

Debatable issues

These articles raise some important questions for debate.

The big banana question

The Cavendish banana is under threat – how can we save it? Or should we look for alternatives?

The banana is one of the world's most important food crops. In countries where bananas are produced, often by small farmers, over 400 million people rely on them for nourishment and income.

The most common variety is the Cavendish banana, which makes up around 95 per cent of the global supply, but it is under threat from a fungal disease that destroys the roots of the plants. The same disease wiped out another popular banana variety – the Gros Michel – in the 1950s. Unfortunately, because Cavendish bananas are all genetically identical and close to sterile, it's very difficult to breed new, resistant varieties.

But there are other varieties of banana that are essential to the health of local populations. In Uganda, the East Highland variety is a staple crop and a crucial source of starch, and local scientists are working with Australian researchers at the Queensland University of Technology to improve it. This project – called Banana21 – aims to increase the banana's levels of vitamin A and iron, often deficient in the Ugandan diet. This biofortification is similar to the way many cereals in the UK have added iron and vitamins.

The researchers are also trying to make bananas more resistant to disease and drought. One variety being trialled is a genetically modified version of a less commonly grown dessert banana called Lady Finger. The modified version has genes that change its response to stress, such as when it is infected by a fungus.

Genetic modification could be a way to develop disease-resistant Cavendish varieties too, as well as making them more nutritious.

QUESTIONS FOR DISCUSSION

- Is this a smart approach to solving the banana problem?
- Or should we be trying to diversify banana farming more widely?

Pros	Cons
Possible prevention of total Cavendish wipe-out.	Unknown effects of new genes on banana genome.
Providing a means to sustain livelihoods in banana-producing countries.	Continues the reliance on the Cavendish variety rather than diversifying banana farming.
Starting small means local populations find solutions for themselves and can contribute what they've learned to a potential solution.	Consumer reluctance to eating a new variety of banana – and a genetically modified one at that.
	Unknown financial costs of new varieties to small farmers.

Banana stats

- Nearly 1,000 varieties of bananas in the world.
- 50 subgroups.
- Cavendish variety makes up 95% of supply and is the one produced for export markets.
- Grown in more than 150 countries.
- 107 million tonnes of fruit produced in 2013.

Sustainable production

How can we increase production of nutritious food while still conserving the environment?

There is much debate over how land should be used to balance meeting the food needs of the world's growing population and protecting natural environments and biodiversity (which can provide 'ecosystem services' such as medicines, carbon storage, and water and nitrogen cycling). The options are often divided into land-sharing and land-sparing approaches.

Land-sharing combines agriculture and nature conservation on the same land – for example, incorporating hedges and ponds into farms. In these approaches, agricultural yields are usually limited.

Land-sparing, on the other hand, creates spare land for nature conservation by sustainably intensifying production and increasing yields on farmed land.

In the European Union (EU), environmental and agricultural policies promote a combination of these approaches through protected areas such as the Natura 2000 network, which covers 18 per cent of EU land, and agri-environment schemes that subsidise farmers to protect wildlife on their land.

Pros (of more land-sharing)	Cons
The UK already has extensive experience of low-intensity farming, such as grazing of livestock on semi-natural land, which maintains some biodiversity.	Lower yields from the same area of farmed land so more land must be farmed overall.
Some ecosystem services, such as pollination, rely on small fragments of semi-natural habitats.	Less land is left completely natural or managed purely as conservation areas.
Land-sharing can be politically and practically easier to implement.	May benefit generalist species capable of surviving in a wide variety of habitats, but not so likely to protect rare species that can only survive in particular habitats.

QUESTIONS FOR DISCUSSION

- What are the pros and cons of the land-sparing approach? How does nutritional value factor in?
- Do your pros and cons change if you consider a country other than the UK, such as one of the South American countries that are home to the Amazon rainforest?

The cocoa tree and the threats it faces

*Take a look at *Theobroma cacao*, how we get chocolate from it, and its biggest enemy: black pod disease*

Before chocolate existed, there was cocoa: a bitter drink made from the beans of the *Theobroma cacao* tree, treasured by the Maya, Aztec and Olmec peoples of Central America.

Spanish colonists were intrigued, and added spices and sugar to make the drink less bitter. The beans were shipped back to Europe, where cocoa went on sale in the late 16th century. At first, it was a luxury drink for the rich, but its price fell and it went mainstream. Rising demand led to cocoa plantations being established around the world.

