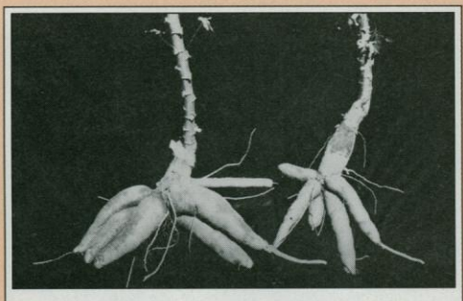
Biotechnology Reaches Beyond the High-Tech West

A common criticism of modern biotechnology is that it has produced products only for the rich—at about $4,500 per dose (current market price of tissue plasminogen activator), a genetically engineered bloodclot buster won't save many lives in the developing world. But proponents of the new biotech industry told an audience at last week's AAAS annual meeting that such criticisms are no longer valid: The fruits of biotechnology, especially in agriculture, are increasingly finding their way into impoverished areas of the world. "The progress in using agricultural biotechnology in developing countries has been remarkable," says Robert Fraley of Monsanto, who spoke with *Science* after his presentation in Chicago. And Fraley predicts that insect- and disease-resistant rice, as well as several entirely new crops, could be commercially introduced into some developing nations "by the middle to end of this decade."

If so, one of the keys to success will have been the mapping of genomes of economically important species. With a genetic map in hand, plant and animal breeders can learn in days or weeks, instead of months or years, whether a genetic cross produced a desired trait.

James Womack, an animal scientist at Texas A&M University in College Station—and another speaker—is putting this kind of selection into practice. Together with researchers at the Commonwealth Scientific and Industrial Research Organization Laboratories in Australia, the International Laboratory for Research on Animal Diseases in Nairobi, Kenya, and the International Trypanosome Tolerance Center in The Gambia, he is probing the genome of African N'Dama cattle. Compared with Western cattle, the N'Dama is a bovine runt, producing only a small fraction of the milk and meat of Holsteins and Herefords. However, N'Damas are resistant to the lethal parasitic disease trypanosomiasis, endemic to much of western Africa. Womack expects to have a genetic map of N'Dama by 1996. With that in hand, Womack says, he can examine newborn calves for the presence of the gene for trypanosome tolerance and only continue breeding those that have evidence of it. This way, he expects the 6 to 8 years normally needed to breed more productive N'Damas can be cut in half.

Success stories are cropping up for plants, too. About 5 years ago, researchers discovered that expressing the coat protein gene of a virus in a genetically transformed plant protected that plant against viral disease. In the United States, genes for viral coat proteins have been successfully inserted into tomato, alfalfa, tobacco, and melons. Now, Mexican researcher Louis Herrera-Estrella, working with the Rockefeller Foundation and Monsanto, is using this general strategy to genetically engineer viral resistance into potatoes, and Kenyan researcher Florence Wambugu, working with the U.S. Agency for International Development, is using the same technique to incorporate viral resistance into sweet potatoes, yams, and cassava, a starchy root crop that is a food staple in the tropics.



ROGER N. BEACHY

Improved roots. *Cassava* (above) *is just one of the crops helped by biotechnology.*

Another promising strategy for protecting valuable crops against losses is to genetically engineer them to express the *Bacillus thuringiensis* toxin, a biocontrol for select predatory caterpillar insects. Cotton growers in Mexico, India, Egypt, and some of the republics of the former Soviet Union are planning field trials of cotton seed that has been transformed to express the *Bacillus thuringiensis* toxin.

Agricultural biotechnology may have had its roots in the wealthy, industrialized nations of the world, but Fraley predicts that by the middle of this decade farms in the developing world will also be benefiting from products developed by recombinant DNA technology. ■ ANNE S. MOFFAT

Do Parasites Reproduce by Clone Alone?

For years, scientists have been designing vaccines and drugs to fight protozoan parasites without taking into account the actual genetic variability of these deadly organisms. Now two biologists have shown that parasites can make clones of themselves—without mating. The bad news is that there are lots of different clones, making the job of finding effective therapies much harder than anyone thought.

French population geneticist Michel Tibayrenc stumbled onto this unfortunate truth while he was in Latin America, studying *Trypanosoma cruzi*. That's the protozoan parasite that causes Chagas' disease, a common and often fatal illness in the region. *T. cruzi* literally strikes at the heart of its human or animal host, weakening its cardiac muscles. Early studies of the culprit's enzymes indicated that different strains were extremely varied genetically. But when Tibayrenc, of the French Institute for Cooperative Development in Montpellier, France, and his collaborator, University of California at Irvine evolutionary biologist Francisco Ayala, took a closer look at certain DNA markers, they decided that the variation in the different strains was far too large to be the result of mating between organisms sharing the same gene pool. They also saw signs that the parasites seemed to be inheriting most of their genes from just one parent—instead of two. And that's when the two scientists came to what, for many, would seem a counterintuitive notion: The parasites got their uniqueness by reproducing clonally!

Yes, clonal reproduction implies perfect copies of one organism—with no chance for a second parent to insert its genes and add variation. That is true, but the fact is that if there were several different strains of a parasite living millions of years ago, they could give rise to genetically distinct lineages, each making copies of itself in isolation and evolv-