Pity the banana. Despite its unmistakably phallic appearance, it hasn't had sex for thousands of years. The world's most erotic 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 humans first propagated it in the jungles of Southeast Asia at the end of the last ice age. And that is why some scientists believe that the banana could be doomed. It lacks the genes to fight off the pests and diseases that are invading the banana plantations of Central America and the small holdings of Africa and Asia.

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 plant varieties without the help of sexual reproduction is expensive and time-consuming. As a result, most people in the

the sterile banana

By Fred Pearce

As uniformity replaces diversity, some of our favorite fruits could be on the cusp of extinction.

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developed world eat just one variety, the Cavendish. And the world's favorite fruit—the one I eat most regularly—could be on the cusp of extinction, says Emile Frison, an old banana hand and head of the International Plant Genetic Resources Institute in Rome.

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 Emile, about how the increasing standardization of food crops is threatening their ability to adapt and survive. Popular fruits are at risk more than most. Your favorite could be on the verge of extinction.

Because all edible varieties of bananas are sterile, introducing new genetic traits to help cope with pests and diseases is nearly impossible. Nearly, but not totally.

The banana is among the world's oldest crops. The first edible banana was unzipped around ten thousand years ago in Southeast Asia. Its very survival is a testament to the wisdom and inventiveness of our Stone Age ancestors. The wild banana is a giant jungle herb with a fruit that normally contains a mass of hard seeds that make it inedible. But now and then, hunter-gatherers discovered plants that produced seedless, soft fruit. And they were very tasty. Plant scientists now know that these mutations resulted from an occasional genetic accident that prevented seeds and pollen from developing normally inside the fruit. The dark lines within the flesh of an edible banana are all that remains of the vestigial seeds. So the mutant plants were sterile, but their fruits were edible.

The early farmers cultivated these sterile freaks by replanting cuttings. And so began mankind's love affair with the banana. The first banana boats took the giant herb to Africa several thousand years ago. Anthropologists believe it became the nutritional mainstay that allowed the Bantu people to colonize most of the continent. And when Europeans first went to the Americas, the banana was among the first old-world fruits that they planted in the new world.

But on this long journey the sterile, constantly cloned banana has barely changed. Today we eat the descendants of the original cuttings taken by the Stone Age cultivators, probably from somewhere in the Malaysian jungle. Normally, cultivated plants develop genetic variety through random mutations during sexual reproduction, just as humans do. This process means that different varieties develop resistance to various pests and diseases, and adaptability to stresses like droughts. Plant breeders tap into this genetic variety all the time. But without sexual reproduction to throw the genetic dice every generation, each variety of modern banana—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 the banana ripe for disease like almost no other crop on Earth.

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 Cavendish, and without the latter's bitter aftertaste when green. I don't remember, but I must have eaten it when I was young. However, the Gros Michel was vulnerable to a soil fungus that produced a wilt known as Panama disease. "Once the fungus got into the soil, there was nothing farmers could do. Even chemical spraying wouldn't get rid of it," says Rodomiro Ortiz, top banana in charge of research at 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 in the 1950s they ran out of clean land and had to abandon the ill-fated Gros Michel. The king of the plantations—a fruit that ruled nations and toppled governments, that brought us the phrase "banana republic"—is now just a laboratory curiosity.

Its successor, and the reigning commercial king, is the Cavendish. This is a variety from southern China "discovered" by British colonial botanists and brought home in 1828, when it was named after the English lord who provided house room for the first samples. Being less tasty than the Gros Michel, the Cavendish languished until the latter's demise. But in the 1960s, tastiness mattered less than resistance

to Panama disease. The Cavendish resisted the fungus and almost overnight replaced the Gros Michel in plantations and on supermarket shelves. If you buy a banana today, it is almost certainly a Cavendish.

But, less than half a century on, the day of reckoning may be coming for the Cavendish. The plan-B commercial banana is already being stalked by another fungal disease. Black Sigatoka has become a global epidemic since its first appearance in Fiji in 1963. Commercial growers keep it at bay by a constant chemical assault. Forty sprayings of fungicide a year is typical, making the Cavendish the most heavily sprayed food crop in the world. This is not good news for the employees of the big Latin American banana-plantation owners. In Costa Rica, the second-largest banana exporter after Ecuador and the place where my bananas usually come from, women in banana-packing plants suffer double the average rates of leukemia and birth defects. Meanwhile, a fifth of male banana workers are sterile, allegedly as a result of exposure to dibromochloropropane, which is now banned, and other fungicides that are not.

