

Ethanol and Citric Acid Increase the Use of Corn

Continued implementation of the Clean Air Act Amendments of 1990 is expected to put upward pressure on the industrial demand for corn during the remainder of the 1993/94 marketing year and 1994/95. The final rule from the U.S. Environmental Protection Agency on ethanol's role in the reformulated gasoline program is due out this month. In lieu of new "green" legislation, the demand for starch, primarily cornstarch, is expected to grow in tandem with the overall U.S. economy. One use of cornstarch is in the production of citric acid, the main acidulant used by the food and pharmaceutical industries.

Use of corn to produce industrial starch and fuel alcohol during 1990/91 through 1994/95 is expected to rise at an average rate of 10 percent per year (table 2). Because of strong economic growth and continued implementation of the Clean Air Act Amendments of 1990 (CAAA), corn use is forecast at 683 million bushels in 1993/94, almost a 9-percent increase from 1992/93. In 1994/95, use is expected to reach 816 million bushels, up nearly 20 percent from the 1993/94 forecast. Again, continued increases in fuel alcohol usage as a result of the CAAA is the main reason for the rise.

Fuel Alcohol Use Up, but Future Increases Are Uncertain

After lower-than-expected demand for oxygenates generated by the CAAA's carbon monoxide provisions during the winter of 1992/93, the winter oxygenate program went smoothly in 1993/94. From September 1993 through February 1994, the amount of corn used to produce fuel alcohol was up 9 percent from the same period a year earlier. The additional alcohol was used to meet requirements of the CAAA, which were in force for 39 metropolitan areas and counties that failed to meet carbon-monoxide air-quality standards. Under the CAAA's winter oxygenate provisions, gasoline sold during at least the 4 winter months must contain 2.7 percent oxygen by weight.

In addition to strong domestic demand from the winter oxygenate program, export demand developed from Brazil, which put upward pressure on ethanol prices. From

September 1993 through March 1994, 44 million gallons of ethyl alcohol were shipped to Brazil. Even though fuel alcohol production per day slowed in March from the February level, production was still above a year earlier. Since the winter oxygenate program ends in February in most metropolitan areas, exports probably took the extra supply, because stocks were lower.

The second stage of the CAAA, the reformulated gasoline (RFG) program, is to be implemented in 1995. RFG requires oxygenates to be used in the nine areas with the worst concentrations of ground-level ozone. Another 86 areas may decide to be included. Because splash-blending ethanol with gasoline may increase evaporative volatile-organic-compound (VOC) emissions and methyl tertiary butyl ether (MTBE)--a fossil-fuel distillate--does not, ethanol-blended RFG will require lower evaporative emissions from the gasoline component than MTBE-blended RFG. Depending on the cost of decreasing evaporative emissions in gasoline, this could drive up the relative price of ethanol-RFG blends, and for all practical purposes, price fuel ethanol out of the ozone nonattainment market. One solution is to use ethyl tertiary butyl ether (ETBE), which is derived from ethanol. ETBE-blended RFG does not increase VOC emissions, but the question is whether it will compete with MTBE-blended RFG. In December 1993, the U.S. Environmental Protection Agency (EPA) issued a proposed rule that 30 percent of the "oxygenate" in reformulated fuels come from renewable resources, which would be primarily ethanol. A final EPA ruling on the matter is expected this month.

Inclusion of ethanol in the RFG program will significantly boost ethanol demand. If RFG is enacted as proposed, corn demand for fuel alcohol in 1994/95 is expected to increase 27 percent from the 1993/94 forecast of 475 million bushels. Some of this additional alcohol will also be needed to meet increased demand created by the CAAA's carbon monoxide provisions.

Current ethanol capacity is probably near the 85,000 barrels per day produced in November and December 1993. If so, capacity would be 31 million barrels or 1.3 billion gallons of fuel alcohol per year. With 95 percent of production from corn, 495 million bushels would be

Table 2--Industrial uses of corn, 1990/91-1994/95

Marketing year 1/	Starch			Fuel alcohol	Total industrial use
	Food uses	Industrial uses	Total 2/		
Million bushels					
1990/91	35	197	232	349	546
1991/92	36	202	237	398	600
1992/93	36	202	238	426	628
1993/94 3/	37	208	245	475	683
1994/95 4/	38	213	250	603	816

1/ Marketing year begins September 1. 2/ Total starch use equals food use plus industrial use, with 85 percent going to industry and 15 percent to food uses. 3/ Forecast. 4/ Projected.

needed, which is below the 1994/95 projection of 603 million bushels. However, as discussed in the December issue of this report, producers are expected to meet demand by building additional capacity or by bringing some unused capacity back into production.

