



Trends in Fertilizer Use and Efficiency in the U.S.

Henrique Monaco, Nick Paulson, and Gary Schnitkey

Department of Agricultural and Consumer Economics
University of Illinois

May 29, 2025

farmdoc daily (15): 98

Recommended citation format: Monaco, H., N. Paulson, and G. Schnitkey. "Trends in Fertilizer Use and Efficiency in the U.S." *farmdoc daily* (15): 98, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, May 29, 2025.

Permalink: <https://farmdocdaily.illinois.edu/2025/05/trends-in-fertilizer-use-and-efficiency-in-the-us.html>

Fertilizer is one of the main inputs for crop production in the U.S., particularly for corn, wheat and soybean. While application rates per acre are increasing for some crops, yields are outgrowing application rates, resulting in increasing efficiency of use. This article examines long-term trends in fertilizer application rates and crop yields, discussing how fertilizer efficiency per unit of output has evolved for the three major crops in the U.S. with implications for demand.

Total Use Shares by Crop

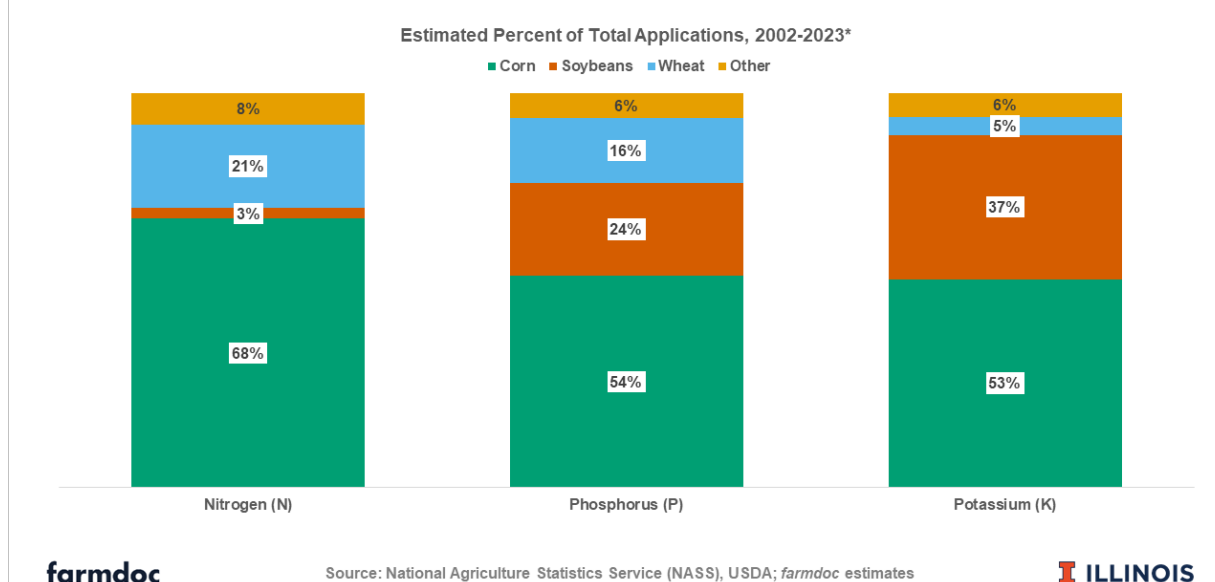
According to the International Fertilizer Association the U.S. utilized about 14,900 thousand metric tons of nitrogen (ammonia), 4,600 thousand metric tons of Potassium Chloride and 6,500 thousand metric tons of phosphate for fertilizer in 2022 (International Fertilizer Association, TEAD Analysis). The majority of fertilizers used for crop production in the U.S. are applied to corn, wheat, and soybeans. USDA survey data suggest that fertilizers used for these crops have accounted for 92%, 94% and 95% of total applications of nitrogen (N), phosphate (P), and potassium (K), respectively, since 2002¹ (National Agriculture Statistics Service (NASS) [Agricultural Chemical Use Program](#)).

