Sweet Spots

BY MARY K. ZAJAC

Sugar beets being delivered on a conveyor belt, for processing at a sugar mill.

JUSTIN TSUCALAS

OUR INSATIABLE APPETITE FOR SUCROSE KEEPS THE WORLD'S SUGAR REFINERIES COOKING

The air smells sweet in the courtyard under the giant Domino Sugars sign visible from all angles of the Baltimore harbor. The ship that discharged the current batch of raw sugar for American Sugar Refining's Baltimore refinery (formerly the Domino Sugar Corporation) has left the port. In a warehouse, a man in a front loader pushes piles of tawny, inedible raw sugar into what looks like giant sand dunes. A few bees, fat and drunk on sugar, buzz about lazily. Dressed in hard hat and safety glasses, his hair (and beard) encased in netting, refinery manager Stu FitzGibbon climbs the refinery's metal steps, pausing only to greet an employee by name or to take in a quick view of the harbor filled with sailboats and swooping Seagulls.

"I love sugar," says the 32-year industry veteran. The world would agree.

Imagine a world without refined sugar. No candy, no jam, no pickles. Bread rises with difficulty without sugar to boost the yeast. Medicines become a challenge to swallow in their unadulterated state. Forget that morning doughnut.

Imagine a world without refined sugar. Difficult, isn't it?

As Michael Pollan acknowledges in *The Botany of Desire*, his exploration of the complex relationship between plants and human desires, humans are wired for sweetness. "A taste for sweetness appears to be universal [among different cultures]," writes Pollan. "This goes for many animals, too, which shouldn't be surprising, since sugar is the form in which nature stores food energy." Mammals get their first taste of sweetness from their mother's milk, explains Pollan, and the taste for sugar only grows from there. Since sugar was first introduced to England in the 13th century, the world's taste for sugar hasn't ceased.

In recent decades, high fructose corn syrup and artificial sweeteners (from saccharine to Splenda® and aspartame) have made inroads into the sugar market. Yet old-fashioned sugar has prevailed. According to the USDA, in 2010, Americans consumed roughly 66 pounds of sugar per capita, the highest amount since 1999, whereas high fructose corn syrup consumption

Above: A sugar beet. Right: A worker stands among sugarcane plants on a plantation in India in 1929.

at 64.5 pounds hit its lowest levels since 1986.

"There's been some migration back to sucrose as a sweetener," says FitzGibbon. "The public started to realize that simpler is better. [Sugar] tastes better too."

Sugar, or sucrose, is a naturally occurring product derived from both sugar cane and sugar beets—one- to two-foot-long white root vegetables weighing three to five pounds. Incredibly, the sugar produced from each source is virtually identical, but only an expert in the sugar industry might be able to tell the difference between the two sugars, concedes Mark Whitford, vice president of sales

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and marketing for Sweeteners Plus Inc., a sugar distributor in Lakeville, N.Y. "Beet sugar has more of an earthy smell, while cane has a clean, sweet smell," he explains.

Still, says Jack Roney, director of economics and policy analysis for the American Sugar Alliance (ASA), "no other commodity in the world that comes from such different plants has an outcome that is so indistinguishable. It's the same outcome from grass and tuber."

Sugar is produced on six continents and in more than 100 countries, including Brazil, the largest producer of sugar worldwide, as well as India, China, Thailand, Poland, Ukraine, Pakistan and the U.S. Eighty-one percent of sugar worldwide is made from cane (grown in tropical and subtropical areas), while sugar beet production is relegated to cooler climes.

Approximately 72 percent of the world's sugar stays within each country of production, with the remaining 28 percent available on the international market. In the United States, nearly all the sugar produced in the 18 sugar-producing states is consumed by Americans.

In the U.S., however, the amount of sugar made from sugar beets versus sugar cane is roughly equal—55 percent comes from sugar beets, while 45 percent comes from cane. Sugar beet production is centered west of the Mississippi in cool climate states like California, Washington, Colorado, Idaho, Minnesota, Montana and North Dakota. Sugar cane, on the other hand, needs a warmer, more humid climate and thrives in areas like Florida, Hawaii, Louisiana and Texas.

