Genes, Genetically Modified Crops, Intellectual Property and Farming

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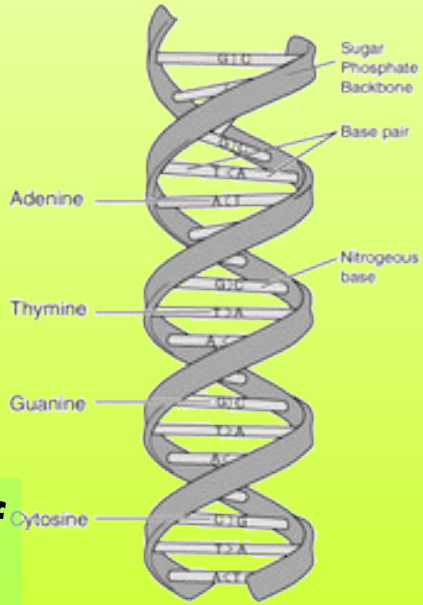
Genetically Modified Organisms

What is a Genetically Modified Organism?

Genetically Modified Organisms or **GMO**s, as they are commonly known, are living things such as plants, animals or even microbes and bacteria whose genetics has been modified synthetically – usually by man.

To understand this, we need to know something about heredity and DNA – the molecule that controls this.



Composition of the DNA

What is DNA?

Deoxyribonucleic acid (DNA) is a nucleic acid that contains the genetic instructions specifying the biological development of all cellular forms of life (and most viruses). This includes basic information such as how we are made of. For e.g. the human genes contain information that tells the human being has two each of eyes, hands, legs, ears etc. and where they are placed. Every living being has it's own DNA.

DNA and Heredity

Within each living being's DNA there is a region called the **Gene** that determines how that being will develop and it's behavior. A DNA can (and usually does) contain more than one gene.

Within the same species, minor variations in gene sequences result in different characteristics such as color, immunity, behavior etc.

DNA molecules that carry genes (or genetic information) are packaged into **Chromosomes**. The chromosomes are inherited by the offspring from it's parent(s). Thus genes are passed from a parent to it's child.

Gene Variations

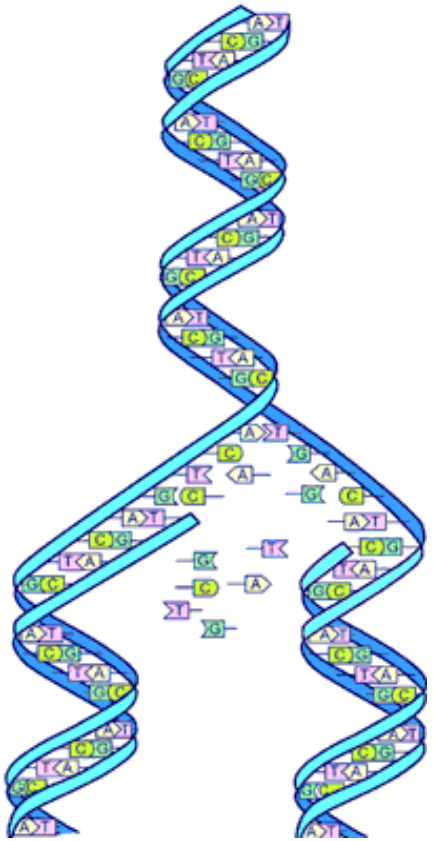
There are many reasons why DNA change.

When a DNA is copied from the parent to the child, there are some very slight variations in the gene sequence. Over time, these variations are significant enough to produce a different gene. Normally, the DNA will also control how much variation is allowable.

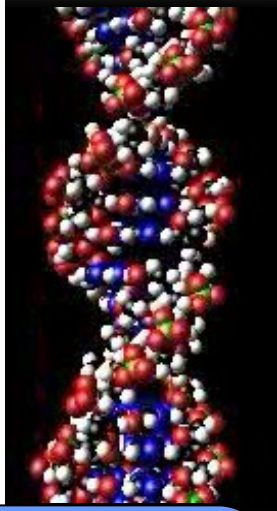
Sometimes, external factors such as environment can cause ones DNA to be altered. For example, radiation, exposure to heavy metals or even prolonged exposure to different climates can cause the DNA to change.

Other organisms (such as viruses) can corrupt or change the DNA by infiltration.

Sometimes errors can occur during duplication leading to mutations. Thus, the offspring will have some characteristic radically different from its parent(s).



Synthetic Variations to the DNA & GMO



Over the past few years, man has found ways to change the DNA of a living being by introducing new, combining or knocking out existing gene sequences and propagate it to it's offspring. Research has also yielded relation between specific gene sequences and disease susceptibility/ resistance. **Any organism whose genes have been modified by these means is called a GMO.**

Many scientists see this as beneficial in that they can add "useful" qualities to a known organism while eliminating harmful or "useless" qualities.