Figure 1 shows estimated shares of fertilizer use by crop for each major nutrient. Corn, given its large U.S. acreage, is the largest user of all three nutrients (78% of nitrogen fertilizer, 54% of P, and 53% of K). Wheat is the second largest user of nitrogen fertilizers. Soybean, as a legume, is able to fix the majority of their nitrogen needs which limits the amount of N fertilizers applied reflecting the lower share of use. Soybean acres use the second largest shares of total P and K.

¹ The NASS Agricultural Chemical Use Program does not survey crops consistently across years. Program states may also vary. This is an approximation based on the sum of reported total applications from 2002 to 2023 for the program states.

We request all readers, electronic media and others follow our citation guidelines when re-posting articles from farmdoc daily. Guidelines are available [here](#). The farmdoc daily website falls under University of Illinois copyright and intellectual property rights. For a detailed statement, please see the University of Illinois Copyright Information and Policies [here](#).

Figure 1. Share of Total Fertilizer Applications by Nutrient Type and Crop, 2002-2023



Trends in Applications per Acre

Total demand for fertilizers are impacted by planted acres to crops. Planted acreage to major crops has stabilized in recent years, though some substitution between crops has occurred (*farmdoc daily*, [April 2, 2025](#)).

Application rates per acre are illustrated in Figure 2 for the major crops and nutrient types. The dots represent observed USDA survey responses while the dashed lines are simple linear trend lines fit to the survey data.

Over time, nitrogen application rates (panel A) per acre have increased for corn and wheat. In 2024 estimated trend values are 151.8 pounds per acre for corn, a 10.8% increase from the average surveyed rate in 2002. The 2024 trend estimate for wheat is 77.15 lbs per acre, a 16.7% increase from the average surveyed application rate in 2002. Nitrogen applied per acre of soybeans has trended down, estimated at 18.5% lower in 2024 than in 2002.

Panel B shows that application rates per acre for phosphate have increased for corn (+11.2%) and soybeans (+10%) and declined for wheat (-8.9%). Panel C shows that application rates per acre for potassium have declined for all three major row crops: -6.6% for corn, -5.8% for soybeans, and -16.9% for wheat.

Trends in Applications per Bushel (Efficiency of Use)

Changes in application rates per acre have coincided with increasing crop yields over time. Yield or productivity increases have been larger than any of the increases in fertilizer application rates (*farmdoc daily* [April 29, 2025](#) and [June 6, 2023](#)). As a result, application rates of N, P, and K per bushel produced have been declining for corn, soybeans, and wheat.

Efficiency of use is defined as lbs of fertilizer applied per unit of crop output (fertilizer applied per acre divided by crop yield). As shown in Figure 3, application rates per bushel for all crops are trending down, meaning less fertilizer is being used to produce each bushel.

