Going bananas

Fred Pearce. **New Scientist**. London: Jan 18, 2003. Vol. 177, Iss. 2378; pg. 27

Abstract (Summary)

Pearce discusses the future of the banana, which has not sexually reproduced since humans began cultivating it and has a gene pool that is virtually devoid of diversity. The banana is a staple crop around the world, but fungi, pests, or diseases could result in the disappearance of the banana due to the plant's genetic conformity.

Full Text (2403 words)

[Headnote]

The world's favourite fruit could disappear forever in 10 years' time. Is there anything we can do to prevent this slip-up, asks Fred Pearce

PITY the banana. Despite its unmistakably phallic appearance, it hasn't had sex for thousands of years. The world's sexiest fruit is a sterile, seedless mutant - and therein lies a problem. The banana is genetically old and decrepit. It has been at an evolutionary standstill ever since it was first propagated in the jungles of South-East Asia at the end of the last ice age. And that is why some scientists believe the world's most popular fruit could be doomed. It lacks the genetic diversity to fight off pests and diseases that are invading the banana plantations of Central America and the smallholdings of Africa and Asia alike.

The banana needs a pick-me-up fast. But science has so far let it down. For decades plant breeders have all but ignored it, because developing new varieties without the help of sexual reproduction is expensive and time--consuming. As a result, most people in the developed world eat just one variety, the Cavendish. And in much of Africa, where the banana is a staple crop, yields have been in decline for half a century. The banana business has reached crisis point. It could disappear within io years, says Emile Frison, the head of a worldwide network of banana researchers.

In some ways, the banana today resembles the potato before blight brought famine to Ireland a century and a half ago. But it holds a lesson for other crops, too, says Frison, top banana at the International Network for the Improvement of Banana and Plantain (INIBAP) in Montpellier, France. Frison, a Belgian plant pathologist, has been professionally obsessed with bananas for more than a decade - and eats them at home most days, too. The state of the banana, he warns, can teach a broader lesson: the increasing standardisation of food crops round the world is threatening their ability to adapt and survive.

The banana is among the world's oldest crops. Agricultural scientists believe that the first edible banana was unzipped around io,ooo years ago in South-East Asia. Normally the wild banana, a giant jungle herb called Musa acuminata, contains a mass of hard seeds that make the fruit virtually inedible. But now and then, hunter-gatherers must have discovered rare mutant plants that produced seedless, edible fruits. Geneticists now know that the vast majority of these soft-fruited plants resulted from genetic accidents that gave their cells three copies of each chromosome instead of the usual two. This imbalance prevents seeds and pollen from developing normally, rendering the mutant plants sterile. The dark lines within the flesh of an edible banana are all that remains of these vestigial seeds.

The first Stone Age plant breeders cultivated these sterile freaks by replanting cuttings from their stems. And the descendants of those original cuttings are the bananas we still eat today. Without sexual reproduction to throw the genetic dice anew every generation, each variety of modern bananas - yellow, red and green, from big starchy ones to small sweet ones - has come down almost unchanged from a separate sterile forest mutant. Each is a virtual clone, almost devoid of genetic diversity. And that uniformity makes it ripe for disease like no other crop on Earth.

Traditional varieties of sexually reproducing crops have always had a much broader genetic base, and the genes will recombine in new arrangements in each generation. This gives them much greater flexibility in evolving responses to disease -- and far more genetic resources to draw on in the face of an attack. But that advantage is fading fast, as growers increasingly plant the same few, high-yielding varieties. Plant breeders work feverishly to maintain resistance in these standardised crops. Should these efforts falter, yields of even the most productive crop could swiftly crash. "When some pest or disease comes along, severe epidemics can occur," says Geoff Hawtin, director of the Rome-based International Plant Genetic Resources Institute.

The banana is an excellent case in point. Until the 1950s, one variety, the Gros Michel, dominated the world's commercial banana business. Found by French botanists in Asia in the 1820S, the Gros Michel was by all accounts a fine banana, richer and sweeter than today's standard banana and without the latter's bitter aftertaste when green. But it was vulnerable to a soil fungus that produced a wilt known as Panama disease. "Once the fungus gets into the soil it remains there for many years. There is nothing farmers can do. Even chemical spraying won't get rid of it," says Rodomiro Ortiz, director of the International Institute for Tropical Agriculture in Ibadan, Nigeria. So plantation owners played a running game, abandoning infested fields and moving to "clean" land - until they ran out of clean land in the 195os and had to abandon the Gros Michel.