Organic farmers, who use natural pesticides, are much healthier, but they face the same problems of infestation. However the banana is farmed, black Sigatoka is getting more and more difficult to control. And now comes what could be the coup de grâce. Panama disease is making a comeback in a new form—known as tropical race 4—that attacks the Cavendish with particular virulence. So far, tropical race 4 has reached South Africa, Australia, and much of Asia. Millions of banana plants have died in southern China, the Cavendish's original home. Chemical fungicides cannot control it. So, it is only a matter of time before what they are calling the banana cancer makes it to the commercial plantations of Ecuador, Costa Rica, Honduras, and Colombia.

One footprint could do it, says Richard Markham, director of the International Network for the Improvement of Banana and Plantain. "A dirty boot with a few grams of soil from an infested site in Asia planted inadvertently in a Latin American plantation is all it would take. It's just a matter of time." And when it arrives, it will do to Cavendish what its predecessor did to Gros Michel. Game over.

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WILD CROP RELATIVES
NEARING EXTINCTION

The negative impacts resulting from the loss of wild species are hard to measure, since in most cases lost species were not previously well studied. Nonetheless, like the growing tide of animal extinctions, the loss of wild crop relatives not only changes the ecosystems in which they once flourished but also limits human opportunities for the future. Following are a few examples of wild crop relatives on the way to extinction:

Soybeans: Wild soybeans could once be found growing over almost all of China's Yellow River Delta and Sanjiang Plain, but now they are scattered in just a few sites.

Tomatoes: Across the South American center of diversity, populations of wild tomato are being severely reduced. Many are endangered by goat herding in the highlands and by habitat loss. One species in Chile is now restricted to about half a dozen populations, and open pit copper mines pose a potential threat to another desert species. Sprawling shantytowns around Lima, Peru, have eliminated others. The loss of just one extremely diverse population can have disproportionate effects.

Coffee: A wild species of coffee that once grew in Côte d'Ivoire in West Africa is known to be extinct. Ten others are either endangered or vulnerable in the wild.

Hard wheat: *Triticum monococcum* is a species that was once widely grown for bread in the ancient Roman Empire. Today it is almost lost, with relic populations existing only in Turkey and possibly in Yemen. Because of its high fiber content, *T. monococcum* is again in demand, and a special project has begun to bring back this crop.

Grapes: The world's grape species are threatened in all areas of their range. In North America, the grape species *Vitis rupestris* has been grazed to the point of near extinction. It was once found in gravelly and sandy creek beds from Tennessee to Texas. Seven other North American grape species are also threatened. Scientists believe these may contain a range of valuable genes, including genes for drought tolerance and resistance to the root-knot nematode pest.

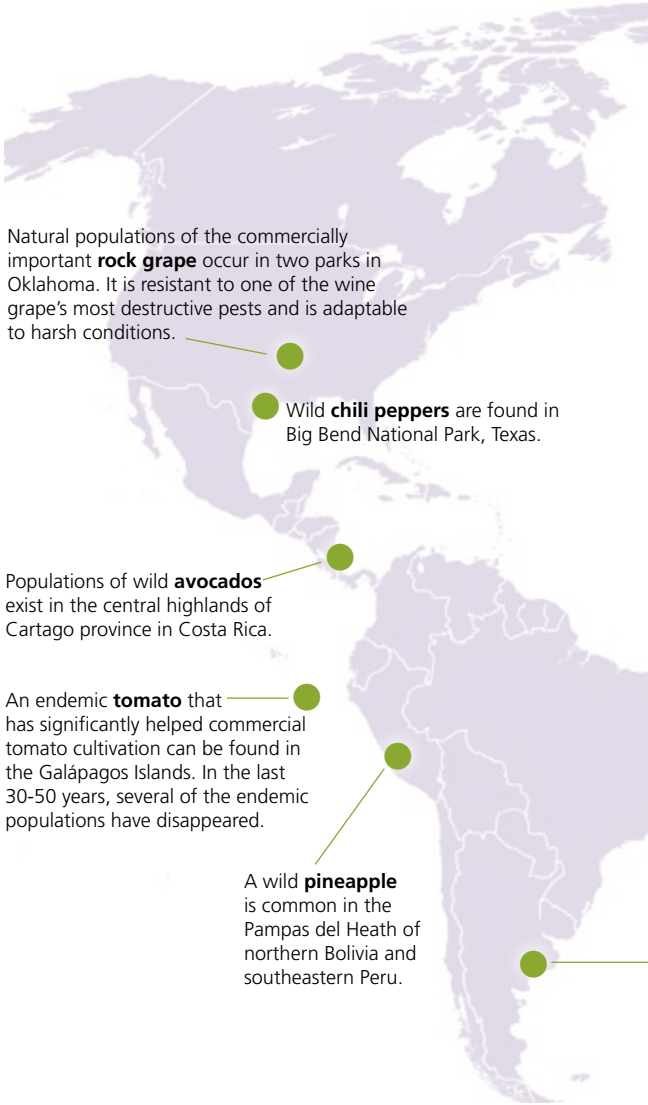
Excerpted from *Crop Diversity at Risk: The Case for Sustaining Crop Collections*, a 2002 report compiled by the Department of Agricultural Sciences, Imperial College Wye, U.K. The report is available at *www.croptrust.org/main/publications.php.*