Figure 2. Application rates (lbs/acre) by Nutrient Type and Crop, 2002-2023

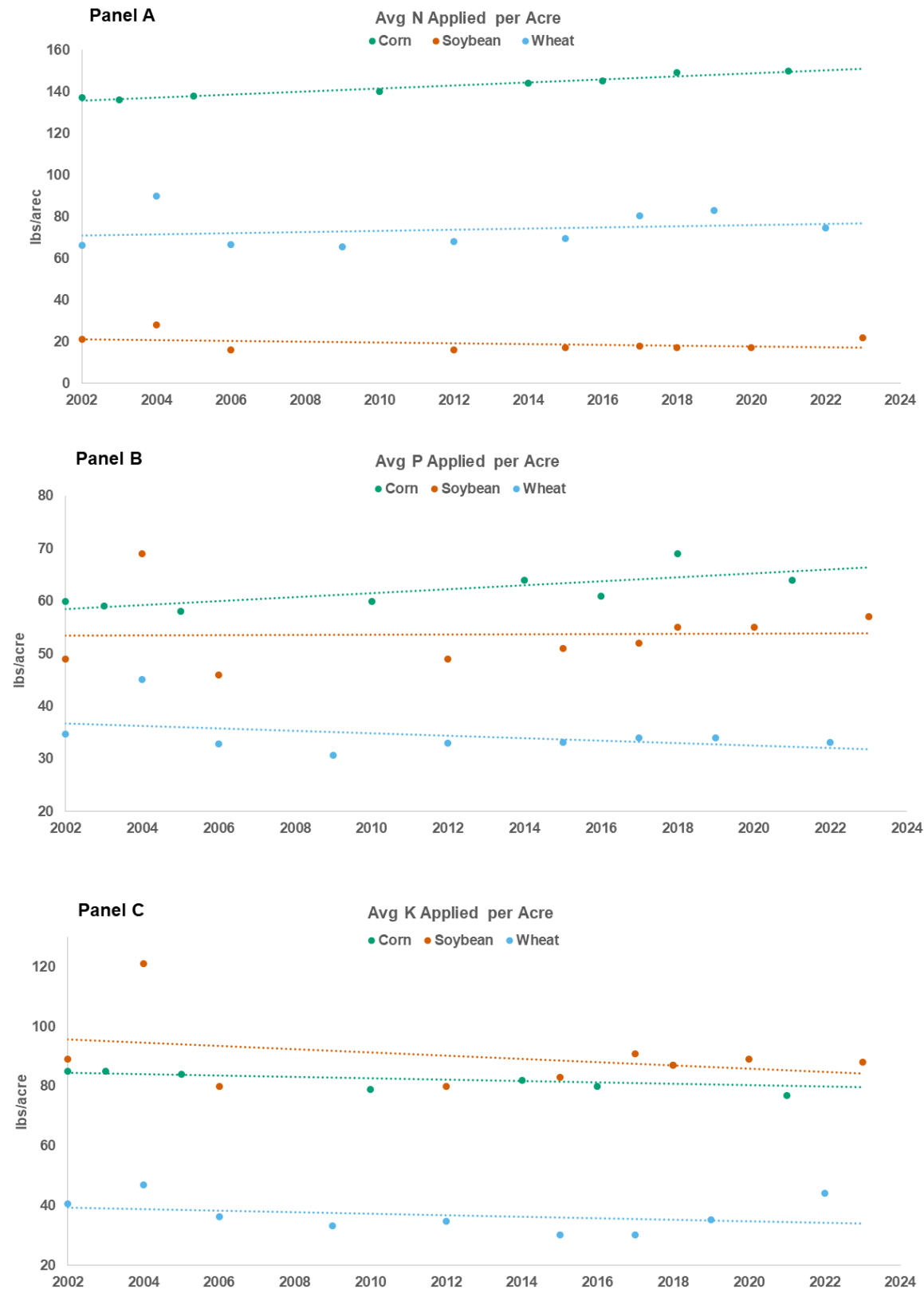
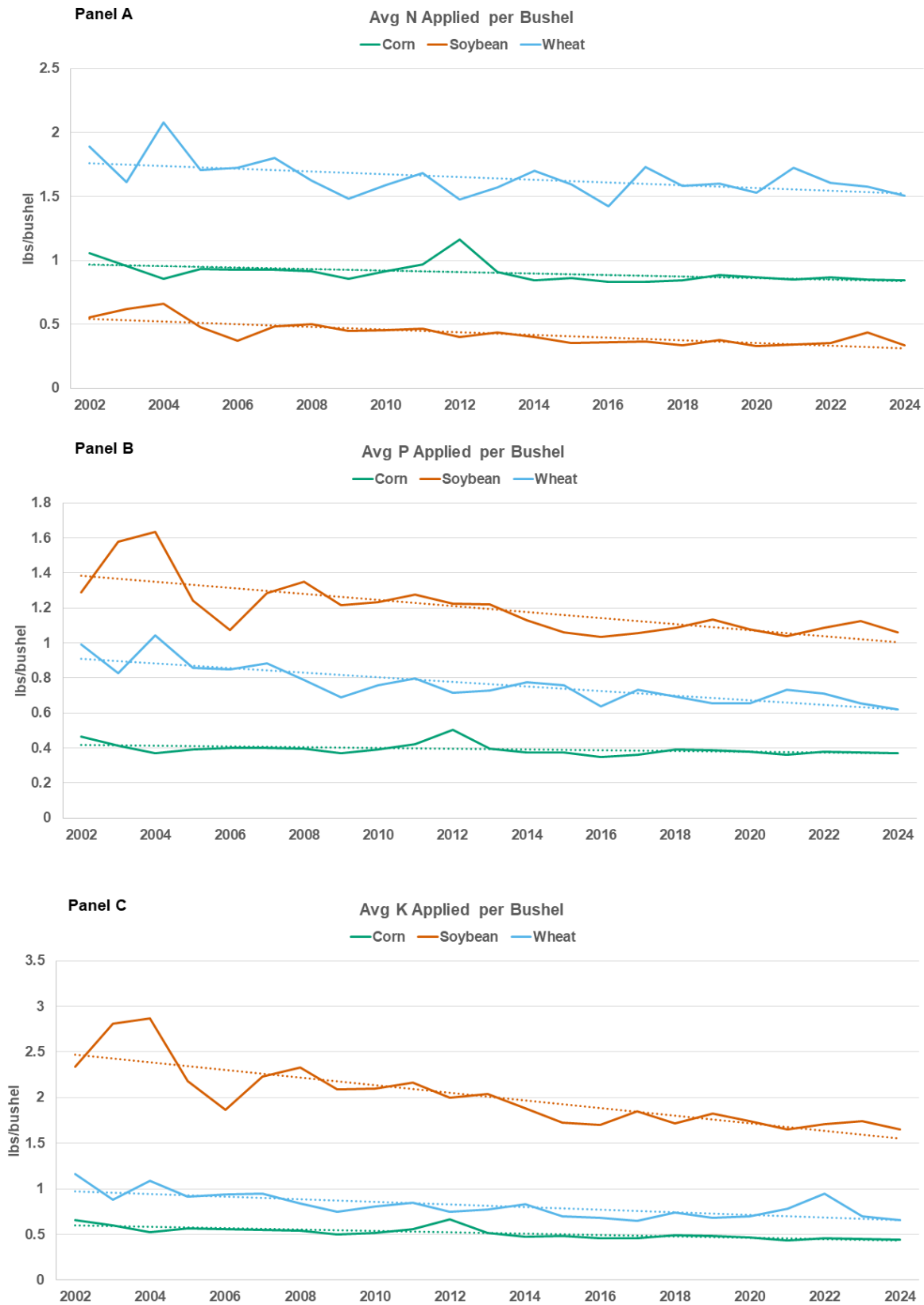