Production costs for each method of refining are highly dependent on weather, explains Roney. Monsoons can severely damage a cane crop in the Philippines, while drought can affect the sugar beet crop in Russia. "In most years with good rain, lower cost productions are associated with sugar beets," says Roney. Both sides of the industry are interdependent on the other's harvest, and will make up for shortfalls if necessary.

"In our industry, we never have two years that are the same," says Whitford. Still, according to the ASA, sugar producers generate nearly $20 billion a year for the U.S. economy. In Brazil, the sugar cane industry contributed $50 billion, or 2.4 percent to the country's GDP in 2010.

Sugar, says FitzGibbon, "is an old industry that's thriving."

A Powerful History

Sucrose has been part of the human diet for more than 12,000 years. It was "first domesticated in New Guinea,

Sugar Fun Facts

- Sugar's name originated from the Sanskrit *sarkara*, which means "material in granule form."
- Sweet is the only taste humans are born desiring.
- Sugar cane stalks can reach up to 30 feet high.
- One teaspoon of sugar equals 15 calories.
- White sugar is pure sucrose. Brown sugar contains molasses. Dark brown sugar has more molasses content than light brown sugar.
- Confectioners, or powdered, sugar is sugar ground to powder, sifted, and then blended with cornstarch to prevent caking.

Cultivating a sugar beet field. A truck unloads sugar beets at a sugar plant in Groningen, Netherlands.

first processed in India and first carried to the New World by Christopher Columbus," explains Johns Hopkins University Professor Sidney W. Mintz, a world authority on sugar and the author of *Sweetness and Power*.

Before sugar reached the New World, the Crusaders brought it back to England in the 13th century. There it was used as both a spice and for medicinal purposes. In the 15th and 16th centuries, both sugar and honey were used as sweeteners, but by the 18th century, Mintz reports, "sugar—sucrose—won out over honey as an item of *mass consumption* … and has never retreated." In the 19th century, he adds, sugar consumption in the United Kingdom quintupled.

The sugar that Britons and other Europeans were stirring into their tea and using to sweeten their chocolate came primarily from colonies in the Caribbean or West Indies. Christopher Columbus brought sugar cane from the Canary Islands to Santo Domingo during his second voyage in 1493. By 1516 Dominican sugar was being harvested and refined via slave labor and shipped back to Spain. In turn, Dutch, British and French sugar plantations dependent on slave labor would follow on islands like Jamaica, the Antilles, Cuba, Puerto Rico and Antigua.

Sugar would become an invaluable international commodity, and until the abolition of slavery in Europe and the United States in the 19th century, it was part of the insidious "triangle trade" that swapped human capital for goods like sugar and rum, made from sugar's byproduct, molasses. After slavery was abolished, Europeans turned to sugar beets, something previously relegated to cattle feed, as a source for their sugar, establishing factories in Germany, France, Poland and other cool-climate countries.

In the United States, sugar refining from cane began in earnest in Louisiana in the late 18th century, with an influx of expert planters and refiners who were fleeing Haiti after its revolution. By 1812, Louisiana boasted 75 sugar mills. Sugar beet production was attempted in the U.S., mostly on the East Coast, soon after, but failed to flourish. It wasn't until 1870 that the first successful sugar beet factory was established in central California. By 1917, the U.S. operated 91 sugar beet factories in 18 states. Today there are 22 sugar beet refineries in 11 states. All the refineries are cooperatives, allowing smaller operators to pool their collective resources for equipment and better buying power.

Refining: From Field to Factory

On paper, the process of making sugar sounds easy: You simply remove sucrose from the sugar beet or cane and then separate molasses, a byproduct, from the raw sugar. In reality, the process is a lot more complicated and slightly different for each product being produced. Sugar beet harvesting is nearly 100 percent mechanical worldwide, whereas sugar cane harvesting varies, with developing countries more apt to use more manual labor. In Brazil, mechanization accounts for roughly 55 percent of the harvest.

