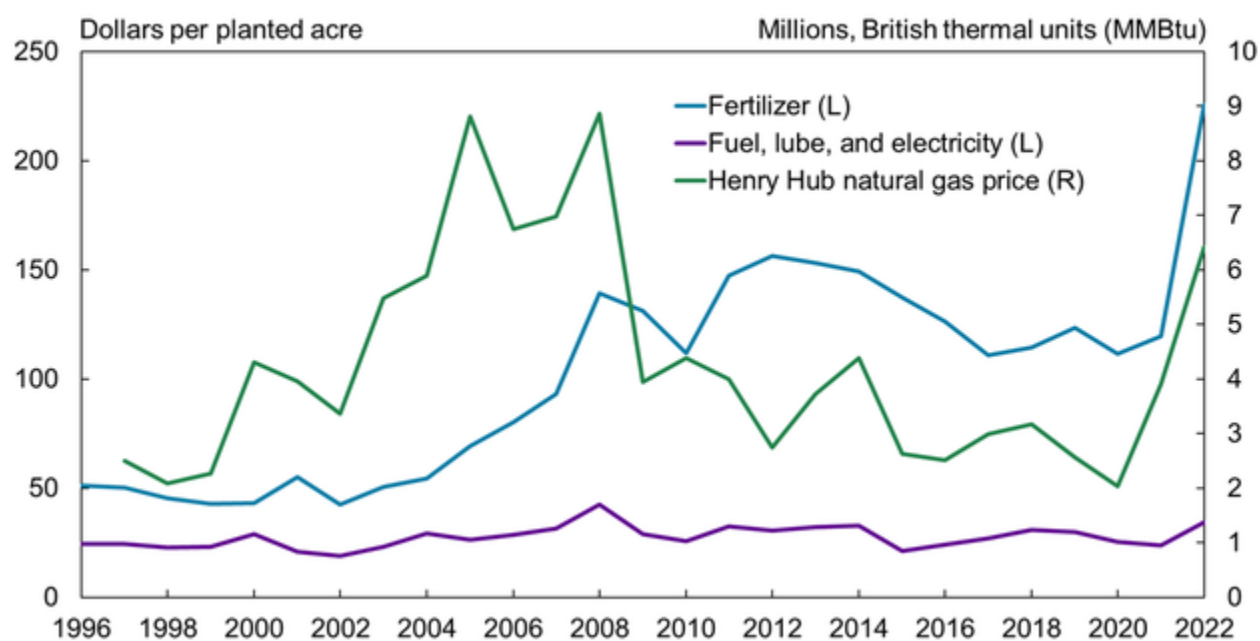


Chart 1: Energy-Related Inputs for Corn, 1996–2022



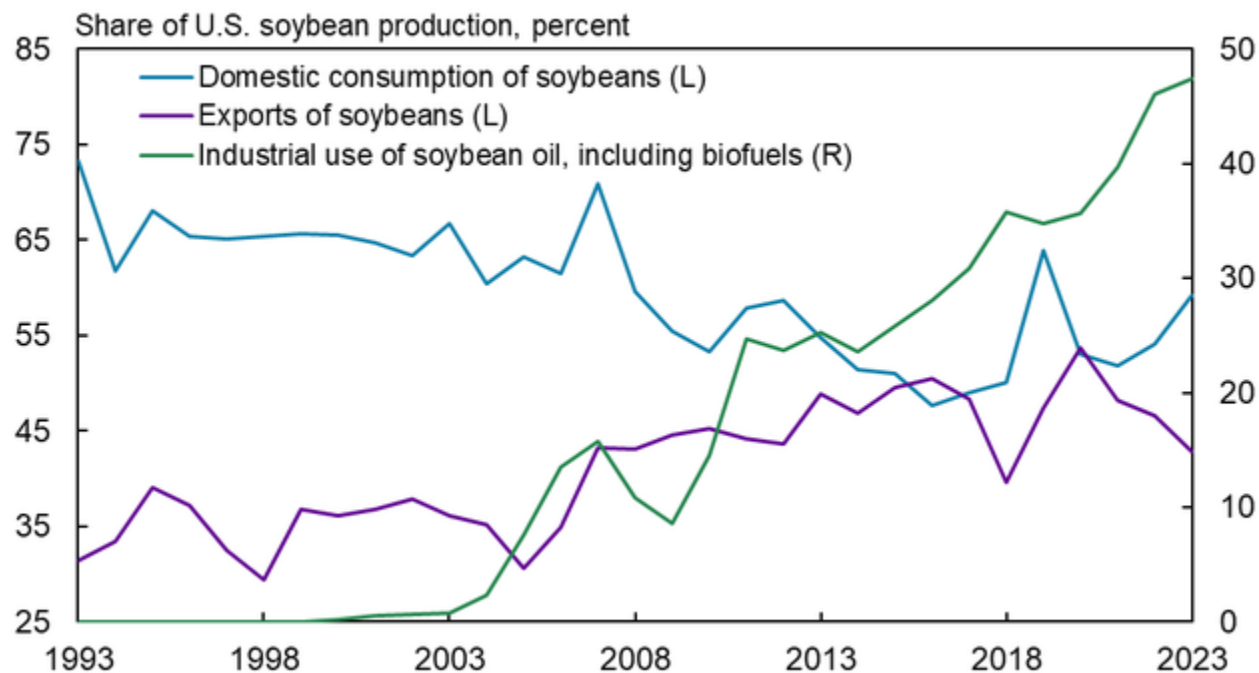
Source: U.S. Department of Agriculture (USDA).

