INTERACTION ENCOURAGED

The Alcohol School brings fuel and beverage producers together to learn and share solutions.

By Lisa Gibson

Jaime Finguerut, director of the Sugarcane Technology Institute in Brazil, showed a presentation slide titled, "EMERGENCY!" as he explained to his audience at The Alcohol School Sept. 10 that the climate crisis is the largest global demand driver for ethanol.

Finguerut presented at Lallemand Biofuels & Distilled Spirits' Alcohol School, Sept. 9-13 in Montreal, Quebec. Hosted by LBDS' Ethanol Technology Institute, the bulk of the event was held at InterContinental Montreal but featured nearby lab and production facility tours, including GreenField Ethanol-Varennes. This year marked the 39th year of the event, geared toward sharing lessons learned and educating both beverage and fuel alcohol industries, said Angus Ballard, president of LBDS. "We're proud of the tradition, but really, it's about information.

"The exchange of good ideas is a good thing in our industry. Interaction is encouraged." Presentations targeted almost all stages in the process, with a goal of helping attendees understand it from beginning to end, Ballard said.

"The success of the school continues to be based on the caliber of the presenters assembled," he said. "They don't come because we pay them money. They come because of their desire to share their expertise."

Students came from all over the world to understand and polish their alcohol processes. "The problems are similar," Ballard said of fuel and alcohol processes around the world. "So it's global, not geographical."

Focus on Feedstock

In Brazil, the world's second-largest producer of ethanol, 43 percent of gasoline is replaced with ethanol, compared to the United States' standard 10 percent, Finguerut said. He told his audience that 80 percent of Brazil's vehicle fleet is flex fuel, even the imports. "It's a very cheap conversion to make a car flexible." The cost includes about $200 in electronics and replacement of most of the plastics.

The sugarcane ethanol production process is refined and incredibly efficient, Finguerut said. Carbon dioxide from Brazil's process is put back into the soil, and the leaves are no longer burned, but are recycled back into production.

The feedstock procurement phase is quick and complex, Finguerut said, as sugarcane begins to deteriorate in a couple of hours, causing bacterial infection. During the process, most of the water comes from the evaporation phase, and fermentation is just eight hours. That results in low productivity because yeast has to be alive in order to recycle it, he said.

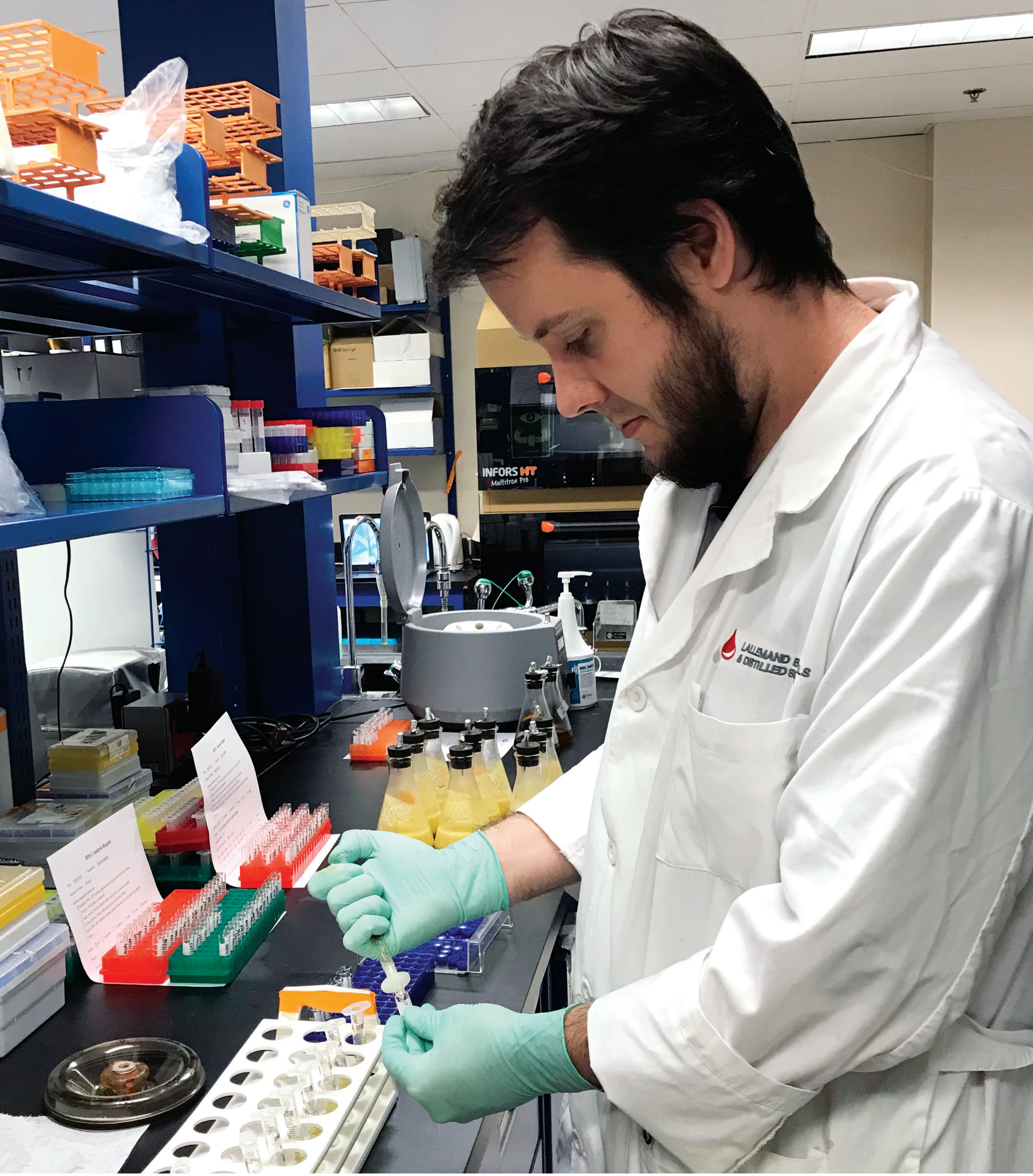
John Duff, of National Sorghum Producers, followed Finguerut and talked about sorghum as a feedstock. "We're a very small industry," Duff said of sorghum ethanol. He said 2 percent of ethanol in the U.S. is sorghum. "It's tiny, but it's exceedingly important in some areas." Those sorghum ethanol plants are in Texas and Kansas, because of sorghum's water, drought and heat tolerance.