These methods are now largely being applied to growing plant and crop varieties that are immune to diseases or can survive in harsh conditions. Others that can are immune to poisonous chemicals such as certain types of insecticides and pesticides can also be developed by changing the gene sequences.

One particular method involves combining the genes of two separate species like that of two different plant varieties (e.g. tomatoes and onions). By this technique scientists hope to develop products that combine the benefits of both varieties. **Such products are called Transgenic products**.

While natural processes may develop such qualities, it takes very long for that to happen. Also, these qualities will also take place across species which may make such a quality less effective. For e.g., if a rice variety that is immune to certain pesticides develop naturally, then chances are that such immunity will also appear in other species such as surrounding weeds and insects. This makes such resistance useless to cultivators of rice. What we want is for the rice variety to be immune while the weeds and insects are not.

Why Genetics and GMO

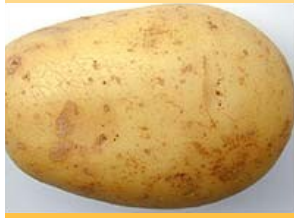
Proponents for Genetic Engineering and GM farming point to several advantages they offers. Among them –

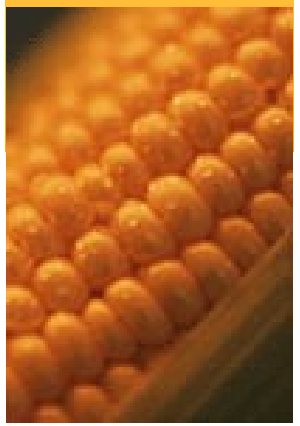
- The ability to develop food varieties with better nutrition. For e.g., it is possible to modify the genetics of say, rice or wheat, to include more vitamins and nutrition.

- The ability to develop strains for harsh environments such as deserts or flood-prone regions. Also, plant/crop varieties that can thrive with minimal nutrition can be developed. This would lessen the dependence on chemical fertilizers and promote environment-friendly agricultural practices.

- The ability to develop pest-resistant (both insect and weed resistant) varieties. This would mean lesser usage of pesticides which in-turn is better for the environment.

- Ultimately, GMO proponents argue, we will be able to develop higher-yielding varieties that require lesser effort to grow than current varieties. This would go a long-way in solving world hunger.





GMO and Intellectual Property

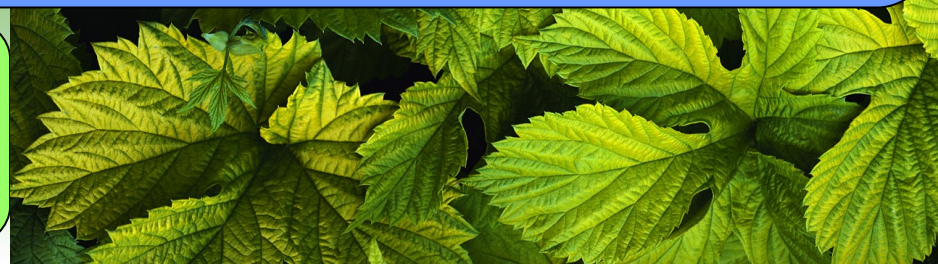
Because knowledge and understanding of the relation between gene sequences and characteristics is very useful, current international law allows for the gene sequences to be patented i.e. owned by those that develop or first claim this relation. Such knowledge is called **intellectual property (IP)**.

This allows the owners to sell such knowledge and make monetary gains from their work and recoup any money they might have spent in gaining it.

In recent years, many governments – primarily Western and developed countries – and organizations such as the World Trade Organization (WTO) have asked for all countries to observe laws relating to IP. To this effect, they have come with a Trade Related Intellectual Properties (TRIPS) agreement they want all countries to enact.

In fact, one need not even develop the actual gene code to patent it – just recognizing such a quality may be enough! The first modern patent for a living organism was granted by the US Supreme Court to a scientist named Chakrabarty for discovering a bacteria that consumes (and cleans up) oil spills.

Plant/crop varieties and gene sequences come under IP laws. For e.g., while wheat as a whole cannot be patented, varieties of wheat can be.



Concerns about GMO and IP

Ever since man started farming, he has depended on natural selection (natural gene variations) to develop better crops. Thus by combining two existing natural varieties, man has been able to produce plant genes that have superior characteristics.