Starch Use Expected To Track U.S. Economic Growth

In lieu of new "green" legislation, the demand for starch, primarily cornstarch, is expected to grow with the overall U.S. economy. Starch production in the first half of 1993/94 used 2 percent more corn than in the same period of 1992/93. Since cornstarch production is usually stronger during the second half of the year, a 3-percent increase in cornstarch use is forecast for 1993/94. Much of the starch is used in paper products and building materials, such as wallboard. As the economy grows and construction increases, more shipping boxes and other types of paper are needed, thus boosting the demand for cornstarch and ultimately corn. A 2-percent rise in demand is expected in 1994/95.

More Citric Acid Is Produced From Biobased Sources

One use of cornstarch is in the production of citric acid, the main acidulant (by volume) used by the food and pharmaceutical industries. An acidulant is acid in taste and, in the food industry, it functions mostly as a flavor enhancer. Acidulants also retard the growth of bacteria and other organisms that cause spoilage, thus acting as a preservative. Citric acid accounts for an estimated two-thirds of the U.S. acidulants market. Acidulants used in foods and beverages consume an estimated 65 percent of total demand, with beverages requiring the bulk of the total.

In the United States, citric acid has been produced from both petroleum and biobased processes. Recently, production has been shifting more toward biobased routes, which depend on a special microbial strain of *Aspergillus niger* to ferment crude sugars or cornstarch in the presence of oxygen. The sugar feedstock can be derived from any starch-rich crop, including wheat, barley, and rice. There are currently three fermentation processes used to produce citric acid: solid state, liquid state, and submerged-culture fermentation. The solid-state fermentation technology is only employed in Japan.

Older U.S. plants built in the 1970's and early 1980's utilize liquid-state fermentation to convert beet or cane molasses into citric acid. In comparison, most newer plants use submerged-culture or deep-fermentation processes. The submerged-culture process can operate on a variety of carbohydrate feedstocks including corn, cane sugar, and wheat.

Current domestic consumption of citric acid is estimated at 360 million pounds annually. This requires approximately 16 to 18 million bushels of corn. In comparison,

414 million bushels of corn were used to make high fructose corn syrup, a corn-derived sweetener, in 1992/93. Cornstarch is the main feedstock for biobased citric acid, with a small portion, under 10 percent, produced from citrus (fruit) waste. Cornstarch fermentation in corn wet-milling plants typically yields 18 to 20 pounds of citric acid per bushel of corn.

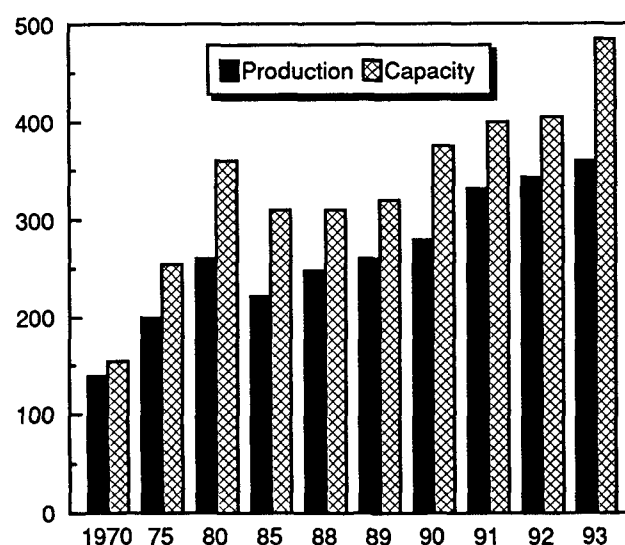
The U.S. citric acid industry has undergone a substantial change in the past 4 years, in both producers and production capacity. In early 1990, Cargill, Inc., entered the business with a new, 5-million-pound-per-year plant at Eddyville, IA. Cargill is currently expanding the capacity of its Eddyville plant from 80 million to 160 million pounds per year. In late 1990, Archer Daniels Midland (ADM) acquired the citric acid and citrates business of Pfizer, Inc. The purchase included a plant at Southport, NC, and one in Ireland, but excluded a Groton, CT, plant. ADM has since expanded its Southport plant's capacity by 80 million pounds to 180 million pounds. The third major producer of citric acid in the United States is the Harman & Reimer Corporation. Harman & Reimer operates two U.S. plants, one in Dayton, OH, and the other in Elkhart, IN. These two facilities have a combined annual capacity of approximately 150 million pounds.