Duff discussed carbon intensity, which comes mainly from farming activities and nitrogen fertilizer applications. Reducing those emissions won't be easy, but carbon sequestration is a large opportunity. "We sequester more carbon than people realize in agriculture," he said.

Corn ethanol has a carbon intensity of about 60 to 75 percent. But accountability of sequestration would result in 19 grams for corn ethanol, and sugarcane could have a negative carbon score, he said. "There is a lot of gain to be made with demonstrating that."

To the Lab

Day three of The Alcohol School moved from InterContinental Montreal to National Research Council Canada, where LBDS' re-



HARD AT WORK: Vincent Domingue Gauthier, Lallemand Biofuels & Distilled Spirits research assistant, works with samples in one of LBDS' labs inside National Research Council Canada facilities in Montreal, Quebec. Tours of LBDS lab space at NRC Canada were included in The Alcohol School, held Sept. 9-13 in Montreal.
PHOTO: LALLEMAND BIOFUELS & DISTILLED SPIRITS

IN THE CROWD: About 100 students gathered in Montreal, Quebec, Sept. 9-13 for Lallemand Biofuels & Distilled Spirits' Alcohol School. The course combines beverage and fuel alcohol education, and attendees receive a certificate at the end of the five-day event.
PHOTO: LALLEMAND BIOFUELS & DISTILLED SPIRITS

JUST A TASTE: The Alcohol School attendees flock around tasting tables at the event's well-known Wine, Beer and Spirits Tasting. The tasting was held in The Caves, a former armory that is now part of InterContinental Montreal.
PHOTO: LALLEMAND BIOFUELS & DISTILLED SPIRITS

search arm, Mascoma LLC, occupies several laboratories. Attendees toured eight of LBDS' labs and learned more about what should be taking place in their own.

Emily Stonehouse, research and development manager for Mascoma, told her audience that she considers herself a "yeast mechanic." Yeast is an important substance, she said, used to produce more than 80 percent of renewable fuels globally, as well as vaccines, pharmaceuticals, chemicals, proteins and more.

Stonehouse explained that the "holy grail" of yeast is to find a naturally occurring strain that possesses the desired traits. "But it's a lot of work," she said.

So, Stonehouse discussed two methods to craft yeast with desired traits: classical genetics and genetic engineering. Through classical genetics, no DNA is added from outside the cell. Instead, it uses other tactics such as mating, hybridization, protoplast fusion and mutagenesis. While it's not considered genetic engineering, classical genetics is time-intensive, imprecise and can result in unintended mutations.

With genetic engineering, DNA is added, Stonehouse explained. First, a trait is identified, and the gene sequencing is obtained. The genes are then synthesized, the yeast is designed and built, the DNA is transformed into yeast, and it's integrated onto yeast chromosomes. "The benefit of genetic engineering is it's really precise," Stonehouse said. "You built what you wanted to build."

Genetic engineering is also extremely fast, but it's regulated and carries a negative consumer perception, she added.

Still, genetically engineered yeast has been used for years in many applications, and about 70 percent of U.S. and Canadian ethanol plants use it to improve tolerance to inhibitors, reduce fermentation byproducts and prompt the yeast to excrete enzymes like glucoamylase, Stonehouse said. In 2012, Lallemand introduced the first commercially available glucoamylase-expressing yeast, TransFerm, which has continually been innovated, Stonehouse told her audience. Other yeast suppliers have developed glucoamylase-expressing strains, as well.

