An introduction to GM seeds: why they're so different to what we know

What is genetic modification (GM)?

Genetically modified (GM) seeds have been created in a laboratory. The process of creating them is completely new and does not happen in nature. Since farming began people have worked with nature to breed plants and animals to suit human needs. Usually this breeding can only happen within the same "species" or family. For example, we breed a tomato with a tomato but we cannot breed a tomato with maize or with a pig.

In the last 30 years scientists have used genetic engineering (GE) techniques, also known as genetic modification, to create plants and animals with novel (new and unique) characteristics. In genetic engineering, the 'genes' responsible for a specific characteristic (called traits) are taken from one organism and forced into the DNA of another organism. In this way the characteristics of one species can be unnaturally bred into a completely unrelated one – across the boundaries between species and even plant and animal kingdoms. The resulting new species is called a genetically modified organism (GMO). *Genetic modification allows scientists to mix the genes of unrelated species.*

The traditional foods that we know were developed by farmers over the last 10 000 years. We know that these foods are safe and which ones are likely to cause allergies because humans have been eating them for such a long time. These natural foods are part of our culture of eating and our bodies are adapted to them. The same is not true of GMOs. Scientists are not sure what impacts these new crops might have on our bodies or on the environment over time. It is just too soon to tell as the science is too new and not enough independent research is being done.

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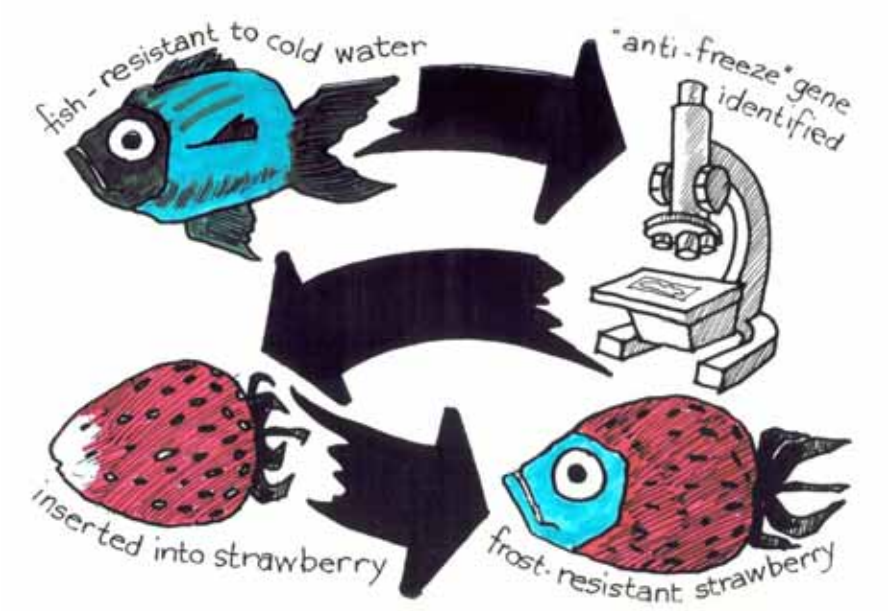


In 1999 Russian scientists experimented with creating a frost-resistant strawberry. They found a fish that lives in the freezing waters of the Arctic called an Arctic Flounder. This fish has "anti-freeze" genes that help it live in these freezing conditions. The Russian scientists identified these genes and inserted them into the DNA of strawberries. When the strawberries grew, they had the "anti-freeze" characteristic of the fish. However, the transformation caused other problems in the new strawberries.[1]

This experiment is a useful example to explain how genetic engineering uses the genes of unrelated species to create new crops. This was an experiment that was never released onto the market and there are currently NO GM strawberries on the shelves anywhere in the world. Strawberries have proved difficult to successfully engineer.[2]

Source: Biowatch South Africa. 2004. Farming for the Future.

Once GMOs are released into the environment, for example when GM seeds are sown, these are impossible to control as they will reproduce and spread. The pollen from plants will drift in the wind or be carried by insects to other plants. Seeds will fall in fields and GM seeds may spill from trucks and begin to grow on sidewalks. We often hear about products that have design faults, which must be brought back to the factory because they don't work or are dangerous. However, if we find there are problems with GMOs, these cannot be returned to the lab. GMOs will continue to spread and we will not be able to undo the damage that is has caused.

What are genes?

The smallest part of a life form (organism) is a ***cell***. Micro-organisms, such as bacteria, have only one cell whereas plants and larger animals have many cells that are stacked together to make up their tissues, organs or structures e.g. brain, bones, fruit etc.