line). As the cost of fertilizer has moved higher, its share of production costs has also moved up, from 4 percent nearly a century ago to about 7 to 9 percent by 2022.

In addition to these inputs, connections between the agricultural and energy sectors have emerged more recently due to the growing role of energy as an agricultural *output*. Corn, for example, is a key input in ethanol, which has become a much more important biofuel since the implementation of the Renewable Fuel Standard (RFS) in 2006.^[1] The RFS specifies volumetric mandates, called renewable volume obligations (RVOs), for renewable fuels to replace or reduce the quantity of petroleum-based transportation fuel, heating oil, or jet fuel. The RFS has three primary policy goals: enhancing energy security through additional domestic production of biofuels, expanding the development and production of renewable transportation fuels such as ethanol, and supporting rural economies by expanding demand for agricultural products, particularly corn.

Around the same time as the implementation of the RFS, California implemented additional policies that boosted demand for biofuels, with several other states following close behind. The Low Carbon Fuel Standard (LCFS) legislation in California and other states introduced policies to reduce carbon emissions, decrease petroleum dependence in the transportation sector, and

Chart 6: Growing Domestic Demand for Soybeans



Sources: USDA and author's calculations.

billion gallons by 2023. The use of soybean oil in industrial production has grown concurrently. By 2023, almost 50 percent of soybean oil was used for the industrial production of biofuels, while the remaining half was used for food production.

As demand for industrial biofuels increases, the share of soybeans consumed domestically could also increase. The blue line in Chart 6 shows that the share of U.S. soybean production consumed domestically fell throughout previous decades. For most of the 2000s and 2010s, only 50 percent of the soybeans produced in the United States were consumed there, partly due to a ramp-up in soybeans produced for export to other countries (purple line) (Cowley 2020). However, since 2021, domestic consumption of soybeans has displaced exports, likely due, in part, to greater industrial demand. In 2023, domestic consumption of soybeans was almost 60 percent of production, the second-highest share in more than 15 years.^[2]

As the production of renewable transportation fuel expands, U.S. domestic consumption of soybeans will likely continue to displace international exports. The United States typically exports half of the soybeans it produces, with the largest share going to China (Cowley 2020). Indeed, recent

articles have explored the United States losing market share of corn and soybean exports to Brazil (Hirtzer and Carey 2023, Veloso 2023). However, one key reason U.S. exports have declined is because they have been displaced by expanding domestic use of crops for the industrial production of renewable fuels. In other words, the decline in exports could reflect growing domestic demand rather than a lack of foreign demand for U.S. crops.

Supply constraints may lead domestic demand to continue to displace exports, as demand from biofuels seems likely to soon outstrip soybean production capacity in the United States. At the beginning of 2023, the total U.S. production capacity for biodiesel and renewable diesel was about 9 percent of average daily U.S. consumption of diesel fuel. More biodiesel and renewable diesel plants are either under construction or proposed for the future, so demand for soybeans from these domestic plants will likely increase. According to the EIA, the production capacity of 59 U.S. biodiesel plants was a cumulative 136,000 barrels per day (as of January 2023). Demand for soybeans from these plants alone could outstrip supply by the equivalent of 28 million acres of soybeans.^[3] However, biodiesel is more costly to produce than petroleum-based and renewable diesel. Biodiesel also has a higher carbon intensity score and generates fewer renewable credits than renewable diesel. In fact, in early 2024, two major biodiesel plants closed indefinitely due in large part to a decline in prices for biodiesel that challenged profitability (Sanicola 2024).