With most crops, such a threat would unleash an army of breeders, scouring the world for resistant relatives whose traits they could breed into commercial varieties. Not so with the banana. Because all edible varieties of bananas are sterile, introducing new genetic traits to help cope with pests and diseases is nearly impossible. Nearly, but not totally. Very rarely, a sterile banana will itself experience a genetic accident that allows an almost normal seed to develop. This gives breeders a tiny window for improvement. Honduran breeders tried to exploit this to create a disease-resistant Cavendish variety.

Every day for a year, workers laboriously hand-pollinated thirty thousand banana plants with pollen from wild fertile Asian bananas. The resulting fruit, some 440 tons, had to be peeled and sieved in search of any seeds. "I'll let you guess how many seeds they collected," says Emile. "About fifteen. 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. Bingo! Well, no. Western consumers didn't like the new hybrid. Some accused it of tasting more like an apple than a banana. The only buyers today are in Cuba, where black Sigatoka wiped out normal Cavendish plantations and there is nothing else on the shelves.

Not surprisingly, the majority of plant breeders have until now turned their backs on the banana and gotten to work on easier plants. Even the commercial banana companies stay away. "We supported a breeding program for forty 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, which, along with Fyffes and the Dole Corporation, dominates the international banana trade.

Could genetic modification come to the banana's rescue? Maybe. A global consortium of scientists is trying to produce a genetic map of wild banana varieties. If they can pinpoint the genes that help them resist diseases like black Sigatoka and tropical race 4, those genes could be spliced into edible varieties in the lab. Whether we will want to eat GM bananas is another matter, but Emile sees it as the only hope for the Cavendish. Without it, the most popular single product on the world's supermarket shelves could be heading for a sterile grave.



All over the world there are fruits, nuts, and other foodstuffs vulnerable to genetic fortune. The story is usually the same. Commercial fruit growers have concentrated on a handful of varieties, discarding the others. They have bred the chosen few to maximize yield or for some specific trait that they value most. In the process, the plant's natural ability to withstand pests and disease has been undermined. Meanwhile, the genetic stores of old varieties and wild relatives alike have often been lost. Most of the time, commercial planters spray their way out of trouble. But sometimes, as when Gros Michel stumbled, the sprays prove useless and the crop is doomed.

It could happen to some of your favorites. There are six major types of pineapple, for instance. But we eat only one, the Smooth Cayenne. By neglecting the others, and ignoring the fruit's genetic base in the wild, we risk losing the genes they contain and undermining

the future of the fruit. The mango is suffering similar genetic erosion. A thousand or more varieties of sweet potatoes in New Guinea are undocumented and uncollected. In the Himalayan foothills of northern India, cultivated varieties of garlic and its wild ancestors are dying out.

The farms and hedgerows of dozens of tiny Italian islands in the Mediterranean are the last refuges for many rare and ancient plants. Watermelons are holed up in Vulcano, tomatoes in Elba, and cabbages in Linosa. But as holiday villas and desertification encroach, how much longer will they survive?

Or take the case of the world's most widely eaten nut. The peanut began in the jungles of South America. The Portuguese took it to Africa, from where it reached North America and first gained wide popularity. Today, it is not just the world's favorite nibble, but also the most important source of vegetable protein for half a billion of the world's poorest people, mostly in Africa. But cultivated peanuts have lost much of their natural resistance to disease. In an echo of the banana story, a fungus is chasing the nut across the world, and it has few genetic defenses. The peanut's wild ancestors are believed to live only in a tiny area of remote rain forest in eastern Bolivia. Researchers believe that if they can find them, they can extract genes that can counteract the fungus. But the area has been declared out of bounds to scientists because of local unrest caused by opposition to an oil pipeline through the forest. Can the peanut survive? It would make a great movie.

