

Agricultural Fertilizer

Commercial fertilizers are applied to agricultural crops to increase crop yields. Before the 1950s, most farming occurred on small family farms with limited use of chemicals. The shift since then to larger corporate farms has coincided with the use of chemical fertilizers in modern agricultural practices. The three major types of commercial fertilizer used in the U.S. are nitrogen, phosphorus, and potash.

Nitrogen (N) is found primarily in an organic form in soils but can also occur as nitrate. Because nitrate is extremely soluble and mobile, it can lead to nuisance algal growth, mostly in downstream estuaries, and cause contamination of drinking water. Nitrogen fertilizer can also stimulate the release of nitrous oxide, a greenhouse gas, from soils (Davidson, 2009). Phosphorus (P) occurs in soil in several forms, both organic and inorganic. Phosphorus loss due to erosion is common, and phosphate, while less soluble than nitrate, can easily be transported in runoff. Phosphorus/phosphate runoff can also lead to nuisance algae and plant growth, often in freshwater streams, lakes, and estuaries. Potash is the oxide form of potassium (K); its principal forms as fertilizer are potassium chloride, potassium sulfate, and potassium nitrate. When used at recommended application rates, there are few to no adverse effects from potassium, but it is a common component of mixed fertilizers used for high crop yields and is tracked in the fertilizer use surveys conducted.

This indicator shows use of the three major fertilizer nutrients in pounds per acre of land per year (expressed as N, P, or K) used for crop production from 1960 to 2015. Data on agricultural fertilizer sales prior to 2011 are from an annual survey for agricultural crops conducted by the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), and in subsequent years from reports by the Association of American Plant Food Control Officials (AAPFCO) and The Fertilizer Institute (TFI). Data on total cropland acreage are from the USDA Economic Research Service (ERS) Major Land Use series. Acreage used for crop production includes cropland harvested and crop failure as estimated in the ERS series. Cropland estimates as used in this indicator are a subset of agricultural land estimates discussed in the [Land Cover](#) and [Land Use](#) indicators. NASS also produces an annual *Agricultural Chemical Usage* report on four to five targeted field crops, based on data compiled from the Agricultural Resources Management Survey (ARMS). The ARMS program surveys farmers in major agriculture-producing states that together account for a large percentage of crop acreage for corn, soybeans, cotton, and wheat. Results are presented for the years 2017-2018 by EPA Region.

What the Data Show

Total commercial fertilizer consumption in the U.S. increased rapidly before 1982 as more acreage was devoted to high-yield crop varieties and hybrids that responded favorably to more intensive fertilizer use. As global demand for grains grew, U.S. consumption of commercial fertilizers peaked at 24 million tons in 1981. Since then, total fertilizer use has fluctuated, with no persistent trend, due to numerous interactions of supply and demand. When grain demand dropped in 1983, a large amount of U.S. cropland went out of production, reducing fertilizer consumption to 18 million tons. Commercial fertilizer use then trended upward, largely due to increased corn plantings. Since 2004, annual fertilizer use has been more volatile in the face of rapidly rising fertilizer prices, driven by rising energy and input material costs. Record fertilizer prices in 2009 reduced consumption to 17.7 million tons, a 24 percent decline from 2004. As fertilizer prices declined in 2010, consumption rebounded to 20.8 million tons (USDA ERS, 2019c). Consumption continued to increase in each subsequent year, up to 23.2 million tons in 2014, and then decreased slightly to 22.0 million tons in 2015. (Data for tonnage of fertilizer, U.S. cropland acreage, and price of fertilizer not shown.)

On a per acre basis, use of the three major fertilizer nutrients increased from 46.2 nutrient pounds per acre per year (lb/acre/yr) in 1960 to a peak of 146 lb/acre/yr in 2004, an increase of 215 percent (Exhibit 1). Mirroring the overall tonnage statistics cited above, commercial fertilizer use per acre has become more volatile since 2004. From its peak in 2004 at 146 lb/acre/yr, it declined to 111 lb/acre/year in 2009, then increased to 136 lb/acre/year in 2015.

Since 1960, the amount of land used for crop production generally has fluctuated between 290 and 360 million acres, with the highest acreage used in the late 1970s and early 1980s. The largest fluctuations occurred between 1969 (292 million acres) and 1981 (357 million acres). Since 1996, the amount of land used for crop production has been relatively stable, ranging between 314 and 328 million acres (USDA ERS, 2019a).

Since 1960, nitrogen accounted for the steepest increase in use, from 17.0 lb/acre/yr in 1960 to a peak of 83.6 lb/acre/yr in 2013. In 2015, nitrogen accounted for about 59 percent of total fertilizer use, up from 37 percent in 1960. During the same period, phosphate and potash use grew more slowly; they remained steady between 25 and 36 lb/acre/yr each since the late 1960s (except 2009) and in 2015 accounted for approximately 20 percent and 22 percent of total fertilizer usage, respectively.