Inside every cell we find ***DNA***, which carries the full 'instructions' for how the organism will look, grow, function and reproduce. The DNA is inherited from the organism's parents. ***Genes*** are small sections that make up the DNA containing the codes for specific proteins. For example, a goat's DNA will ensure the goat looks like and behaves like a goat but a specific gene in the DNA will make the goat have white hair or brown hair.

Getting to know about seeds

Seeds can be categorised into three groups: those that are farmers's varieties have been selected and bred naturally over time, hybrid seeds that are specially bred and GMOs that are artificially made in laboratories using genetic engineering techniques.

Farmers varieties

Farmers have experimented with seeds for thousands of years. Farmers have selected and bred seeds to suit and adapt to local environments, increase yields, taste better and for good storage, pest resistance and much more. Farmers also have a tradition of saving and exchanging their seeds through well established social networks. For these reasons, farmers' seeds are very diverse. For example, when a farmer grows a traditional

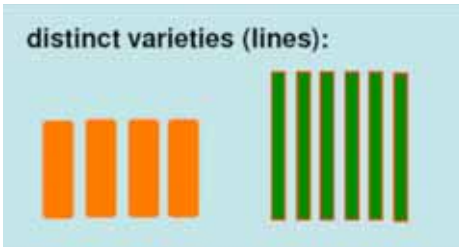
maize variety, he or she will notice all sorts of characteristics in their field in a season. The farmer will select the best performing seeds to plant the following year. There is a deep relationship between farmers, seeds, and the local environment.

Many of the farmer varieties include open pollinated seeds (OP). OP seeds are cultivars that will grow out 'true to type' when the seed is collected and planted. This is of benefit to farmers because when they save this seed to plant, their next crop will be like the parent. OP varieties are usually old cultivars that have developed over many generations of seed saving and sharing to have good qualities and are stable.

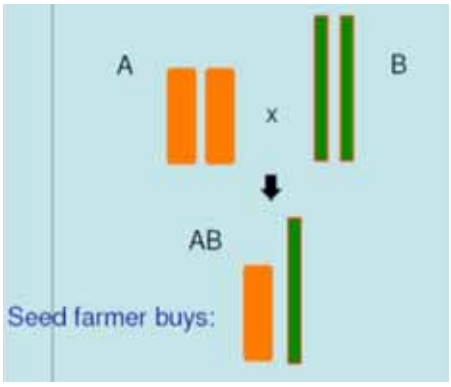
Hybrids need to be bought every year to ensure a reliable crop. Why is that?

Hybrids work very differently; they are bred to be uniform (to be all the same), not to be diverse. The advantage of hybrids is that farmers know exactly what kind of crop they will get when they plant because every single seed has the same characteristics.

Hybrids are a result of crossing two distinct varieties, for example:



Each variety has only one pure characteristic, created through breeding in a laboratory.

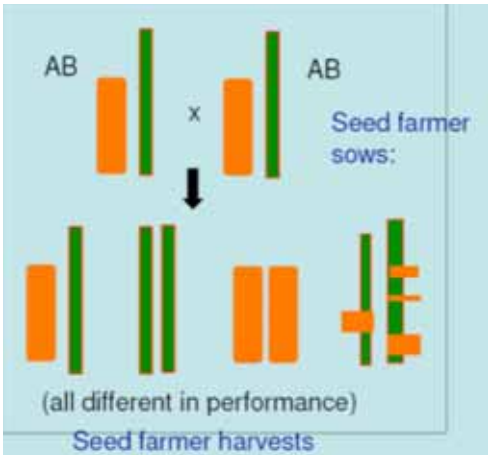


These two distinct varieties are bred together to create a new hybrid (F1) seed.

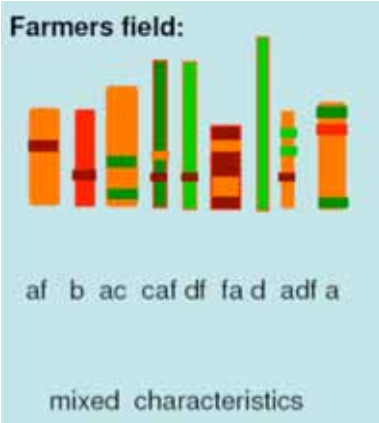
The F1 seed the farmer buys is drought resistant and high yielding. Every seed is exactly the same and will perform the same.