Figure 3. Estimated Fertilizer Use Efficiency (lbs/bushel) by Nutrient Type and Crop, 2002-2024



farmdoc

Source: National Agriculture Statistics Service (NASS), USDA; farmdoc estimates

ILLINOIS

Table 1 shows the comparison between observed USDA survey results from 2002 and trend estimates for 2024. The annual change in the last column of the table represents the compounded annual percent change in efficiency. A negative number means use has become more efficient. For example, corn used 1.06 lbs of nitrogen fertilizer to produce one bushel in 2002, and 0.85 lbs in 2024. This implies a 1.01% reduction in the use of nitrogen fertilizer per bushel of corn produced each year since 2002.

Table 1. Efficiency of Use of Fertilizer, 2002 and 2024			
N Efficiency (lbs/bu)	2002	2024*	Annual Change
Corn	1.06	0.85	-1.01%
Soybean	0.55	0.34	-2.22%
Wheat	1.89	1.51	-1.02%
P Efficiency (lbs/bu)	2002	2024*	Annual Change
Corn	0.46	0.37	-1.00%
Soybean	1.29	1.06	-0.87%
Wheat	0.99	0.62	-2.13%
K Efficiency (lbs/bu)	2002	2024*	Annual Change
Corn	0.66	0.44	-1.78%
Soybean	2.34	1.65	-1.57%
Wheat	1.16	0.66	-2.54%
*Trend estimates based on available historical survey data			farmdocDAILY

Discussion

The observed gains in fertilizer use efficiency are significant. For nitrogen, for instance, the efficiency of use for corn has increased 20% from 2002 to 2024. Considering the estimated production of 15.8 billion bushels of corn for 2025/26 ([WASDE 2025](#)), the improvement represents approximately 1,500 thousand fewer metric tons of N fertilizer than would have been used to produce the same crop in 2002.

These improvements are the result of a combination of several factors, including genetic advancements, improved management practices, better timing of applications, better products, better access to information etc. In addition, yields and applications rates will vary a great deal depending on location, soil, target output and varieties (*farmdoc daily* [October 25, 2023](#)). However, this shows that fertilizer use is trending in the right direction.

Economically, from 2000 to 2024 fertilizer costs represented approximately 45% and 30% of total direct costs for corn and soybeans, respectively (*farmdoc daily* [April 30, 2024](#)). Improved efficiency lowers the cost of production per bushel, which is especially important in years such as 2022 when fertilizer prices spike (see *farmdoc daily* [September 27, 2022](#), and [June 18, 2024](#)).

From the demand perspective, understanding trends in application rates is important since it impacts demand for fertilizer and, thus, prices and the management decisions made by farmers.

Improved fertilizer efficiency is also environmentally beneficial, contributing to sustainability goals by reducing nutrient runoff and lowering emissions per unit of output.

Conclusion

Fertilizer application rates per acre have increased for some nutrients and crops over time, while others have declined. Yields for the major row crops that account for the majority of N, P, and K fertilizer use in

the U.S. have all increased over time. For the cases where application rates per acre have increased (N for corn and wheat; P for corn and soybeans), the yield increases have been relatively larger.

As a result, U.S. agriculture is applying less fertilizer per unit of output for major crops like corn, wheat, and soybeans. From an aggregate use perspective, there is little evidence of sharp changes in total fertilizer use due to trends in application rates and efficiency. Future trends in aggregate use will continue to be impacted to a greater extent by planted acreage and crop rotation decisions of farmers.

References

Irwin, S. "[Estimating Total Crop Acres for the U.S. over 1998-2025.](#)" *farmdoc daily* (15):61, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, April 2, 2025.

Paulson, N., G. Schnitkey and C. Zulauf. "[2024 Corn and Soybean Yields.](#)" *farmdoc daily* (15):80, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, April 29, 2025.

Paulson, N., G. Schnitkey and C. Zulauf. "[Where Might Nitrogen Fertilizer Prices Be Headed?](#)" *farmdoc daily* (14):114, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, June 18, 2024.

Paulson, N., C. Zulauf and G. Schnitkey. "[Trends in Input Costs for Corn and Soybean Production in Illinois.](#)" *farmdoc daily* (14):82, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, April 30, 2024.

Schnitkey, G., C. Zulauf, N. Paulson and J. Baltz. "[Perspectives on Non-decreasing National Yield Trends.](#)" *farmdoc daily* (13):103, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, June 6, 2023.

Schnitkey, G., N. Paulson, C. Zulauf, K. Swanson and J. Baltz. "[Fertilizer Prices, Rates, and Costs for 2023.](#)" *farmdoc daily* (12):148, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, September 27, 2022.

Nafziger, E. "[Nitrogen Supply for the Corn Crop.](#)" Department of Crop Sciences, University of Illinois, October 25, 2023.

U.S. Department of Agriculture. (2025, May 10). *World Agricultural Supply and Demand Estimates* (No. WASDE-652). Office of the Chief Economist.
<https://www.usda.gov/oce/commodity/wasde/wasde0525v2.pdf>