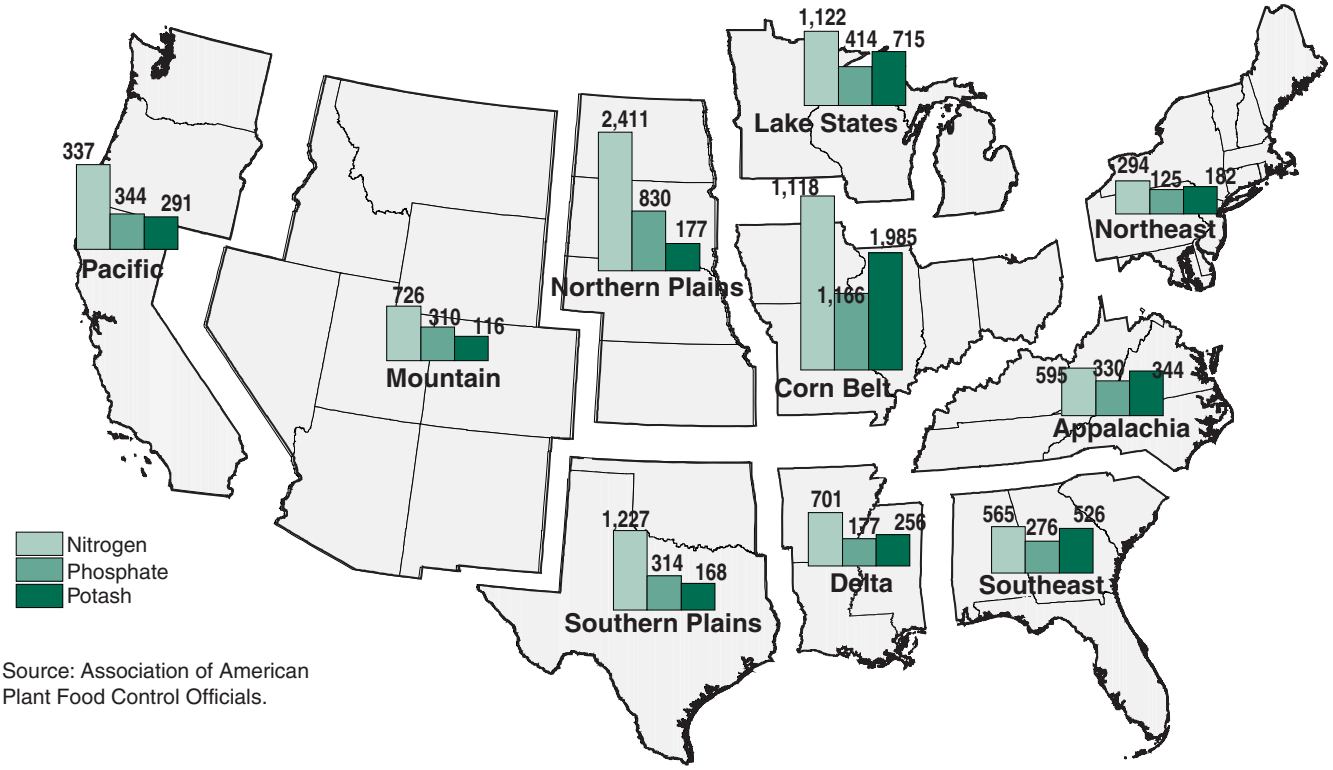
Fertilizer Use by Major Crops

The four major U.S. crops—corn, wheat, soybeans, and cotton—currently account for about 60 percent of principal crop acreage and receive over 60 percent of all nitrogen, phosphate, and potash used in the United States. Corn typically accounts for over 40 percent of all commercial fertilizer consumed, followed by wheat (about 10 percent), soybeans (about 5 percent), and cotton (5 percent). However, these shares vary from year to year (and by nutrient) due to the mix of crops planted, share of acreage treated, and application rates.

The share of acreage treated and application rates were fairly stable over 1990-2003, although cotton exhibited greater variability (table 4.4.1). For example, 97-98 percent of corn acres received nitrogen fertilizer in most

Figure 4.4.3

Fertilizer consumption by farm production region, year ending June 30, 2003



Source: Association of American Plant Food Control Officials.

years (excluding the high and low years), while phosphate was applied to 79-84 percent of the acres. Similarly, for most crop/nutrient combinations, the amount of nutrients applied each year varied 5 pounds or less. This relative consistency in production practices stems from modest changes in factors like the ratio of prices received to fertilizer prices paid by farmers, agronomic relationships, seed traits, public policies, and producer education.

While nutrient use, in general, has been stable since 1990, modest trends for some crop/nutrient combinations are apparent. For example, the share of corn acres treated with phosphate and potash declined slightly, while the share of cotton acres treated with potash rose along with application rates. The share of wheat acres treated with nitrogen likewise rose, as did application rates; these increases may have been due to the decline of wheat acreage in several arid States in the Mountain and Plains regions. Also, a significant price increase for fertilizer, especially nitrogen, in 2001 and 2003 likely dampened nutrient use during those years.

