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Harvested bananas
waiting transport to
market

When crops die

Plant disease and food supply

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In the highlands of south-western Uganda, bananas – of many sorts – are the staple food and the main agricultural product. So the appearance of a new disease of this important crop can cause great problems. Professor Michael Shaw of the University of Reading explains.

Bananas grow as stems emerging from an underground root system, called a mat. A stem flowers once, producing a bunch, perhaps 10-15 kg, and then dies. The root system produces new shoots which repeat the cycle, and new plants are produced by cutting these out of the root system and re-planting them. The bananas are harvested by cutting down the stems when the bunches are ripe; the stems are also pruned to let light reach crops growing underneath in their shade.



A banana field undersown with beans to take advantage of the rains and supply some fertilisation. The lower banana leaves have been pruned to let light on to the beans.

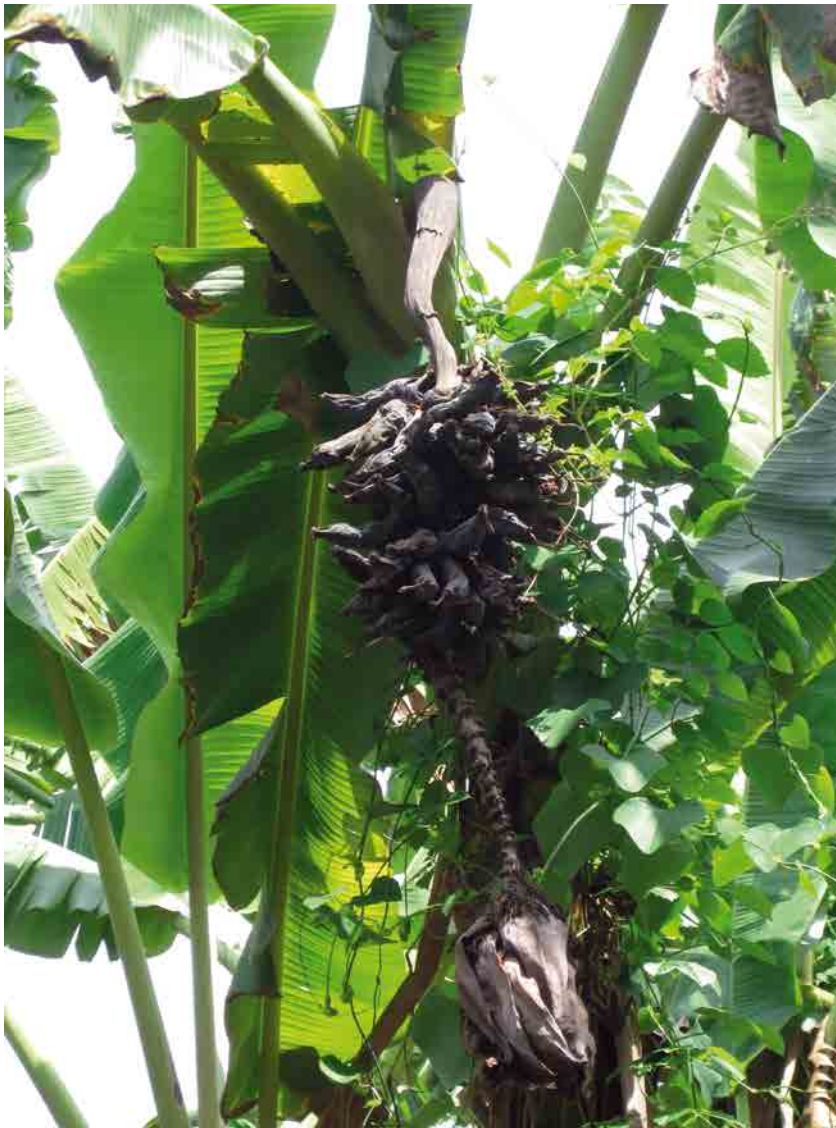


Uganda is an East African nation of over 40 million people.

A new disease

In the early 2000s, a new disease appeared and spread very fast, killing stems in entire banana fields. There was great hardship, with food scarce, and no bananas to sell to provide cash for essentials.

The disease killed the standing stems, and rotted the bananas entirely. Dead plants oozed a thick yellowish liquid, containing enormous quantities of a previously unknown species of bacteria; this was blocking the conducting tubes which bring water from the ground to the leaves in all plants. By inoculating the bacteria into wounds on healthy stems, inoculating other stems just with water, it was shown that the bacteria caused the disease. Comparison with similar diseases of other crops suggested that the bacteria were probably spread in several ways. Machetes contaminated by cutting into an infected stem were later used to cut into healthy stems. There were bacteria in the male flowers at the tip of a flowering shoot, and bees could move these to another stem, causing the stem to die from the top back to the ground, as the bacteria spread downwards. But the first infections in a plantation probably came from planting a young, apparently healthy, shoot brought from elsewhere.