Its successor, and still the reigning commercial king, is the Cavendish banana, a 19th-century British discovery from southern China. The Cavendish is resistant to Panama disease and, as a result, it literally saved the international banana industry. During the 196os, it replaced the Gros Michel on supermarket shelves. If you buy a banana today, it is almost certainly a Cavendish. But even so, it is a minority in the world's banana crop.

Some 85 per cent of the world's bananas are grown by tropical smallholders, as a starchy staple rather than a sweet dessert. They grow dozens of varieties, for frying, boiling, chipping, steaming and mashing, for making banana ketchup and banana flour, brewing banana beer and distilling banana gin. Banana leaves and plant fibre are widely used for thatching, in textiles, handicrafts, cosmetics, dyes and even for umbrellas and table covers.

Half a billion people in Asia and Africa depend on bananas. In Uganda, bananas are grown on a third of all cultivated land and per capita consumption is 50 times that in Britain. Bananas provide the largest source of calories and are eaten daily. One kind of banana, the matooke, is served at almost every meal, and throughout the East African Highland region its name is synonymous with food. Threequarters of all Uganda's farmers grow some bananas, and the plant is even grown on roadside verges and backyards throughout the capital, Kampala, and other cities. It is an everpresent source of food.

But the day of reckoning may be coming for the Cavendish and its indigenous kin. Another fungal disease, black Sigatoka, has become a global epidemic since its first appearance in Fiji in 1963. Left to itself, black Sigatoka - which causes brown wounds on leaves and premature fruit ripening - cuts fruit yields by 50 to 70 per cent and reduces the productive lifetime of banana plants from 30 years to as little as 2 or 3.

Commercial growers keep Sigatoka at bay by a massive chemical assault. Forty sprayings of fungicide a year is typical, making the Cavendish the most heavily sprayed major food crop in the world. Fungicides now make up a quarter of production costs, and the social costs may be even higher. Women working in Costa Rican packing plants suffer double the average rate of leukaemia and birth defects. A study by the UN's Pan-African Health Organization found that a fifth of the country's male banana workers are sterile, allegedly as a result of exposure to dibromochloropropane -- now banned - and other fungicides. But despite the fungicides, diseases such as black Sigatoka are getting more and more difficult to control. "As soon as you bring in a new fungicide, they develop resistance," says Frison. "One thing we can be sure of is that the Sigatoka won't lose in this battle."

Poor farmers, who cannot afford chemicals, have it even worse. They can do little more than watch their plants die.

When the fungus reached Uganda in 1980, yields dropped by 40 per cent in a year. The banana's genetic uniformity allowed black Sigatoka and a host of other plant diseases to thrive, and the poor soils exacerbated the problem. The regions most reliant on the banana are now facing the African equivalent of the Irish potato famine, says Frison. Much the same is happening in the Brazilian Amazon, where black Sigatoka arrived five years ago and people sometimes go hungry as a result. "Most of the banana fields in Amazonia have already been destroyed by the disease," says Luadir Gasparotto, Brazil's leading banana pathologist with the government research agency EMBRAPA. Production is likely to fall by 70 per cent as the disease spreads, he predicts.

And now comes what could be the coup de grace. Panama disease is making a comeback. Unlike the old Panama disease, this new form-- known as race 4 - attacks the Cavendish with particular virulence. So far it has reached South Africa, Australia and much of Asia. Unlike black Sigatoka, which attacks leaves, race 4 is a soil-borne fungus, so chemical fungicides cannot control it, says Frison. It is only a matter of time before race 4 makes it to the commercial plantations of the Western hemisphere, a study for the UN Food and Agriculture Organization warned last year. And when it arrives, it will do to Cavendish what its predecessor did to Gros Michel. Game over. "The only option will be to find a new variety" says Frison.

But how? Almost all edible varieties are susceptible to the diseases, so growers cannot simply change to a different banana. With most crops, such a threat would unleash an army of breeders, scouring the world for resistant relatives whose traits they can breed into commercial varieties. Not so with the banana. Because all edible varieties are sterile, bringing in new genetic traits to help cope with pests and diseases is nearly impossible.