With increase in knowledge of genetics, we are now able to understand scientifically how this happens. This knowledge has also empowered us to tinker with the very basis of life on Earth and it's variety – the DNA. By making such knowledge patentable, we have in effect turned life forms into commodities.

Forced modification and patenting of living beings has raised several concerns not only in older (Third World) societies, but also in Western circles. We will explore these further in the next few pages.

Implications of IP & GM to farming

The introduction of patents to living organisms has far-reaching consequences to the whole world – especially farming. Currently plant and crop varieties are the most patented objects in the world!

- Because users of a patented product often have to pay a user fee, it restricts the number of users. In some cases, the fee is high enough to prevent many people from using the product. Often people that need it most are poor and thus have no access to this. This has disrupted traditional paths and affects the free flow of knowledge in many older farming societies.
- Patented products – such as seeds, plants or even live culture – cannot be shared without paying the patent owner. In many countries, sharing seeds and saplings is a traditional way of spreading a beneficial crop or plant. Patents, thus, infringe on traditions and restricts age old agricultural practices.
- The patenting process itself is not very robust and often lends to abuse. Furthermore, the cost of obtaining a patent is very high and outside the reach of many poor farming communities. These communities are not only excluded from patent ownerships, but are also restricted from contesting the abuses due to high cost. **Many people fear that ultimately a few companies/countries will be able to control agriculture and food-supply across the world leading to monopolies.**
- With the introduction of GM crops, the issue has become more complicated. There have been no long-term studies performed to understand the impact of synthetic gene sequences on the environment and consumers. Individual crop strains developed over several thousand years and biodiversity are under threat from the introduction of these varieties.

We will look at these closely through some actual cases.

It is a misconception that lack of food is causing starvation in poorer countries and GMO is a solution. Many poor countries such as India have a vast overstock of food grains – often reaching several million tonnes! Clearly it is not lack of food that is causing starvation in these countries. The causes are more complicated and deals with pricing and distribution methods. Growing and distributing GMO foods by these methods will thus not decrease availability of food to the poorer sections of population

IP and conflicts with natural processes

The case of Monsanto Vs Schmeiser

In many cases, granting patents for genetically modified crops and enforcing the associated restrictions does not take natural processes into account. We can illustrate this through a rather interesting case – Monsanto Corporation Vs Percy Schmeiser.

Monsanto is a multinational giant based out of St. Louis, USA that provides seeds, fertilizers and pesticides to farmers, including Roundup – a commonly used pesticide & weed control chemical. Roundup being a pesticide, is harmful to most plants including generic canola (related to rapeseed). So farmers that use Roundup with regular canola dust their fields with it before planting their crops.

About 10 years back, Monsanto developed a genetically modified variety of canola that could survive Roundup – called Roundup Ready canola. Farmers that use this variety can plant the canola and then use Roundup without worrying about losing their crop.

Monsanto sells this variety based on certain conditions:

(1) Farmers cannot save seeds from their own crop – every year they have to buy the seeds from Monsanto

(2) They cannot share the seeds with other farmers – each has buy his/her own from Monsanto

(3) Farmers that use the crop have to pay a per acre fee plus a onetime user fee for every crop.

To ensure farmers do no illegally use Roundup Ready canola, Monsanto goes into fields and inspects their crops. If more than a certain part of the crop is Roundup Ready, then Monsanto says the farmer uses that variety. If the farmer is not a Monsanto customer, then he has to pay a very heavy fine. Monsanto employs private security firms that go into suspected farms sometimes without the permission of the farmer and inspects the crops!

Mr. Schmeiser is a farmer in Saskatchewan, Canada who has been growing Canola for over 40 years. Over this period, he has developed his own strains through cross-pollination. He uses chemical fertilizers and pesticides including Monsanto products, but not Roundup Ready.

The case of Monsanto Vs Schmeiser

In 1998, Monsanto inspectors found some Roundup Ready plants in Mr. Schmeiser's farm. The company says he has to pay for the crop as per the customer agreement.

Mr. Schmeiser disagrees that he bought their crop. He said that the canola was carried by the wind from from trucks on the nearby highways transporting the seeds and cross-pollination from neighboring farms. From these, because this variety was hardier than his own, they have spread across his farm. He says that he does not want Roundup Ready in his farm as he is against GM crops and has his owns strain.

Monsanto's argument is that it does not matter how the crop got there. They say that their own tests indicate more than 90% of Mr. Schmeiser's crops are Roundup Ready and this would not be possible unless the crops were planted. Independent tests show that the crops are anywhere from 0-68% Roundup Ready. Monsanto filed a patent violation charge against Mr. Schmeiser and asked him to pay punitive damages. Mr. Schmeiser filed counter charges against Monsanto for contaminating his own strain.