The four major crops in the U.S.—corn, cotton, soybeans, and wheat—account for about 60 percent of the principal crop acreage and receive over 60 percent of the nitrogen (N), phosphate (P), and potash (K) used in the U.S. (Daberkow and Huang, 2006). From 1995 to 2018, between 72 and 97 million acres of corn were planted annually. Land planted for corn peaked in 2012 at 97.3 million acres (USDA NASS, 2018b). In 2019, the most recent year for which acreage data are available, 92 million acres were planted (USDA NASS, 2019a). Corn acreage is concentrated in the center of the country (EPA Regions 5 and 7), but most EPA Regions grow some corn. Use of fertilizer on corn has historically accounted for more than 40 percent of commercial fertilizer used in the U.S. (Daberkow and Huang, 2006).

The acreage of land planted for cotton was 13.7 million acres in the most recent acreage survey year (2019) (USDA NASS, 2019a) and has ranged between 11 and 16 million acres since 1990. Major cotton-producing states include states located in EPA Regions 4, 6, and 7.

Production of winter, durum, and other spring wheat occurred on 46 million acres in 2019, the most recent acreage survey (USDA NASS, 2019a). Wheat production is distributed across EPA Regions 4 through 10. Wheat typically accounts for about 10 percent of all commercial fertilizer used (Daberkow and Huang, 2006).

Soybeans were the fastest-growing crop in total acreage, increasing from 29 million acres in 1963 to 90.1 million acres in 2017 (Nickerson et al., 2011; USDA NASS, 2018a). However, the planted acreage of soybeans (80 million acres) decreased 10 percent between 2018 and 2019 (USDA NASS, 2019a). Soybean acreage is concentrated in the upper Midwest in EPA Regions 5 and 7. Soybeans require the least fertilizer per acre of the four crops described here.

Overall, production of these four crops in the ARMS states used 16.1 million tons per year (MT/yr) of fertilizer in 2017-2018 (Exhibit 2). Of this amount, approximately 42 percent (6.7 MT/yr) was applied in EPA Region 5 (Exhibit 2), most of which was used for corn. An additional 4.7 MT/yr was applied in EPA Region 7 (29 percent), primarily on corn or soybeans.

Limitations

- Estimates of fertilizer use are based on sales data provided by states, not actual fertilizer usage, and are susceptible to differing reporting procedures or accuracy from state to state.
- Within the ARMS, not all states report fertilizer data every year for each crop type, making it difficult to establish year-to-year trends (a decrease in fertilizer use for a specific crop might be attributed to failure of a state to report, rather than an actual decrease of use).
- ARMS sampling is limited to program states, which must represent 80 percent of crop acreage (across all surveyed crops) for the years 2017 and 2018.
- The NASS *Acreage* report has estimates of acreage in production for the entire nation by crop, while fertilizer sales data are based only on USDA Program States. Even though USDA Program States represent the majority of U.S. planted acreage (often more than 90 percent), the ability to generalize the data to the country as a whole is unknown, as non-Program States, while representing a small percentage of a crop, might have much different application rates due to climate, weather, etc.
- Fertilizer applied to trees that are considered agricultural crops (e.g., nut-producing trees) is included in field crop summaries, but fertilizer applied in silviculture (e.g., southern pine plantations) is not covered by the NASS data collection system.
- Loading of nutrients in aquatic systems is not necessarily correlated directly with fertilizer use, but rather with the levels of fertilizer applied in excess of amounts used by crops, natural vegetation, and soil biota.
- The NASS data regarding the amount of fertilizer applied to agricultural lands for which wheat is the main crop contains multiple points that are withheld to avoid disclosing data on individual farmers. Due to their small magnitude, these data points are excluded from the current analysis.

Data Sources

Exhibit 1 is based on two sets of summary data from ERS. Annual estimates of fertilizer use from 1960 through 2015, by nutrient, were obtained from summary tables in USDA ERS

(2019b). Fertilizer use per acre was calculated based on annual estimates of the acreage of cultivated (harvested or failed) cropland from 1960 to 2015 from summary tables published in USDA ERS (2019a).

Exhibit 2 is based on fertilizer use data from USDA's 2017 and 2018 ARMS survey, which were obtained from USDA NASS (2018c, 2019b). The published data are by state, so additional aggregation was required to report by EPA Region.