Caleb Ogden, technical manager for LBDS, spoke later that afternoon about sampling, saying consistency is important in process monitoring. Communication between the sampler and analyzer is crucial, he said, as is processing that sample in a timely manner. Make sure the sample is a sufficient quantity and representative of the batch, too, he added.

Ogden discussed monitoring of five areas of a plant: grain receiving, milling, cooking/liquefaction, yeast and fermentation, and distillation/final product. In grain receiving, low-tech equipment options include grain sieves, and even visual indications. High-tech grain receiving equipment includes near infrared or moisture analysis, Ogden said. Don't forget to clean bins, he told his audience.

Milling quality checks should employ consistent use of a sieve shaker, he said.

"There's a lot to look at when it comes to the third section, liquefaction," Ogden said. Plants will need to watch viscosity, density, pH, color, temperature, enzyme rates and odors. Density can be correlated to various percentages of solids measurements, he said. Viscosity can be visual, usually an indication of enzyme but also can indicate an improper grain-to-water ratio.

"Yeast cell counts and health are extremely important to monitor," Ogden said. Monitoring of yeast and bacteria can be done efficiently with microscopy, he said. "You have real-time contamination tracking." He also introduced other methods including dyes and bioluminescence.

Francois van Zyl, director of technical services for LBDS, had said during his presentation earlier that identifying contamination in yeast can be as easy as using a fluorescent microscope. The annual cost related to contamination can exceed $5 million, he said. "How many microscopes can you buy with $5 million?" It justifies basic monitoring, he said.

Finally, in distillation, Ogden continued, density can be determined with a hydrometer. More high-tech options exist but are not approved yet for fuel alcohol.

Ogden ended his presentation with a recommendation to calibrate regularly. Competent, passionate participants are needed in calibration, as well as adequate record keeping, he said.

"Calibration is critical," he concluded. "Without it, your data is useless."

The Case for Fractionation

At the beginning of his presentation, Vijay Singh, professor in Agricultural and Biological Engineering at the University of Illinois at Urbana-Champaign, said he was going to "make the case for fractionation." The conventional corn-to-ethanol production process does not maximize coproduct opportunities, he said.

Corn contains all kinds of unique proteins and fibers the ethanol industry is not currently separating out, Singh said. Removing these nonfermentables adds high-value coproducts, increases markets for distillers dried grains with solubles (DDGS), and improves final ethanol concentration, he said.

Lipids that are ideal proteins for human food and can reduce cholesterol, for instance, are present in significant quantities. "It's a natural product that has pharmaceutical properties," Singh said. He also named antioxidants that can be recovered such as tocols and carotenoids.

Then, there's fiber. "Right now, all this fiber that's present in the corn kernel gets concentrated in DDGS. And DDGS, because of its high-fiber content, is only used in ruminant animal diets." Only about 10 percent goes to poultry and swine because they can't digest the fiber, he said. Taking that fiber out expands the market for the product. "That's one reason we need to do fractionation."

For the front end, Singh detailed wet and dry fractionation. Wet fractionation, which consists of soaking corn in water and separating coproducts in an aqueous medium, uses wet grinding mills, hydrocyclones and screens for separation. Wet fractionation is very similar to the corn wet milling process, he said.

From one bushel of corn, wet fractionation removes 3.3 pounds of germ, 4 pounds of pericarp fiber and 4 pounds of endosperm fiber, Sing said. The result is higher protein in DDGS and higher final ethanol concentration.

The same separation can be done with the dry fractionation process, borrowing the unit operations from the corn dry milling process, including degerminators, gravity tables and sifters. The process removes 4 pounds of germ and 4 pounds of pericarp fiber.

Comparing wet and dry fractionation showed wet fractionation resulted in better quality germ and pericarp fiber, as well as better nutritional DDGS quality, Singh said.

On the back end, DDGS fractionation utilizes the Elusieve Process to remove 4 pounds of pericarp fiber from a bushel of corn, resulting in 11 pounds of DDGS that are digestible by poultry and swine, Singh said. The DDGS undergoes a physical separation process, sieved into different categories based on size, using different thermal velocities to separate fiber and enhanced DDGS.

The payback period of installing a system for DDGS fractionation is less than two years, Singh said, and the process has been commercialized in Hungary.

Thin stillage fractionation recovers crude oil through evaporation and centrifugation. The oil serves as an additional coproduct and reduces the oil content in DDGS, Singh said.

Scott Kohl, chief technology officer for Franzenburg, discussed several innovations in ethanol production, but echoed Singh when he said current DDGS are not the best feed for most animals. Protein is too high for beef cattle, fat content is too high for dairy cattle, fiber content is too high for poultry, and oil content in hog diets produces softer bacon fat.

"The industry is showing that's going to be the next big wave of process changes," Kohl said.

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