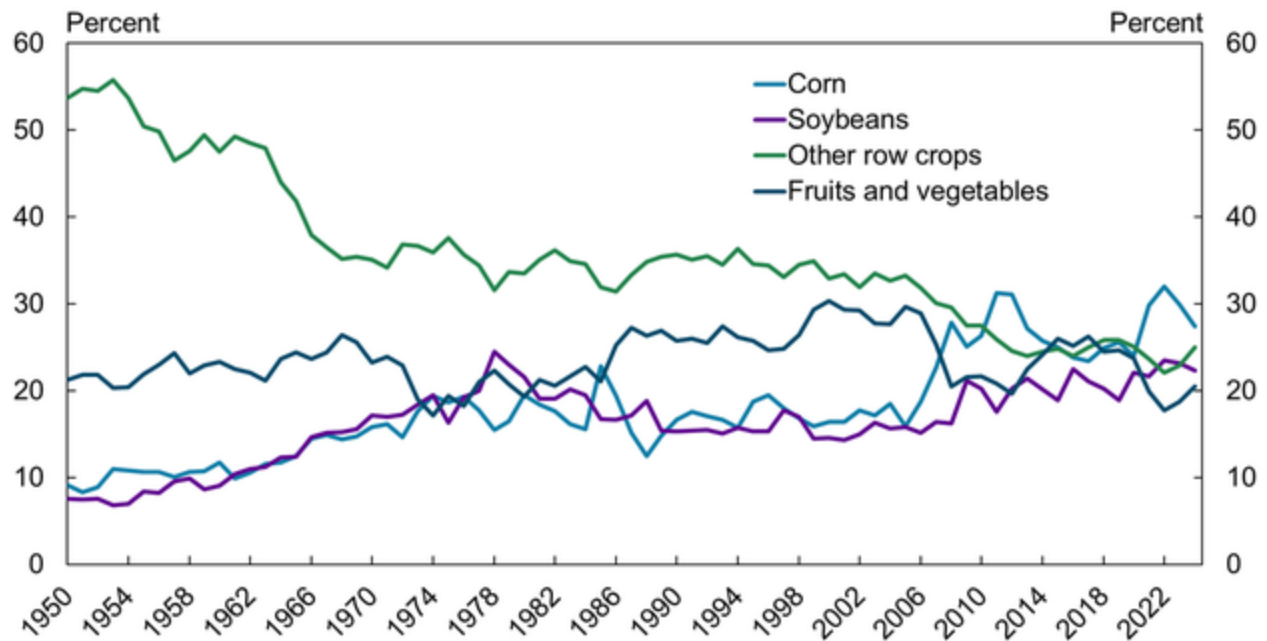
Even so, higher demand for domestic biofuels may further tighten the correlation between crop prices and energy prices, increasing both the level and volatility of soybean prices. This correlation is especially likely to tighten over the next few years, reflecting historically low levels of U.S. soybean inventories at the end of 2023. In 2023, U.S. ending stocks for soybeans were 6 percent of total domestic use, down dramatically from 23 percent in 2018 amid a trade dispute with China. Tight inventories can make prices especially sensitive to increases in demand due to limited supply buffers. Pressure on U.S. soybean supplies could be compounded by limited suppliers of soybeans globally. Unlike crops such as corn and wheat, which are grown all over the world, soybeans are primarily grown in just three countries: the United States, Brazil, and Argentina.

Increased domestic biofuel production could also considerably increase demand for other oilseed crops such as canola and sunflower seeds, which are more efficient sources for producing biofuel. While soybeans yield about 50 gallons of oil per acre for biodiesel production, sunflower seeds

produce about 82 gallons of oil per acre, and canola seeds yield about 95 gallons of oil per acre (Isom and Booker 2008). Despite their better yields, canola and sunflower—along with other oilseeds grown in the United States, such as flaxseed, cottonseed, mustard seed, rapeseed, and safflower—currently make up less than 2 percent of total farm revenues and less than 15 percent of all acreage planted in oilseed crops.^[4]

Although the production of other oilseeds has expanded slightly, soybeans remain the dominant oilseed crop. For example, the share of harvested crop acres that are other oilseeds (not soybeans) has inched toward 1.5 percent over the last few years, and the share of crop revenues for other oilseeds has slowly moved toward 2 percent. However, despite some growth in other oilseeds, soybeans still dominate. Chart 7 shows that in 2022, soybeans (purple line) became the second largest revenue-grossing crop behind corn (blue line). Despite a slight retraction in 2023, the overall growth of soybeans represents a major shift from 50 years ago, when the crop sector was much more diversified.

Chart 7: The Growing Prominence of U.S. Soybeans as a Share of Total Crop Revenues



Sources: USDA and author's calculations.

Endnotes

- [1] The RFS was one piece of legislation in two larger acts: the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007.
- [2] Domestic consumption of soybeans was slightly higher in 2019 following a sharp drop in exports amid the trade dispute with China.
- [3] As an input for biofuels, soybeans contain roughly 20 percent oil and yield about 50 gallons of biodiesel per acre. To meet current demand for biodiesel, U.S. farmers would need to harvest about 1.4 billion bushels of soybeans per year. At current average yields, that would be equivalent to about 28 million acres of soybeans, or one-third of the 83 million acres harvested in 2023. This estimate is likely a lower bound. The IRA was not signed into law until August 16, 2022, and many of the provisions related to renewable fuel production did not take effect until later in 2023. Oilseed production requirements could expand moving forward.
- [4] The largest vegetable oil crop in the world is palm oil, which makes up about 40 percent of global vegetable oil production. Although palm oil is not produced in the United States, U.S. imports of palm oil have grown rapidly in recent years. Since 2006, palm oil imports have grown about 8 percent each year.

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