Fertilizer application rates vary widely by crop and nutrient, and are influenced by yield response, climate, and fertilizer/commodity prices (fig. 4.4.4). Among the major field crops, annual application rates for all nutrients are typically highest for corn, but rates vary widely for other crops and nutrients. Certain specialty crops, like fall potatoes and rice, consume more fertilizer per acre than the major crops, but are planted on far fewer acres.

Table 4.4.1

Share of acres treated and application rates, 1990-2003, by major crop and nutrient[1]

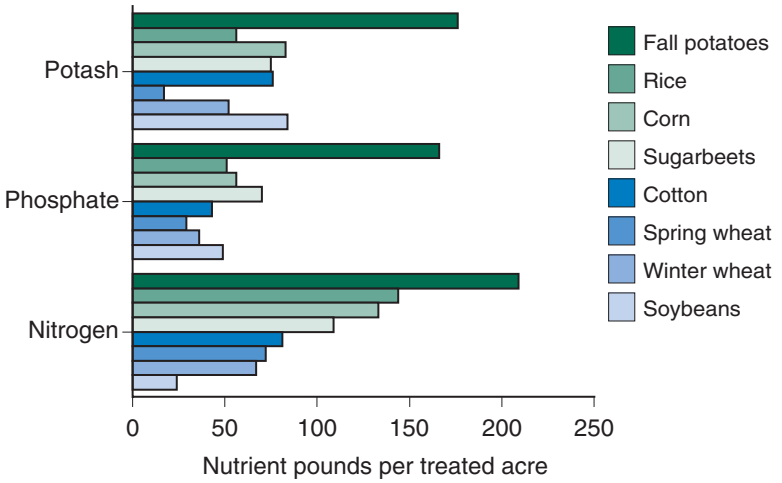
	Nitrogen	Phosphate	Potash
Corn			
Share of acres treated (%)	97-98	79-84	65-73
Application rates (lbs/treated acre)	127-136	56-59	80-84
Cotton			
Share of acres treated (%)	79-86	49-66	34-53
Application rates (lbs/treated acre)	84-100	44-49	48-76
Soybean			
Share of acres treated (%)	13-18	21-26	25-29
Application rates (lbs/treated acre)	22-25	47-50	76-88
Wheat			
Share of acres treated (%)	80-88	54-63	18-20
Application rates (lbs/treated acre)	63-68	32-35	37-41

[1]Excludes values for high and low years which may have been influenced by such factors as number of States surveyed, weather, commodity and/or fertilizer prices, etc.

Source: ERS from NASS data on Agricultural Chemical Usage

Figure 4.4.4

Average application rates of commercial fertilizers, by selected crops, 2001[1]



[1]Data for wheat, rice and sugarbeets are for 2000.

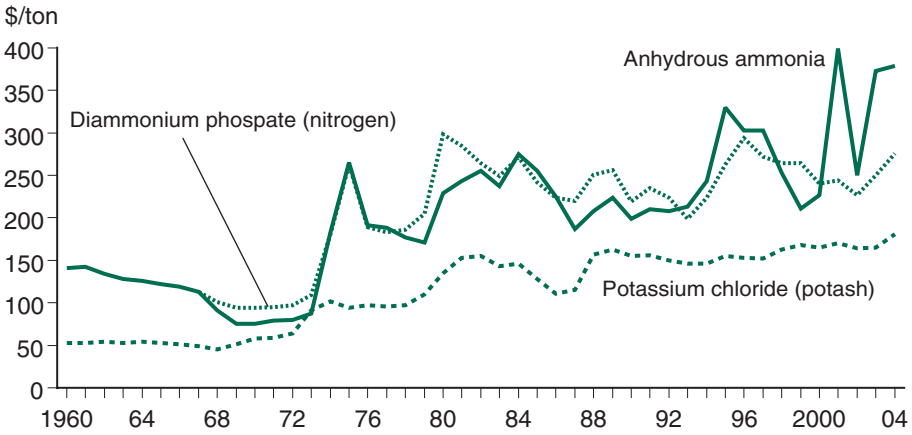
Source: USDA, Economic Research Service.

Prices of Major Fertilizer Products

Since 1990, the primary fertilizer products purchased by farmers have exhibited much different nominal price patterns (fig. 4.4.5). Potash prices, in the form of potassium chloride (KCl), have been stable. A major source of phosphate, diammonium phosphate (DAP), has demonstrated much more price variability—peaking in 1995 at near-record levels, declining steadily through 2002, then rising again in 2003 and 2004. Nitrogen product prices, such as those for anhydrous ammonia, have shown the greatest volatility during the last several years—a spike in 1995, a fall to historically low levels by 1999 and 2000, record-high prices in 2001, followed by a large

Figure 4.4.5

Farm prices for anhydrous ammonia, DAP, and KCl, 1960-2004



Source: USDA, Economic Research Service.

decline in 2002 and recovery in 2003. Fertilizer markets are influenced by trade, raw material prices, and planted acres. Potash is largely an imported product, whereas the United States exports large amounts of phosphate; both of these markets are influenced by international demand and supply factors. Natural gas is the primary raw material for nitrogen fertilizers, comprising 75 percent or more of their cost of production. During 2001 and 2003, nitrogen fertilizer prices rose dramatically in concert with natural gas prices. In response to higher prices in the United States, nitrogen-based fertilizer imports have increased significantly in recent years.

