Kisaalita Engineers Solutions for Africa's Rural Poor

http://www.psmag.com/science/kisaalita-engineers-solutions-for-africas-rural-poor-24895/ July 5, 2012

William Kisaalita is slowly revolutionizing the milk market in Uganda, guinea hen breeding in Burkina Faso and nut-oil cooperatives in Morocco. (Flip Chalfant)

For a moment, William Kisaalita is distracted. In a spacious, sunlit office at the University of Georgia, Kisaalita should be focused on the book he just published, or the pile of papers teetering on his desk, or the phone calls and visitors that repeatedly interrupt his afternoon. Instead, Kisaalita, a professor and tissue engineer at the university, leans back in his chair, locking his hands behind his head, his dark eyes narrowing.

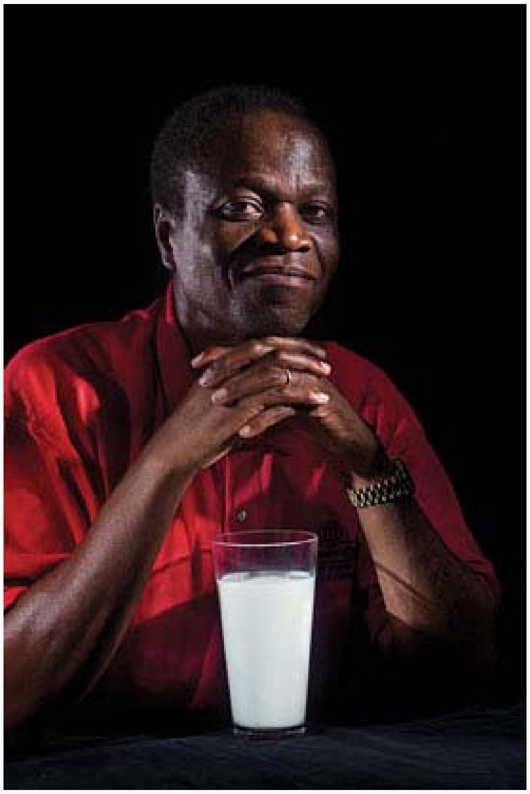
"When you come here and are successful," he says, gesturing around the large office, "you have this nagging feeling. What have you done for the people at home?"

William Kisaalita was born, raised and educated in Uganda. Now he works by day as a bioengineer, designing three-dimensional cell-based biosensors, a promising new technology that could revolutionize how pharmaceutical companies test new drugs. But for every minute Kisaalita talks about biosensors and microwells, he's apt to spend an hour discussing his true vocation — bringing simple engineering solutions to the rural poor in Africa. "This is not the kind of work you do to get tenure," Kisaalita says in a melodious accent.

Kisaalita is devoted to smallholders, African farmers who cultivate 2 to 10 acres of crops on single-family farms. His passion (obsession, some would call it) has cost him a promotion and recognition. But with perseverance and funding from a surprisingly diverse set of organizations — including the World Bank, the U.S. Department of Agriculture, the Environmental Protection Agency and the National Science Foundation — Kisaalita is slowly revolutionizing the milk market in Uganda, guinea hen breeding in Burkina Faso and nut-oil cooperatives in Morocco.

"What he's doing is absolutely unique," says Vicki McMaken, Kisaalita's colleague and assistant director of the Office of Global Programs at UGA. "He identifies a problem that affects the poorest people in a community and finds a solution that fits the scale of the problem."

Every night along Uganda's "cattle corridor," a 50,000-square-mile dry-land area stretching north to south, farmers pour milk down the drain. There are more than 2.5 million dairy farms in the region, and most have between two and five cows. Milked in the morning and evening, the cattle produce an average of 50 liters of milk per day. During the day, the milk can be sold to local vendors, who test its freshness and transport it to cooling stations. When markets are closed in the evening, though, farmers have no way to cool the milk. They



William Kisaalita received a $200,000 grant from the World Bank to commercialize his milk cooler product. (Flip Chalfant)

When he first attempted to tackle the problem, Kisaalita drew up plans for solar-powered cooling centers scattered across the region. But at $200,000 apiece, the centers were implausible. So in 2002, Kisaalita organized a design team for UGA engineering undergraduates, intended to expose them to Third World engineering challenges. He took his first group of students to Uganda during spring break to introduce them to the milk-cooling problem. Then, thanks to a $100,000 grant from the National Science Foundation, Kisaalita brought a team of students with him to Kampala, Uganda's capital city of 1.5 million, for eight weeks during each summer for three years to work on a prototype cooler.