People tried many ways of preparing cocoa, but the big innovation came in 1828, from Dutch father and son Casparus and Coenraad van Houten. They worked out how to separate cocoa into solids and fat. This made it easier to produce the drink, but also allowed further processing to make a solid bar of chocolate.

Other industrialists of the 19th century – Rowntree, Cadbury, Lindt, Nestlé, Hershey – developed specialised processes for making their own brands of chocolate. And brands they were: chocolate was marketed with great ingenuity. It has been sold as a tasty treat, an energy booster, a health food, an aphrodisiac and more.

And we bought it. Chocolate is now a huge global industry.

Producers and consumers

In 2013, 4.6 million tonnes of cocoa beans were produced worldwide – two-thirds of this in Africa. The biggest producers were Côte d'Ivoire (32 per cent), Ghana (18 per cent), Indonesia (17 per cent), Nigeria (8 per cent) and Cameroon (6 per cent).

The keenest consumers of chocolate are the Swiss, eating 9 kg each per year. The Germans are second with 7.9 kg, and the British and Irish are joint third with 7.4 kg. The Americans are ninth, eating 4.3 kg a year each.

From tree to treat: how to make chocolate

Theobroma cacao needs a humid, tropical climate with rich soil, shade and plenty of rain. Its flowers ripen into cocoa pods. Farmers slice these open and scoop out the juicy pulp and the cocoa beans. They leave the beans to ferment in the pulp for a few days, then dry them out for shipping.

At the factory, the beans are roasted, then each shell is cracked open and removed to leave the nib – the cocoa core. The nibs are ground to produce cocoa liquor, which is essentially what the Central Americans and Europeans were drinking before the Van Houtens' innovation.

The liquor is separated into cocoa solids and cocoa butter. The solids are reduced to fine particles, which can either be sold as cocoa power or recombined with cocoa butter – more of it than the liquor naturally contained – to be made into chocolate. At this stage, milk, sugar and any other flavourings are added.

Then, to give the final product a good solidity, the liquid is repeatedly heated and cooled to change its crystal structure. Finally, it's poured into a mould to set, then wrapped and distributed to sweet-toothed consumers.

Black pod disease

But cocoa trees are at risk.

Several species of the water mould *Phytophthora* can make the cocoa pods blacken, shrivel and die. This black pod disease can also spread to the rest of the tree. Globally, up to 10 per cent of *Theobroma cacao* trees are killed by black pod disease every year, and 20–30 per cent of the cocoa crop is lost.

Phytophthora spores are carried by wind and water, and by insects, rodents and bats. When a spore lands on a pod or a leaf, it germinates and the infection begins. As well as spreading across the surface, the mould grows deeper into the pod, rotting it from the inside.

Farmers can do several things to reduce the spread of *Phytophthora*:

- Plant trees a few metres apart, and prune them if their branches grow too close to each other.
- Make sure planting sites have good drainage, so surface water doesn't accumulate.
- Cut off pods showing early signs of infection immediately. Remove them and destroy them.
- Use pest control to stop animals spreading the disease.
- Spray infected plants with certain copper-based fungicides.

Scientists are also trying to breed varieties of tree that have better resistance to black pod disease. Different strains of *Theobroma cacao* have different responses to the infection, which suggests this approach could pay off. But it may be hard, because resistance to one species of *Phytophthora* may not mean resistance to others.

Other dangers to chocolate

While black pod is by far the biggest disease of cocoa trees, it's not the only one:

- **Witches' broom:** *Moniliophthora perniciosa* is a fungus that stunts the growth of flowers and pods.
- **Frosty pod rot:** *Moniliophthora roreri*, another fungus, eats the pods from the inside.
- **Vascular streak dieback:** The fungus *Oncobasidium theobromae* stops the leaves producing chlorophyll and can kill the whole tree.
- **Mirids:** Also known as capsids, these insects – including species of *Sahlbergella*, *Distantiella* and *Helopeltis* – feed on the trees, causing leaves and branches to die.
- **Pod borer:** The moth *Conopomorpha cramerella* infests the pods, where it lays its eggs.

The other big looming threat is climate change. As the world warms, the African countries that supply most cocoa are predicted to become drier, which will make it harder for the trees to grow. Growers may be able to adapt by moving to higher-altitude plantations or breeding trees with better drought resistance.

QUESTIONS FOR DISCUSSION

- What other major plant diseases are there? How are these being fought?
- What would happen if black pod disease spread more widely?
- Why do the countries that produce the most cocoa not consume very much of it?