"Once a beet is out of the soil or cane is cut, it has to be processed quickly because the sucrose depletes quickly," explains Jack Roney. For this reason, most beet and cane refineries are located close to the beet or cane fields.

Although sugar beet refineries operate year-round, the process begins in earnest in the U.S and in most international beet-growing locations

Processing raw sugar and molasses from sugar cane in Bais City, Philippines. A technician works inside a sugar factory in the Mexican town of Ameca, Jalisco.

with the October harvest, when sugar beets are harvested by machine. A defoliator removes the green tops and slices a portion from the top of the beet, which contains a high level of impurities, while a pinch wheel harvester pulls the beets from the soil at the root. Beets are weighed and a sampling is tested for sugar content, which can vary between 10 percent and 20 percent. Then the beets are moved to storage and stacked in piles measuring 18 feet tall and 1,500 feet wide. Although beet sugar refineries are busiest during the fall harvest, technology has made it possible for beets to be kept under controlled conditions for up to six months so that refining can occur throughout the year.

In preparation for extraction, beets are washed several times before being sliced by large drum slicers (industrial graters equipped with pairs of rotating opposed groove knives) into thin strips called cossettes, making them look a little like raw shoestring French fries. The cossettes are placed in large diffuser tanks filled with hot water and then agitated in a process called countercurrent flow—this extracts sugar, turning the water into a thick liquid mix of water and sugar called juice. To remove impurities in the juice, a slurry of calcium hydroxide called "milk of lime" is added and then the entire mixture is carbonated in large tanks for 20 minutes to an hour. The milk of lime bonds with the impurities and is filtered out, leaving a thin syrup, which is first evaporated and then crystallized and spun in a centrifuge to dry. The result is refined white sugar; the byproduct is molasses. Some of the molasses is sold as food grade. In a process called molasses de-sugarization, a small quantity of molasses is run back through the system for further extraction, which often yields around 10 percent more sugar. The largest portion is sold to supplement cattle feed (yes, cows have a sweet tooth, too).

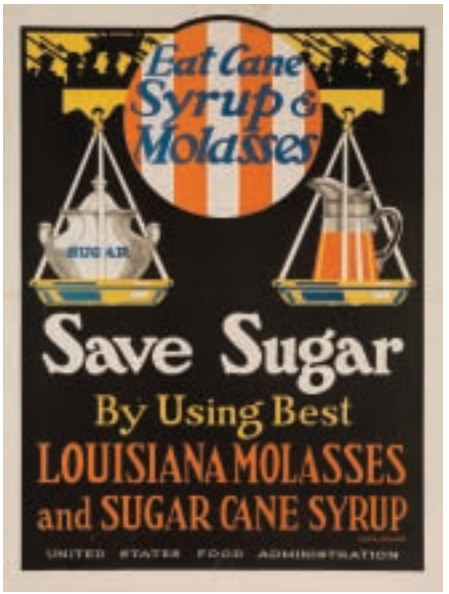
Sugar beets can yield 70 percent to 86 percent of the sugar already within beets when the process started, and a sugar beet cooperative like the Southern Minnesota Beet Sugar Cooperative in Renville, Minn., can process 6,500 tons of sugar beets per day, and 562.5 tons of sugar per day.

Unlike sugar beet production, cane refining is a two-step process that takes place at sugar cane mills and then at cane refineries. The first step in cane sugar refining is extraction, where the cane is put through rollers similar to an old-fashioned laundry mangle and crushed to extract the juice. Slaked lime is added to the juice to filter out impurities, and then the juice is thickened into a syrup through evaporation. The syrup is then boiled until conditions are right for the sugars to form crystals, and the resulting crystals are spun in a centrifuge to separate them from the remaining liquid. Next comes step two: The raw sugar, an inedible product that results from cane extraction, is sold to cane refineries, like American Sugar Refining Inc. (ASR), where it will be turned into 40 different sugar products—including white, confectioners and various browns—and sold under familiar labels like Domino, Florida Crystal, C&H and Redpath (ASR also packages sugar for other customers under their labels).