If the farmer saves the seed from his crop, that seed will be a mixture of the two parents.

The crop that grows could be drought resistant and high yielding like the parents, or it could be just high yielding, just drought tolerant or a strange mixture of both. The farmer has no idea what to expect. Because these seeds are so inbred with so little genetic diversity, they are not robust. The crop will not perform well.



Why is it better for farmers to use open-pollinated seeds?



Open pollinated varieties, or farmers varieties are very different. They have been bred over generations through selection and swapping. Each seed is a mixture of many characteristics, making them very stable and robust. The farmers field will always have a variety of characteristics. The plants that display the most useful characteristics will be chosen for seed. This is how the farmer interacts with nature to develop useful varieties. Seeds can be saved and planted year after year and they will continue to give good results.

Source: Steinbrecher, R. 2012 Genetic Engineering. The risks to food, farming and biodiversity. Presentation at Regional Biosafety Meetings 2012

Hybrids are developed when a breeder identifies two "distinct varieties", for example a high yielding maize and a drought resistant maize. These will be crossed to create a high yielding, drought resistant seed. The new variety, or cultivar, is called an F1 hybrid. F1 is short for Filial 1, meaning the "first offspring".

Farmers will know what to expect when they buy a packet of F1 seed as all the plants will grow out in the same way. If the plants are grown in the same conditions they will also be ready for harvest around the same time. This suits large-scale farmers who use machines to harvest. But what happens when the farmer saves the seed? The next generation will be a mixture of the two, so some seeds might also be high yielding and drought resistant but others might be drought resistant with low yields, high yielding but thirsty, a very strange mixture of the two or even sterile. For this reason farmers who grow hybrid seed buy new seed every year.

What are the differences between farmers varieties, hybrids and GMOs

	Farmers varieties	Hybrid	GMO
Breeding process	Developed through farmer observation, cultivation, experimentation, selection and sharing. Knowledge passed down from generation to generation	Developed in a laboratory by breeding two "distinct varieties", e.g. drought tolerant and high yielding	Developed in a laboratory by inserting genes from another species into a crop. E.g. insecticide from soil bacteria. The parent crop is usually a hybrid
Seed saving	Seed can be freely selected, saved and planted year after year	Performs well for one growing season only. Seed has to be bought fresh every year	Performs well for one growing season only. Seed has to be bought every year
Who is it for?	Suited to local conditions, taste and cultural needs	Commercial varieties, used by commerical farmers often for export or large markets	Commercial varieties, used by commercial farmers often for export or large markets
Type of Agricultural system	Fits into diverse cropping systems, agro-ecology, traditional agriculture	Usually developed to work within monocrop systems supported by irrigation, fertilisers, herbicides and pesticides	Usually developed to work within monocrop systems supported by irrigation, fertilisers, herbicides and pesticides
Intellectual property	No legal ownership rights. Seed is enriched and developed through sharing	These are corporate owned seeds and are usually protected by Plant Breeder Rights which does not allow farmers to exchange seed	These are corporate owned seed and protected by patents. Farmers can be sued for sharing or saving seed from their harvest

GM seeds are patented

Because scientists have inserted novel genes into the GMO, they argue that they have "created" something new. When a farmer plants GM seed he or she is doing this by permission of the company that owns the patent, for example, from Monsanto. This 'permission' is paid through paying a higher cost for the seed. Farmers are not allowed to save the seed to replant because it belongs to the company. Or, in the case of some crops like Soya, where the seed is saved and replanted the farmer must pay a license fee to the company or face being sued in court. This is the reason that GMOs are even more expensive than hybrid seed and why multinational corporations try by any means to get farmers to switch to GM crops.

1. Schestibratov K.A., et al 2009. .Strawberry Molecular Breeding. Black Sea Biotechnology Association http://www.bsbanet.org/en/publications/files/Strawberry-molecular-breeding-Russia-en.php. Accessed 12 September 2012
See also Sun, R. et al. 2009. The genetic transformation of strawberry with winter flounder antifreeze protein gene. Journal of Nuclear Agricultural Sciences. 2009-03 http://en.cnki.com.cn/Article_en/CJFDTOTAL-HNXB200903015.htm Accessed 12 September 2012
2. Schestibratov K.A., et al 2009. .Strawberry Molecular Breeding. Black Sea Biotechnology Association http://www.bsbanet.org/en/publications/files/Strawberry-molecular-breeding-Russia-en.php. Accessed 12 September 2012