Given domestic consumption of 360 million pounds and production capacity until recently of 410 million pounds (excluding Cargill's 80-million-pound expansion), U.S. citric acid firms have been approaching 90 percent of capacity (figure 6). In recent years, imports have played a significant role in the U.S. market, contributing 15 percent of U.S. demand. A pound of citric acid currently has a market value of 76 cents. According to industry sources, prices are expected to increase to 88 cents per pound by 1995/96.

Figure 6

U.S. Citric Acid Capacity and Production

Million lbs.

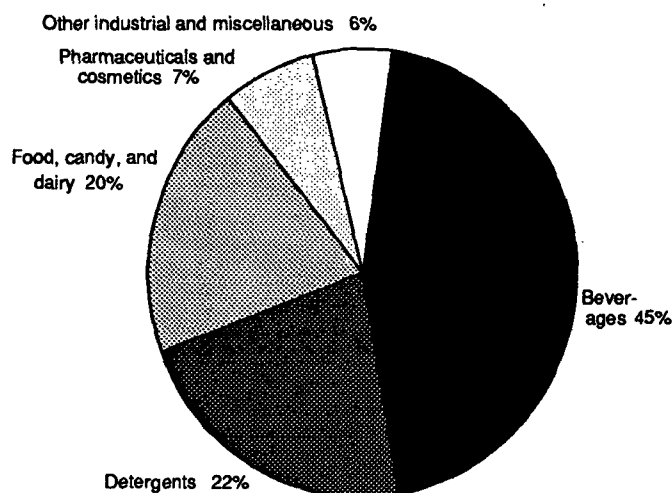


Source: Irshad Ahmed, Institute for Local Self-Reliance, Washington, DC, May 1994.

The beverage market accounts for approximately 45 percent of citric acid used in the United States, with another 20 percent used by the food-confectionery industry, 22 percent in the soaps and detergent industry, and the remaining 13 percent in a variety of industrial processes and product applications (figure 7). As mentioned above, the food industry uses citric acid as an acidulant, mostly in carbonated beverages, jams, jellies, and other foodstuffs. While overall food and beverage markets are relatively mature, this segment has regularly contributed 2 to 3 percent a year to the growth in citric acid demand. This increased demand has recently taken the form of new consumer products, such as "natural" beverages, "clear" beverages, and "sports drinks."

Figure 7

End Uses of Citric Acid in 1993 ^{1/}



^{1/} Use in 1993 was 360 million pounds.

Source: Irshad Ahmed, Institute for Local Self-Reliance, Washington, DC, April 1994.

Eutrophication of streams and lakes by phosphates in soaps and laundry detergents has resulted in a drastic increase in the demand for sodium citrate, a derivative of citric acid. Unlike phosphate-containing formulations, detergents with sodium citrate do not require high-cost, energy-intensive sewage treatment. Sodium citrate acts as a bulking agent in detergents and is widely used in liquid laundry detergents. The demand for sodium citrate in liquid detergents is growing 3 to 5 percent per year.

Citric acid has also captured a portion of the pharmaceutical industry. It is used in a variety of drugs, including the manufacture of citrates and effervescent salts. The ion-sequestering and buffering properties of citric acid are important to industry, both in product processing and end-product formulation. Industrial applications include degreasers, metal-cleaning and -finishing compounds, agricultural nutrients, oil-well acidizing, and stack-gas desulfurization. Citric acid also is used in the production of acetyl tributyl citrate, a vinyl resin plasticizer used to impart flexibility to molded plastic products.

With Cargill's new capacity on line, the U.S. supply of citric acid is adequate to meet demand for the foreseeable future. Because no significant demand changes are expected in the food and beverage industry, the U.S. demand for citric acid is expected to track the growth of the U.S. Gross Domestic Product, which is projected at 3.6 percent for 1994. Worldwide demand is expected to be slightly higher, between 5 and 6 percent. Increased environmental regulation could push these estimates upward. Moreover, since major U.S. producers are expanding their capacities, the United States may soon become a net exporter of citric acid, rather than a net importer. [Douglas Beach (202) 219-0428, Tom Tice (202) 219-0840, Allen Baker (202) 219-0840, and Irshad Ahmed (202) 232-4108]