Unlike sugar beet production, cane refining is a two-step process that takes place at sugar cane mills and then at cane refineries.

American Sugar Refining is the world's largest sugar company, with more than 17,000 employees (including manufacturing and distribution) and 10 refineries in the United States, Canada, Mexico, England, Portugal

A trio of sweeteners: regular, cane and high fructose corn syrup. An advertisement from the United States Food Administration, ca. 1918.



and across the Caribbean. The company farms 439,000 acres of sugar cane and harvests 12.5 million tons of cane annually. The Baltimore facility is second in production only to the New Orleans refinery; in 2011, the Baltimore plant produced 885,000 tons of refined sugar. It is, as refinery manager Stu FitzGibbon describes it, "a major operation."

Still, on first glance, it's also easy to understand what FitzGibbon means when he says that the public perception of sugar refineries is that they are old and outdated. The 29-acre ASR Baltimore refinery opened in 1922 and many of its darkened brick buildings are still in use (its iconic neon sign was erected in the 1950s). But "just because sugar refineries are old does not mean the technology and equipment are old," says FitzGibbon. As he points out frequently throughout a tour of the Baltimore facility, jobs that once required mostly manual skills now require critical thinking.

"The main thing our employees do is think," says FitzGibbon, pointing to a 10-year employee who is monitoring a computer screen that regulates "affination centrifuges"—tanks that spin 900 pounds of raw sugar that has been blended with a small amount of water and molasses (also known as magma) every three minutes. "It's a more thoughtful process than it used to be," he adds.

Raw sugar is 98 percent sucrose, and the Baltimore refinery is "a huge facility for 2 percent removal," jokes FitzGibbon wryly. The refining process is a series of melts, rinses and evaporations all designed to separate the molasses from the sugar crystals. This refinery produces 6.5 million pounds of sugar (or melt, as the industry calls it) per day. It even has its own powerhouse.

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Opportunity … and Challenges