Together, they fabricated an insulated metal cylinder about the size of a dishwasher, big enough to hold a traditional 50-liter milk can. The design relies on zeolite, a mineral with a remarkable capacity to absorb water. A milk can placed into the container is surrounded by a small amount of water. The container is attached, by a valve, to a vacuum. When the valve is opened, water exposed to the vacuum vaporizes. As it does so, the water sucks heat from the milk, a process called evaporative cooling — like the chill you feel on your skin when stepping out of a pool. The zeolite — packed into an attached container — absorbs the water vapor, so the vacuum remains and vaporization continues in a loop.

But the system does require an energy input. Each morning, after cooling the milk all night, the zeolite has to be heated to burn away the collected water. Mia Mattioli, an undergraduate who joined Kisaalita during the first summer, remembers that tedious process. "My job was literally to watch rocks dry all summer long," she says, laughing. They toiled away, but the prototype simply didn't work well enough to market. "Product development takes a long time," Kisaalita says, chuckling in hindsight. Then, inspiration came from an unlikely source — a

In Germany, a company called Cool-System had designed a self-cooling keg for affluent beer drinkers. Kisaalita approached the manufacturers and suggested the design, which also used zeolite, might be suited for rural Africa. “They initially laughed at us,” Kisaalita says. But he was eventually able to convince the executives that there was a market for the cooler in Uganda, and with some redesign, Cool-System produced the “CoolChurn,” a keg-like cooler that chills 15 liters of milk within three to four hours and keeps it cold for a full day. In 2008, Kisaalita received a $200,000 grant from the World Bank to begin commercializing the product. The company made 60 coolers, designed to be recharged each night at a central station where electric heat is used to dry the zeolite. Kisaalita prepared to distribute the coolers but ran up against an obstacle that all his engineering ingenuity couldn’t solve — the smallholder farmers didn’t want them.

Last year, at a town meeting in rural Uganda, Kisaalita welcomed farmers to an informal gathering to introduce the prototype. Just 14 farmers showed up. One warily approached Kisaalita. “Why are you targeting us?” he asked. Kisaalita was floored. He soon learned the farmers were leery of using a technology that richer, neighboring farmers weren’t. The milk cooler was just too small and too cheap: Larger farmers wanted a bigger cooler to store significantly more milk, and poorer farmers wouldn’t invest in a cooler until the larger farmers did. But unlike many aid groups that make their way to Africa, Kisaalita is in the development business for the long run.

If the poor wouldn’t use a milk-chiller until the rich bought it, then William Kisaalita would build a milk-chiller for all men.

Kisaalita grew up on a 2-acre farm 10 miles outside Kampala, where he worked alongside six siblings planting and harvesting seasonal crops — corn, cassava, bananas, peanuts and more — by hand.

When he was 9, Kisaalita became ill. His father brought him to the Kampala hospital; he recovered. As they headed home, his father made a quick stop at the Ministry of Works, where he was a mechanic for the government to provide a supplemental income for his large family. Kisaalita had never been to the workshop before. He stood transfixed in front of a massive machine that shook the ground beneath his feet. The tall metal structure hissed and banged as a giant hammer lifted into the air, then slammed down onto red heated metal below. “I thought, ‘Man, I want to build something like that,’” Kisaalita recalls.

At age 15, Kisaalita was sent to boarding school, then to Makerere University in Kampala, where he studied mechanical engineering and met Rose Mayanja, the woman who would someday be his wife and mother of his four children. As a capstone project at Makerere, Kisaalita constructed a hand-operated mill to squeeze juice from sugar cane. Kisaalita made the mill with Ugandans in mind: They could use it while harvesting sugar cane for subsistence; they couldn’t sell it because the sugar industry in Uganda had collapsed when dictator Idi Amin expelled the country’s Asians, who had controlled the industry.

As Kisaalita prepared to graduate, Amin’s regime was on the brink of collapse. The country was in turmoil, and Kisaalita knew he would need to continue his education abroad. He went to the University of British Columbia in 1978, returning to Uganda in 1982 with a master’s in bioengineering and big plans to solve Uganda’s food challenges. But the political atmosphere was still tumultuous, so Kisaalita went back to Canada to complete his doctorate. He took a string of postdoctoral fellowships across Canada and the U.S., finally landing at the University of Georgia for his first faculty position in 1991. Almost 20 years later, he’s still there. But it hasn’t all been smooth sailing.

Several years after arriving at the University of Georgia, Kisaalita was up for a promotion that he didn’t get. Colleagues attribute the loss to his split interests. “Tissue engineering is sexy, and inquiring about how to move two gallons of milk is not,” says Brahm Verma, a professor of engineering at UGA and Kisaalita’s mentor.