While most economic studies indicate that farmer response to fertilizer price changes is fairly inelastic (i.e., relatively unresponsive to price changes), farmers can make some adjustments in fertilizer use when faced with dramatically higher prices. Shifting to a crop that needs less fertilizer, reducing application rates, and adopting improved nutrient management practices are all options. When the 2001 ARMS asked corn producers how they responded to higher nitrogen fertilizer prices, about one-third reported that most of their nitrogen had been contracted at a pre-determined price, so they were not affected by increased fertilizer prices. Another 11 percent reported reducing application rates or changing nutrient management practices. The remaining producers, who did not change their nutrient use or management, tended to operate smaller farms and use less nitrogen per acre.

Nutrient Management Practices for Major Crops

The use of nutrient management practices in crop production can have economic and environmental implications (Heimlich, 2003; and "Agricultural Chemicals and Production Technology" briefing room on the ERS website). For example, using soil tests to assess the need for additional commercial fertilizer or manure applications can reduce fertilizer costs and losses to the environment. Applying nitrogen inhibitors to delay the release of nitrates from ammonium fertilizers until later in the growing season may reduce nitrate leaching. If nitrogen fertilizer products are broadcast, incorporating the product into the soil may reduce nitrogen

losses through volatilization. Applying nitrogen at strategic times (i.e., split applications), such as after planting when crop demand is greatest, may reduce the risk of nitrogen loss through leaching or volatization.

In general, ARMS data indicate that the use of most nutrient management practices has remained steady from year to year for the major crops. Between 1996 and 2000, soil testing was conducted on 40-50 percent of the acres planted to corn and cotton—the crops with the largest fertilizer use per acre. On soybeans and wheat, only about 30 percent of the planted acreage was soil tested. No clear soil-testing trends were reported for any of these crops. Similarly, with the possible exception of winter wheat and corn, nitrogen management practices, such as fall application, split application, and incorporation of broadcast materials, showed little consistent change over time. The share of corn acres with all nitrogen broadcasted without incorporation declined from about 15 percent to 9 percent between 1996 and 2000. The share of winter wheat acres with split nitrogen application increased, as did non-incorporated broadcast acres. Nitrogen inhibitors were used on 7-9 percent of U.S. corn acreage from 1996 to 2000, but were used on less than 2 percent of other major crops. As with the share of acres treated and application rates, nutrient management practices tend to change little from year to year.

Programs and Regulations That May Affect Fertilizer Use and Management

Nitrogen and phosphorus have been identified as major contaminants of U.S. surface and ground water (see Chapter 2.2, "Water Quality: Impacts of Agriculture"). The U.S. Geological Survey (1999) estimates that about 90 percent of nitrogen and 75 percent of phosphorus contaminants originate from nonpoint sources, with the remainder from point sources. Agricultural point sources include livestock operations, while nonpoint sources include fertilizers and animal waste applied to cropland.

Given the concerns over water quality, a number of voluntary and nonvoluntary programs have been promulgated to address agricultural nutrient use and management. Most Federal programs are directed at encouraging producers to alter cropping or nutrient application practices. These programs range from nutrient use regulations affecting producers of large confined animal operations to voluntary cost-sharing and educational/technical assistance programs available to all producers. Livestock producers who meet the criteria for a concentrated animal feeding operation (CAFO) must formulate a nutrient management plan for animal waste disposal that includes record-keeping, and in certain cases, limits on the application of other sources of nutrients, such as commercial fertilizer. The Environmental Quality Incentives Program (EQIP) and the Conservation Security Program (CSP) provide cost-sharing to producers who adopt environmentally friendly practices, including a nutrient management plan. Such plans focus on managing the amount, source, placement, and timing of fertilizers and animal manure to minimize pollution on cropland. Other Federal programs include Conservation Compliance, which reduces nutrient losses associated with soil erosion, the Conservation Reserve Program (CRP), which has retired over 34 million acres of environmentally sensitive cropland under 10- to 15-year contracts,

and Conservation Technical Assistance (CTA). More recently, the Conservation Reserve Enhancement Program (CREP) and the Wetland Reserve Program (WRP) have been implemented to remove environmentally sensitive land from crop production (i.e., buffers, filter strips, and wetlands). (See Chapters 5.1, 5.2, 5.3, and 5.4.)

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