Death of a bunch following insect infection of the flower head

Scientists working in Uganda and in Ethiopia agree that the initial source of the disease was probably a few plants imported from Ethiopia where the bacteria were ravaging a related crop plant, Enset. Where the bacteria had been before we don't know. Plants defend themselves against infections with fungi and bacteria in complex ways. Almost all of the countless microbes which live in and on us and our crops are harmless or even helpful. But from time to time a mutation may occur in a fungus or bacterium growing in a wild plant or harmlessly in the crop which allows it to attack a new host or turns it from harmless to a killer, just as new flu strains arise from time to time to kill humans.

So what has happened since the peak of the epidemic over ten years ago? Land has been abandoned for banana growing, new farming systems have been devised, and farmers, guided by researchers and advisory workers, have worked out how to manage the disease. Spread by bees from flower to flower can be minimised by twisting off the large male flower and its nectar supply from developing bunches, using a long forked stick.



This farmer is using a long forked stick to twist off the male flowers at the end of a forming bunch to prevent infection by insects harvesting nectar. The bananas do not set seed and do not need the male flowers, a relic of their wild ancestors.

Machetes used for pruning can be sterilised between cuts in fires of burning dead leaves or in bleach. Infected stems can be removed as soon as they are spotted: often a succeeding shoot will be healthy. So the farmers have learnt to live with the disease. A little more skill is needed, and bananas are a bit more expensive.

Patterns of disease

This is a typical pattern when a new crop disease emerges by mutation or from another host plant. At first, individual communities who are dependent on the crop are very badly hit, but few in wider markets or communities are affected. As the epidemic continues, farmers learn ways to combat the disease – a lot faster if professional scientists can help – or change cropping systems, but many more are affected and a foodstuff may become scarce or more expensive. After many years, management of the disease becomes one of the many things that farmers must consider as they plan their production, along with soil, seed, fertiliser, harvest, weather; the impact is diffused across the whole of society by small changes in price or availability.

The parts played by scientists in this pattern is varied. In an early example, Henry Marshall Ward was sent to Sri Lanka by the (British) imperial government to investigate the epidemic of ‘rust’ which destroyed the coffee industry there and has since spread round the world. Ward’s first task was to work out the cause of the disease, which is always the first task when a new disease problem emerges. It was a very characteristic fungus.



Coffee rust symptoms on a coffee leaf; this field is planted with both coffee and banana to avoid complete loss if one or the other fails.

Subsequently it was found to have come from wild coffee in north-east Africa. For many diseases the symptoms are not very specific – death, for example – and it is important to develop ways to diagnose the disease quickly. Then more detective work is needed to understand how it spreads from plant to plant and how it gets into the plant.

Once this is understood, it is a question of finding practical ways of managing the disease. Usually, one of the best ways is to breed new varieties of the crop which suffer less from the disease. This isn’t always possible – there may be no varieties from which resistance can be bred into the main crop, or, like bananas, the crop may be sterile and new plants produced as cuttings from old ones.

For some pathogens, spraying the crop with fungicide may be an option, though fungi often evolve very rapidly to grow despite the fungicide. In other cases, like the de-budding of banana in Uganda, the life-cycle of the pathogen can be interrupted in ways which must be worked out for each case.

Potato blight



Leaves of a potato plant showing signs of blight; the tuber is badly affected too.

Potato blight emerged from the original range of potato to cause the infamous potato famine in the 1840s, worst in Ireland. Millions of people died or had to move in search of work and food. Now, the disease remains more or less universal in potato.

Fungicide applied to the leaves as a spray is essential in most production systems and represents a cost and a need for constant research to find new fungicides, but we have adapted in this way to the disease problem.

Dealing with disease

We will probably never overcome crop disease completely. For the next decades, it will be a continuing worry. Plants and crop products are traded over great distances and in huge volumes. This makes famine or even shortages of particular crops less likely because bad weather or epidemic disease is unlikely to strike the whole world at once, but it makes it easier for pathogens to find new hosts. Shipments of plants are inspected when they arrive and should be certified healthy when they leave a country of origin, but no inspection process can be perfect. Plant pathologists (as plant doctors are called) will be needed for a long time.

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