“Professors like William are rare. He doesn’t work because he’s employed,” Verma adds. “He has a passion for the things he does.” These days, that passion has led him to confront the needs of guinea hens and the art of nut cracking.

In 2005, Vicki McMaken, in the Office of Global Programs at UGA, pitched an idea to Kisaalita: Could he find a way to help Moroccan women crack nuts?

The deep roots of the thorny argan tree prevent erosion along the savanna in southwest Morocco. More important to international consumers, the trees produce argan nuts, the source of argan oil, a product rich in vitamin E that is used in cosmetics and as a hazelnut-like ingredient by gourmet chefs. Companies that export the oil employ local women to crack the nuts and harvest the seeds. It is no easy task — the almond-like nuts are some of the toughest in the world. Sitting on the ground, women smash the shell between two rocks without damaging the kernels inside. Producing a liter of oil takes some 20 hours of work, in a labor-intensive process that has mangled many hands.

McMaken and Kisaalita traveled to Morocco, where Kisaalita sat down on a dirt floor, to the laughter of the woman around him, and attempted to crack a nut. “It’s very hard,” he admits with a sheepish grin. As soon as they stepped outside of the hut, Kisaalita turned to McMaken and declared, “We have to help them.”

Kisaalita assigned the project to his students: Make a nutcracker that uses some kind of crank shaft requiring human skill (so the women would retain their jobs) and is only three times faster than cracking with stones (because if it is too fast and profitable, men will take it over). Today, Kisaalita and his students have developed three prototypes, simple metal and wood structures that catch and crack a single nut at a time. Kisaalita has declined to patent the technology. “It doesn’t matter to us if someone takes the technology and improves it, if it stays directed at the customer,” he says.

Argan nuts in teh nutcracker Kisaalita and his students engineered. (Flip Chalfant)

As his students worked on the nut-cracking project, Kisaalita began another, which has taken him to Burkina Faso, a poor, landlocked country just north of Ghana with one of the lowest per capita gross domestic products in the world. In 2005, Salibo Some, founder of Africa’s Sustainable Development Council, or ASUDEC, gave a seminar at UGA, his alma mater, on guinea fowl production. For a variety of reasons, smallholders in Burkina Faso struggle to raise more than 50 guinea fowl — locally called “chickens” — at a time, Some says. As he described the problem to the crowd, Kisaalita’s ears perked up. After the talk, Kisaalita approached Some. “This is something I can help with,” he said.

One of the central problems for the farmers is lack of incubators. Incubators failed in the region before, Some says, because they required daily technical adjustments for temperature and humidity, and farmers with little incubator that can brood up to 100 eggs at a time. He and Some tested the incubator in the field, where it worked with 85 percent success. Now they are looking for a local manufacturer that will make the unit, reducing the price and bringing industry into the country. “If we succeed in putting these technologies into the countryside, it will really be a revolution,” Some says.

But as he’s become wrapped up in nuts and chickens, Kisaalita hasn’t forgotten about the milk.

Today, 15 Ugandan farmers use the smaller, keg-styled milk cooler Kisaalita built with Cool-System. But he’s also changing his product to meet demand, designing a larger cooler with the 70-to-100-liter capacity that wealthier farmers want. Once the new cooler is adopted, he hopes more poor farmers will be interested. And Kisaalita has engineered both the smaller cooler and the new, larger prototype to run on biogas, rather than electricity.

Last May, Kisaalita went back and built the first such biogas system at a farm in western Uganda, outside the city of Mbarara. Flavia Kato, a widow with 10 cows had volunteered her farm as the biogas system test site. In her yard, wooden posts stick up from the ground, marking the beginnings of a cow dung shack. A pipe runs from the shack to a deep trench dug into the red clay, where men build two small brick domes. Kisaalita takes pictures from above. One dome will be an underground dung fermentation reservoir; the other will hold fermented slurry. Gas that emanates from the process, consisting primarily of methane and carbon dioxide, will be collected from the second dome via a pipe and then transported to an oven and burned each night, providing heat to dry out the zeolite.

Kato is thrilled with the progress. A widow, she needs all the extra income she can get, and once the new system is in place, she hopes to expand her herd, Kisaalita says. “I’ve learned if you bring technology to expand their production, farmers’ immediate reaction is to expand and improve as much as possible,” he says.

Kato ushered the men inside for lunch, demanding they take a break from the African sun. Construction will take days, testing the new system will take months and finding a way to encourage other farmers to adopt it may take years. But it will happen, Kisaalita believes. “We’re optimistic,” he says. “Besides, the journey is more fun than the destination.”