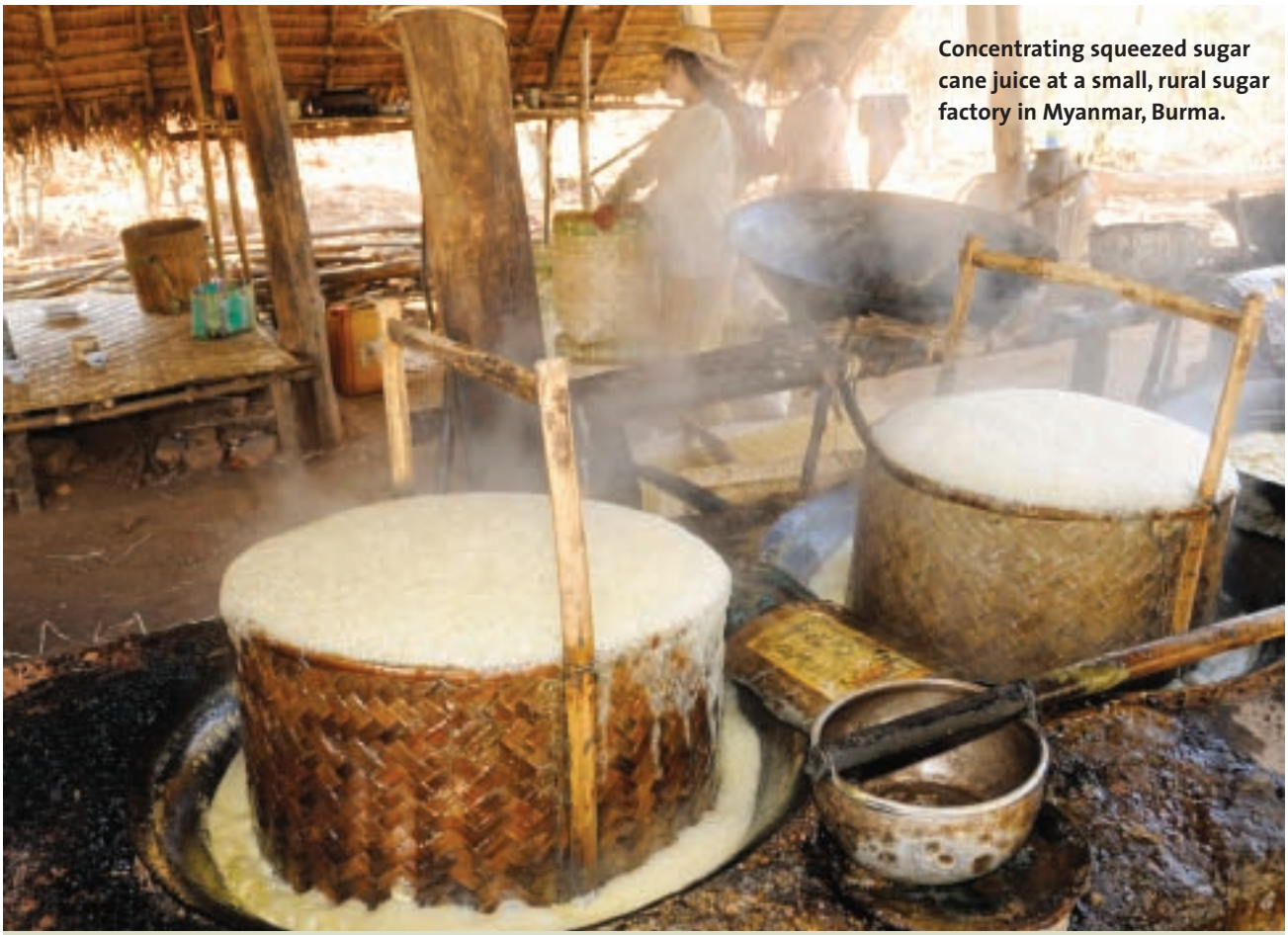
Consumers across the U.S. and around the world can choose from white, brown, confectioners and other specialty sugars in their supermarkets, and the industry continues to introduce new products and packaging. A demand for organic products has led to a limited production of organic sugar. Domino has also begun to offer alternative packaging in the form of four-pound plastic tubs of refined sugar rather than the familiar five-pound bags.

Although the American sugar industry receives no government subsidies, it is heavily regulated, and both the domestic and international sugar industries pay close attention to discussions of free trade agreements since such agreements—as well as weather and supply—affect both the international commodity market and pricing.

The sugar industry will also continue to face competition from the artificial sweetener industry as people worldwide face the conundrum of trying to cut calories without eliminating sweetness.

"Sugar-free has taken a huge bite out of the sugar industry," admits Mark Whitford of Sweeteners Plus Inc. "But while you get sweetness from sugar, you also get body. Take that away from soft drinks and you're left with water and sweet. It's not the same.

"Sugar will never go away."



Concentrating squeezed sugar cane juice at a small, rural sugar factory in Myanmar, Burma.

Sugar Around the World

- Global consumption of sugar increased steadily by 2.5 percent per year between 2000 and 2010.
- Global sugar production for the 2011–12 marketing year is forecast at roughly 185 million tons, up 4 percent from 2010–11, according to the USDA.
- The U.S. is the largest consumer of natural sweeteners, consuming around 10 million tons of refined sugar each year.
- India is the largest consumer of sugar in Asia (roughly 17,000 tons), followed closely by China.
- Brazil is the largest exporter of sugar (accounting for 53 percent of world trade), followed by India, China and the United States.
- The U.S. produces approximately 70 percent of the sugar it consumes, importing the remaining 30 percent from other countries like the Philippines, Zimbabwe, Belize and Fiji.