References

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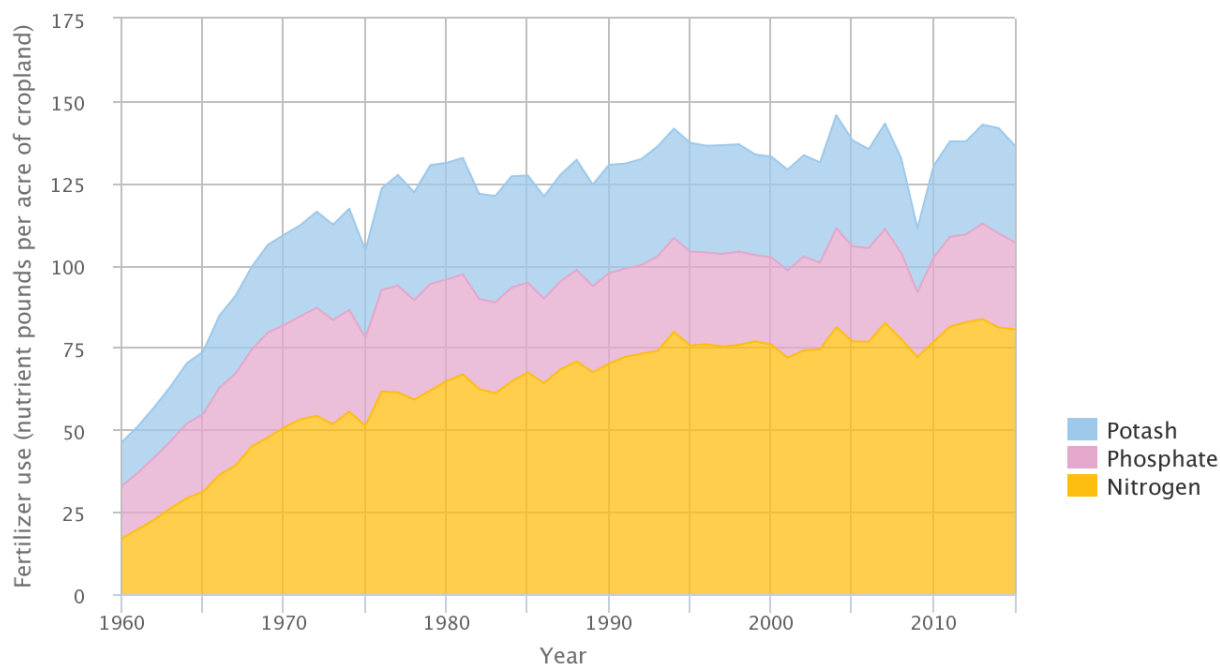
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Exhibit 1. Commercial fertilizer use in the U.S., 1960–2015

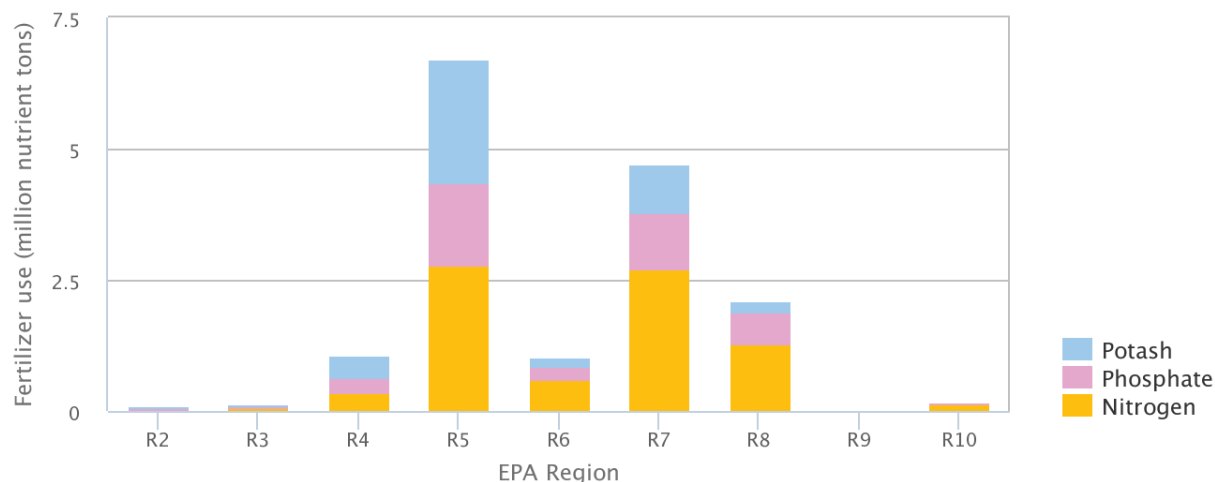


Based on sales data. Per-acre use based on the total acreage of harvested or failed cropland, as reported by USDA's Economic Research Service.

Information on the statistical significance of the trends in this exhibit is not currently available. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: USDA ERS, 2019a, 2019b

Exhibit 2. Fertilizer use for four common crops (corn, cotton, soybeans, and wheat) in major agriculture-producing states, by EPA Region, 2017–2018



Coverage: States surveyed by USDA's Agricultural Resource Management Survey (ARMS) Program in 2017–2018 for corn, cotton, soybeans, and wheat. Each commodity was surveyed in a different subset of states, which together account for a substantial portion of the nation's production of that particular commodity. No states in Region 1 were surveyed by the ARMS Program for corn, cotton, soybeans, or wheat.

Trend analysis has not been conducted because these data represent a single snapshot in time. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: USDA NASS, 2018c, 2019b