Nearly, but not totally. Very rarely, a sterile banana will experience a genetic accident that allows an almost normal seed to develop, giving breeders a tiny window for improvement. Breeders at the Honduran Foundation of Agricultural Research have tried to exploit this to create disease-resistant varieties. Every day for a year, workers laboriously hand-pollinated lo hectares of commercial bananas - 30,000 plants -with pollen from wild fertile Asian bananas. The resulting fruit, some 400 tonnes, had to be peeled and sieved in search of any seeds. "I'll let you guess how many seeds they collected," says Frison. "About 15. And of those, only four or five germinated." Further backcrossing with wild bananas yielded a new seedless banana resistant to both black Sigatoka and Panama disease.

Force feeding

Neither Western supermarket consumers nor peasant growers like the new hybrid. Some accuse it of tasting more like an apple than a banana. But there has been some interest. The biggest take-up is in Cuba, where black Sigatoka wiped out banana plantations just as the country lost its economic umbilical cord with Russia. Having no money for fungicides, it switched virtually all its national production to the new Honduran varieties. Its domestic consumers eat them, or nothing.

Not surprisingly, the majority of plant breeders have till now turned their backs on the banana and got to work on easier plants. "We are behind other crops in research by 50 to 100 years," says Frison. And commercial banana companies are now washing their hands of the whole breeding effort, preferring to fund a search for new fungicides instead. "We supported a breeding programme for 40 years, but it wasn't able to develop an alternative to Cavendish. It was very expensive and we got nothing back," says Ronald Romero, head of research at Chiquita, one of the Big Three companies that dominate the international banana trade.

Could genetic modification come to the banana's rescue? Maybe. Last year, a global consortium of scientists led by Frison announced plans to sequence the banana genome within five years. It would be the first edible fruit to be sequenced. Well, almost edible. The group will actually be sequencing inedible wild bananas from east Asia because many of these are resistant to black Sigatoka. If they can pinpoint the genes that help these wild varieties to resist black Sigatoka, the protective genes could be introduced into laboratory tissue cultures of cells from edible varieties. These could then be propagated into new, resistant plants and passed on to farmers.

It sounds promising, but the big banana companies have, until now, refused to get involved in GM research for fear of alienating their customers. "Biotechnology is extremely expensive and there are serious questions about consumer acceptance," says David McLaughlin, Chiquita's senior director for environmental affairs. With scant

funding from the companies, the banana genome researchers are focusing on the other end of the spectrum. "Work on the banana genome will be concentrated on finding ways to improve the varieties on which Africans depend for their survival, rather than the one you and I buy off supermarket shelves," says Frison. Some researchers, though, have yet to be convinced that sequencing the banana genome will make much difference to poor smallholders any time soon. Even if they can identify the crucial genes, they will be a long way from developing new varieties that smallholders will find suitable and affordable.

Still, bananas might represent one of the strongest cases for using GM technology. "Greens say genetically manipulating crops narrows the genetic base. Sometimes it does. But in the case of the banana we are broadening it," says Ortiz. And bananas' sterility means that newly inserted genes run very little risk of spreading to wild relatives or other species. At least one African nation, Uganda, is establishing its own lab for research on GM bananas.

The study of the banana genome offers another treat for evolutionary geneticists. The genome of sterile varieties has not changed since their accidental birth thousands of years ago, so comparing this to modern wild bananas - which have continued to evolve through sexual mixing - yields a rare look at how genomes change over time. "You will be able to see what happens in genome evolution," says Frison. "I know of no other species where you can do that."

But whatever biotechnology's academic interest, Frison sees it as the only hope for the banana. Without it, he says, banana production worldwide will head into a tailspin. We may even see the extinction of the banana as both a lifesaver for hungry and impoverished Africans and as the most popular product on the world's supermarket shelves.

Indexing (document details)

Subjects:	Genetics, Agriculture, Fruits, Plant reproduction
Author(s):	Fred Pearce
Document types:	Cover Story
Publication title:	New Scientist. London: Jan 18, 2003. Vol. 177, Iss. 2378; pg. 27
Source type:	Periodical
ISSN:	02624079
ProQuest document ID:	280179531
Text Word Count	2403
Document URL:	http://proquest.umi.com/pqdlink?did=280179531&sid=2&Fmt=3&cl ientId=20178&RQT=309&VName=PQD