Vitamin A Super Banana in human trials

The first human trial to test the efficacy of a genetically modified (GM) nutritionally enhanced banana is starting in the US. Conceived by researchers at the Queensland University of Technology (QUT) in Brisbane, Australia, to provide a good source of beta carotene, the Super Banana has $10 million in backing from the Bill and Melinda Gates Foundation. The genetically enriched, golden-colored banana may help prevent blindness caused by vitamin A deficiency in Ugandan children whose diets are deficient in this nutrient (*Nat. Biotechnol.* **30**, 1017–1019, 2012). But leaders of the banana project are embarking on a historically precarious path. Golden Rice, the previous GM crop developed to alleviate vitamin A deficiency in the poor, met fierce hostility and regulatory hurdles that have plagued its development for 15 years. The rice still hasn't been commercialized in its target country, the Philippines. Whether the banana will meet a similar fate remains to be seen.

Opposition from anti-biotech activists in the media so far has been minimal, and radical activist presence in Uganda and other African countries is generally small. "I don't have the feeling that we'll have a big negative response in this part of the world," says Claude Fauquet, director of the Global Cassava Partnership for the 21st Century (GCP21) at the International Center for Tropical Agriculture (CIAT) in Cali, Colombia. "None of the field trials in Uganda has been destroyed or even visited by anti-GM groups. I'm not sure the anti-GM activists will spend money on this country." Uganda is the world's second biggest banana grower and possibly one of the highest consumers. Ugandans eat between 0.61 and 1.6 kg of bananas a day. Fauquet says rural farmers in Uganda have little exposure to the media and tend to trust the advice of local organizations and national ministries, many of which have been supportive of biotech.

Super Bananas have been modified with the banana gene phytoene synthase (PSY2a), isolated from the asupina banana, which is naturally high in beta carotene, a precursor to vitamin A. The gene is under the control of the maize polyubiquitin promoter or the banana aminocyclopropanecarboxylate oxidase promoter. The gene construct can increase the level of beta carotene in bananas to 20 μg per gram dry weight, says James Dale, director of the Centre for Tropical Crops and Biocommodities at QUT and leader of the Super Banana project.

Dale says the gene construct will be used in two banana cultivars suitable for Ugandan diets: the East African Highland banana and a conventionally bred, disease-resistant hybrid called Kabana 6H. For the US feeding trial, human volunteers will eat a different variety—the cavendish banana—containing the transgenes. The trial aims to determine how well beta carotene from the banana is converted to vitamin A in the human volunteers.

Erika Fish, QUT

But is it golden? Stephen Buah (left) and James Dale, from Queensland University of Technology, display the Super Banana.

Still, academic scrutiny and debate has begun. The Super Banana has "divided in some way the banana research community," says Rofina Yasmin Othman, a plant virologist and banana researcher at the University of Malaya in Kuala Lumpur, Malaysia. The concern is that funding organizations are pouring money into GM bananas at the expense of conventional breeding research, which costs less and can, arguably, produce new cultivars faster. Some critics argue that it is unclear whether biofortified crops like the Super Banana can actually raise vitamin A levels in people who are malnourished. "A lot of vitamin A deficiency is simply due to poverty, and adding some vitamin A–rich foods can only go so far," says Michael Hansen, a senior scientist at Consumers Union in Yonkers, New York. People who are malnourished may not have the nutrients required to absorb beta carotene and convert it to vitamin A, adds Doug Gurian-Sherman, director of sustainable agriculture at the Center for Food Safety in Washington, DC.

How much vitamin A levels will increase in people who eat the banana is a question that the crop's developers hope to answer with the human trial. Results are expected by the end of the year. At the same time, Dale and his colleagues must be cognizant of the difficulties faced by their Golden Rice predecessors. One misstep of that group was failing to inform the parents of children involved in a human feeding trial of Golden Rice that it was genetically engineered. Another setback occurred when Golden Rice developers realized that early strains of the rice did not contain enough beta carotene.

"We've certainly learned from all of that," says Dale. "We've been incredibly lucky to come after Golden Rice. They've taken a lot of hits on the way through," he says. One advantage Super Banana has over Golden Rice is that it was jointly developed with scientists in its target country. "It's produced by Ugandans for Ugandans," Dale says. "That's a big difference." And unlike rice, bananas are sterile. "So there's no concern about movement of transgenes," Dale says. Plus there's no multinational company involved—a factor that raised suspicions about Golden Rice, which was developed with help from Basel-based Syngenta.

A biotech law must still be passed by Uganda's parliament before any GM crop can be commercialized. The Super Banana project commenced in 2005, and Dale hopes to have it in farmers' hands by 2020. That's 15 years from laboratory to farm, even without the delays that plagued Golden Rice.

Emily Waltz *Nashville, Tennessee*