A few botanical Indiana Joneses are out there trying to track down the wild ancestors of many modern crops. One of them is Emile's colleague Stefano Padulosi, the world's foremost authority on rare, unusual, and plain exotic fruits and vegetables. Without him, the chic salad vegetable called rocket would still be a forgotten weed in the ruins of his hometown, Pompeii. His main stomping ground is Central Asia, the genetic heartland of many of our most familiar crops, where he tracks down

Crop genetic diversity provides important resources for food security, environmental sustainability, and economic stability. Yet, according to the U.N. Food and Agriculture Organization, 75 percent of the genetic diversity of agricultural crops has been lost in the last century due to the abandonment of genetically diverse traditional crop landraces in favor of genetically uniform modern crop varieties. (Source: *Food Stores: Using Protected Areas to Secure Crop Genetic Diversity*. A research report by WWF, Equilibrium, and the University of Birmingham, U.K., 2006)

both wild ancestors and the collections of traditional varieties. Soviet scientists were masters at the business of collecting obscure varieties. But many of their collections have languished since the Russians went home after 1989. And, like your grandfather's stamp collection, the fate of the plant collections is in doubt because nobody realizes their value. The loss of these plants could prove another casualty of the fall of the Berlin Wall.

The future of the apple, for instance, may now hang in the balance. Around the world, farmers have over the centuries bred about ten thousand distinct varieties. Though only around fifty are grown commercially today, many more are kept for breeding purposes. Britain has more than two thousand apple varieties, and the U.S. government and Cornell University keep more than three thousand in research orchards. But by far the world's greatest genetic resource is in the Tien Shen mountains of Kazakhstan, where wild apple woods still grow. Ninety percent of the world's apples are believed to come from parent trees taken long ago from these woods. Many apple trees with potentially invaluable genetic traits are still in these hills. Or were when Stefano last looked. They could have been chopped down for firewood by now.

Somewhere up there is the world's one and only wild pomegranate forest. Still flourishing, it is said. I want to walk through that forest, pick some fruit. Just for the hell of it.

Stefano is also concerned about what has happened to the watermelons and pistachios that once grew wild across Uzbekistan, and the native walnuts of Kyrgyzstan, not to mention the equally prized forerunners of modern apricots, peaches, and almonds in their homeland of Afghanistan—a country where protecting wild geneses does not have the highest priority right now.

Quixotically, perhaps, I am most interested in the fate of another native of Central Asia, the pomegranate—one of the world's juiciest fruits and prized for its exceptional nutritional qualities. Some say it fights prostate cancer. I enjoy its taste but, to be truthful, what interests me most is the prospect of one day going to find its genetic homeland in one of the world's oddest and most inaccessible countries.

Turkmenistan was, until his recent death, the fiefdom of Turkmenbashi, an eccentric leader of the former Soviet socialist republic. Once off the Moscow leash, he became an increasingly paranoid and megalomaniac leader of the independent state. Such was his omnipotence that he renamed the days of the week after members of his family and on a whim banned men from growing beards and anyone at all from sporting gold teeth. He prevented all access to the World Wide Web, shut down most of the country's universities, uprooted the state botanical gardens, and cut off funding for the country's other plant collections. Which left the pomegranate in the lurch.

People have been growing pomegranates in the remote valleys of the Kopet Dam mountains of southern Turkmenistan for six thousand years. While other countries grow pomegranates, the assemblage of ancient varieties is found only in Turkmenistan. In recent decades most of the old varieties have been lost from the country's orchards. Only around fifty are still grown. But on the edge of the mountains, starting in the 1930s, Soviet scientists assembled a unique collection of more than one thousand varieties of pomegranate trees at the Garigala experimental station. It is the holy grail of pomegranate biodiveristy.

How is the collection doing? Few people really know. Most of the varieties have never even been catalogued, says Stefano. Garigala has been all but impossible to get to for some years. The last curator was Russian-born botanist Grigory Levin, who spent much of his life nurturing the collection but eventually fled to Israel. He keeps in touch with the demoralized and frequently unpaid staff. "Many of the trees are being plowed under to make way for vegetables," he says.

The world's pomegranate collection is expiring. But the fruit could still survive. For Grigory says that the Kopet Dam mountains have one last treasure. Somewhere up there is the world's one and only wild pomegranate forest. Still flourishing, it is said. I want to walk through that forest, pick some fruit. Just for the hell of it. And now that Turkmenbashi is gone, I may get my chance. ❧

Fred Pearce, a frequent contributor to *Conservation* magazine, is the author of over 14 books and a regular columnist for *New Scientist* magazine in the U.K.