In 2004 the Canadian court determined that while Monsanto's patent was valid, Mr. Schmeiser did not have to pay any charges to Monsanto as he could not prevent infringement of the patent. They also threw his lawsuit out. So nobody had to pay the other party, but the lawsuit has cost Mr. Schmeiser considerably compared to Monsanto which has more resources to deal with such lawsuits.

This case illustrates some issues in enforcing patents and GM crops. Clearly the enforcing has not taken into account natural processes such as dispersal mechanisms. It also ignores dangers of strain contamination that happen because of indiscriminate spread of GMO varieties – in this case Mr. Schmeiser's crops were contaminated. In many cases, the victims of such contamination end up paying other penalty as well!

Thirdly, it restricts or even disrupts the age old practice of seed-saving and sharing among farmers. This practice has been very effective in promoting and spreading newer varieties without the dangers of seed contamination. The lack of overhead associated with seed sharing has been of immense help to many small farmers whose livelihood will now be threatened by the new IP laws. By imposing such conditions on farmers, critics fear that companies will be able to control farming and thus food supply.

IP and Traditional Knowledge – BioPiracy

The case of Neem pesticide

Another area where the IP of Genes and GMO have issues is with traditional knowledge. At heart of this conflict is how IP laws recognize original knowledge. Many newer societies recognize only published knowledge – the fact whether it is a quality or relation has to be published in a scientific journal or magazine. Any other forms such as oral are not recognized as enough proof that such knowledge is original.

In modern day, new scientific knowledge has to be published in a peer reviewed journal to be recognized as original. The authors of this work are credited with discovering the knowledge. Traditional knowledge – called "Prior Art" – too has to be published to be recognized as such.

Most Indians know about the Neem tree. For centuries, Indians have been consuming Neem leaves, chewing Neem twigs and in general using most parts of the tree to cure ailments, maintain health, complexion and immunity.

The Neem tree and it's medicinal properties have become legendary in India and neighboring countries. Farmers in India, too, have been using Neem-based pesticides for centuries. However, there has been no formal research on this property – nobody in living memory has conducted a study and proved that Neem-based pesticides are effective. This knowledge is traditional – it has been handed down over generations orally either as a general fact or through anecdotes. Where mentioned – such as in *Ayurveda* and traditional medicine texts – this knowledge was provided without any proof.

None of this, however, has affected it's use in India and other communities. Nor has it been disproved in any way that Neem possesses these qualities.

The case of Neem pesticide

In 1995, The US Department of Agriculture and the multinational WR Grace conducted some studies on Neem-based pesticides and found that the gene sequence that makes it effective. They applied for a patent for Neem-pesticide based on this knowledge and were granted it by the European Parent Office (EPO). Their argument was that this knowledge, though traditional, was never published in any scientific journal! They said that while many knew about Neem, there were never any tests conducted to establish these qualities. They claimed that their process (and pesticide) was different from what traditional neem-based pesticides which farmers have processed for centuries. Since they took the trouble of conducting these tests, they should be awarded the patent. Based on the patent, WR Grace started making and marketing a Neem-based pesticide called Neemix.

The Indian Government together with Europe's Green Party and agricultural organizations such as the Indian RFSTE and the world IFOAM contested this claim in Europe. Their argument was that even if it was not published somewhere, this was common knowledge to most Indian farmers. They said that the oral/anecdotal practice of maintaining and spreading knowledge was common to most societies in the world and has to be recognized as such.

In 2000, the EPO upheld the Indian Government's claim and reversed it's original decision. WR Grace appealed against this decision to the EPO. Finally in 2005, the EPO ruled against WR Grace and the patent is now nullified.

This case demonstrates an issue with the robustness of patenting process. Similar patents were awarded and partially retracted to items such as Basmati rice and turmeric. Others such as bean varieties have been granted patents to people that exposed them to the West. US and Japanese companies now hold patents for over 200 varieties of rice alone! Many traditional medicines and herbs have also been patented by third party companies.

In many cases, patents to a product or knowledge is granted to parties without any checks on it's antecedents. In fact, many patents are granted to those publishing traditional knowledge, but not to those that maintain this tradition! <u>This method of usurping ownership of a traditional agricultural product is called "Bio-Piracy"</u>.

This method of granting patents hurts traditional and poor societies like India and much of the Third World. As most of the knowledge here is old it is passed on orally. Publishing and going through a formal process of claiming ownership is very expensive for most poor communities and often results in loss of ownership of traditional knowledge.

Long-term effects of GM Crops

Of special interest to us are the effects of GMOs and food on the environment and consumers. One of the fundamental problem with large scale GM farming and product consumption is that many of the products are very new – less than 10 years old. The long-term effects of GMOs to both the surrounding environment as well as to consumers of GM food have not been studied rigorously so far.

Naturally occurring gene modifications tend to be limited and happen over a greater period of time. Nature limits the variations that can occur within a generation thus slowing down the evolution of newer genes. This enables the surrounding environment to absorb and adapt itself better to these changes. Radical changes tend to occur rarely. Such changes occur only in stray cases. Based on their ability to survive this gene pool can grow. When it does, the surrounding environment also changes to adapt and thus the disturbance is controlled.

When synthetic gene pools are introduced in large batches, the effects on the environment are unknown and may end up harming it beyond repair. For e.g., we saw earlier that GM plants spread faster because of their ability to withstand harsher conditions better than non-GM plants. Further, these gene sequences can transfer to surrounding environment thus causing unexpected and thus unpredictable effects. This becomes a concern if the transfer occurs to pests. Also, pesticide-resistant crop varieties may encourage more use of pesticides which may harm the surrounding environment as a study in England found out. Likewise GM plants that thrive better under certain environment may lead to the extinction of other species that are seen as pests/weeds to the farmers, but help support biodiversity.

GM rapeseeds can transfer gene sequences to it's wild cousins

A study on the Monarch butterfly larvae showed that they were harmed if exposed to a bio-engineered corn variety

Effect of consuming GM food

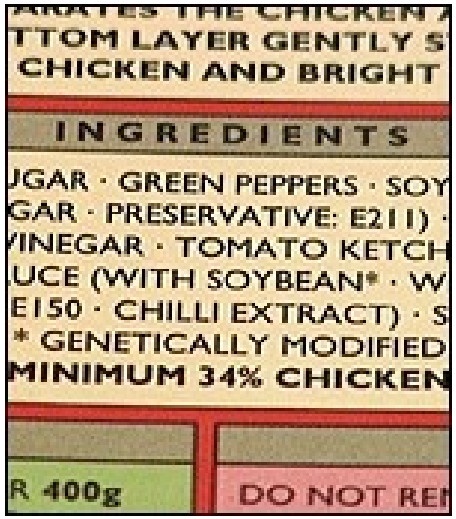
The rapid proliferation of GM crops has not allowed time to observe it's effects on consumers. Consequently, there is still a lot of concern on what long-term effect it will have on those that consume GM foods.

Currently, the US government is pushing for labeling only in those GM foods that are "substantially" different from it's non-GM variety. GM foods are also being extensively used in animal feed whose meat are consumed by humans. This leaves many consumers in the dark when it comes to knowing what they eat. The current explosion in use of genetics to engineer food varieties has resulted in many business opportunities. Imposing any restrictions would harm the industry.

Proponents of GM foods argue that there is no proof that the GM foods available in the market today cause any harm. They also insist that there is a rigorous process to determine whether GM foods are harmful. Products that are harmful never make it to the market or are withdrawn from the market as soon as any harm is detected.

Critics point to the fact that we do not have enough understanding of the ways genes can combine or get absorbed from the food to it's consumer. They say that without the information on long-term effects of GMO, assuming GM foods are safe is dangerous. Under these conditions, they want each and every GM food variety – even if there are minimal variations – to be studied.

Fear of the effects has prompted many European countries and some states within the US to ban GM foods and crops.



"A decade-long project to develop genetically modified peas with built-in pest-resistance has been abandoned after tests showed they caused allergic lung damage in mice."

11:18 21 November 2005
NewScientist.com news service

Resources

Clearly, the effect of looking at gene sequences and living organisms as patentable resources has far reaching consequences for the world. This issue needs to be debated particularly in the light of the emerging GMOs and GM foods. Below are some resources for further reading.

Genetics and GMOs

http://en.wikipedia.org/wiki/Genetically_modifi
http://gslc.genetics.utah.edu/
http://en.wikipedia.org/wiki/Genetically_modifi
http://www.gene-watch.org/index.html

GMO foods on consumer & environment

http://en.wikipedia.org/wiki/Genetically_modified_food

http://www.greenfacts.org/gmo/index.htm

http://www.guardian.co.uk/life/science/story/0,12996,1443004,00.html

Intellectual Property and Bio-Piracy

http://www.percyschmeiser.com/

http://americanradioworks.publicradio.org/features

http://en.wikipedia.org/wiki/Biopiracy

http://www.twnside.org.sg/title/neem-ch.htm

Arguments for and against GM

http://www.newscientist.com/channel/opinion/gm-

http://scope.educ.washington.edu/gmfood/positio

http://www.pbs.org/wgbh/harvest/exist/arguments.