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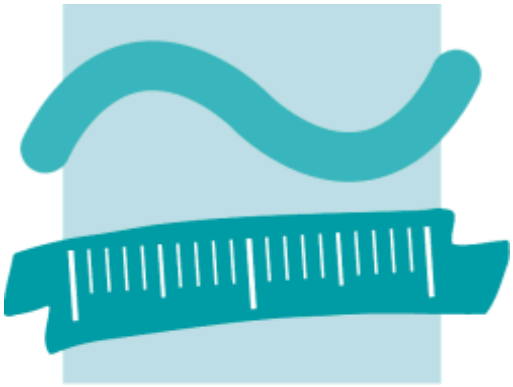

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GREEN GENETIC ENGINEERING –

Gene Revolution in the Food Industry

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1 Introduction

Crops used to be bred by inspecting the plants of an equal species and crossing those that had the most preferable quality features. Maternal and paternal characteristics were randomly combined and after harvesting, the plants were selected once again. This breeding and crossing method took several years until the farmers were contented with the crop they were growing. Today, green genetic engineering makes it possible to precisely transfer one or more genes into a plant even beyond the species barrier in order to create a perfect crop immediately.

2 What is green genetic engineering?

Genetic engineering in general involves the manipulation or transferring of genetic material within or between organisms. The core of every cell contains its DNA (Deoxyribonucleic Acid) in which the genetic structure is encoded. According to the one-gene-one-polypeptide hypothesis every gene on a chromosome provides the information to synthesize one specific protein[1]. In order to create a genetically modified organism a gene is oftentimes placed on microscopic particles of gold and fired into a different cell. Penetrating the DNA the gene creates a new protein and simultaneously a desirable characteristic.
Green genetic engineering in particular deals with the genetic modification of crops, leaving a plant that is perfect but sterile as a result. This new biotechnology is supposed to solve the problems of world famine and environmental issues and is said to make the coexistence with organic and conventional systems possible by any means.
Monsanto is by far the most nameable company that has brought green genetics in the form of seeds and appropriate herbicides on the global market. However, Monsanto's and related companies' ideas regarding the realization of green genetics are similar: plants are being manipulated in a way that they become resistant to a certain herbicide which is produced and distributed by the same firm that sells the manipulated seeds. When this herbicide is sprayed onto the farmland it will eliminate all weeds leaving the genetically modified crop intact. Monsanto for instance has developed soybeans that are resistant to an herbicide called *Round Up*[2]. Additionally, a gene that encodes an insecticide can be added to the plant's DNA, enabling the plant to produce its own bug protection. This was achieved with *Bt-Corn* which contains a gene that was obtained from the bacterium *Bacillus thuringiensis* and protects the

[1] BAYRHUBER, H./KULL, U., 1998, Linder Biologie, page 336
[2] MONSANTO company, http://www.monsanto.de/Produktbereiche/pflanzenschutz.php

plant against the corn borer, an insect that damages "[…] the ears of corn, as well as the stalks, chewing tunnels which cause the plants to fall over […]"[3]. Furthermore, green genetic engineering allows to fortify foods and therefore has the potential to make them more nourishing than traditionally grown plants. The so called *Golden Rice* for example is a type of rice that is capable of producing provitamin A because two genes were added to the genome.

3 Why green genetics are beneficial

Green genetic engineering is probably one of the most controversial modern technologies and seems to have just as many proponents as it does opponents. The most forceful argument for green genetics is the promising defeat of world hunger in all third world countries. But there is even more to it.

3.1 Sensory aspects and continuous food supply

Due to the immense heat, lack of water, insect attacks and flooding in developing countries, a major part of the vital harvest gets lost every year. In addition, ripe crops can oftentimes not be stored properly because neither warehouses nor refrigeration is available. Furthermore, many countries - especially industrialised countries - import crops that are grown overseas and damaged during longsome transportation. By the use of genetic engineering, foods can be optimized so that fruits and vegetables stay fresh longer, in storage as in shipping. Since the plants become more resistant to heat and other difficult environmental circumstances, higher yielding, better tasting and more flavoursome crops can be produced all year around. This could assure the world food sustenance and raise food quality in many countries.

3.2 Pesticides

The word pesticide includes "[…] any substance or mixture of substances intended for preventing […] unwanted species of plants […] interfering with the production, processing, storage, transport or marketing of food […]".[4] Oftentimes, these highly toxic substances do not only reach their destination but also contaminate water, air, soil and of course the food. That is because plants absorb and store everything that is dissolved in the water they are irrigated with in their tissues. When plants are genetically modified so that they can produce their own insecticide like *Bt-Corn* does they do not need to be sprayed and thus insecticides

[3] WIKIPEDIA, http://en.wikipedia.org/wiki/European_Corn_Borer, line 5f.
[4] WIKIPEDIA, http://en.wikipedia.org/wiki/Pesticide, line 7ff.

do not have to be used anymore. This does not only save the farmers time and money but more importantly it allows to produce healthier food with no pesticide residues. Moreover, it reduces soil, air and water pollution and therefore contributes to the preservation of the environment.

3.3 Enriched foods

It is believed that genetically engineered crops hold the promise of feeding the world and put an end to the suffering in developing countries that is caused by hunger and starvation. That is not only because more food can be produced since gene-modified plants are resistant to many environmental influences (see 3.1) but also because crops can be nutritionally enhanced and therefore protect people from diseases and malfunctions resulting in undernourishment. The first step was taken in 2000 when the *Golden Rice*, a genetically engineered type of rice that is able to produce beta carotene, was introduced. In the body, beta carotene is converted into vitamin A which is essential for vision in particular. On that account, green genetics do not only have the potential to reduce the number of children suffering from blindness which has reached 350.000 – 500.000 a year[5] but also it can bring about more enriched foods that help malnourished people to receive all essential nutrients like vitamins and minerals they need for a healthy being.

4 Why green genetics are not sustainable

Although green genetic engineering sounds very promising there are some serious reasons why we should abstain from genetically modified foods. Aside from health hazards (see 4.1) and the fact that consumers are tricked in the supermarket (see 4.2) this biotechnology is no sustainable alternative to organic crops. Some unthinkable but quite realistic consequences are depicted in the following paragraphs.

4.1 Health Risks

First and foremost, one has to keep in mind that so far there are no long term studies concerning the impacts of green genetics on health since it is a very young biotechnology. As with any new technology scientists have limited abilities to predict the full set of risks. Up to the present, genetics, nutrition and physiology are not completely understood, let alone their correlation and therefore, nobody knows if genetically modified food is really safe.

[5] WORLD BLIND UNION, Newsletter # 3, page 9

By far, most concerns about green genetics centre on the probability that gene-modified crops could bring new allergens into foods. As we know, genetic engineering always involves the changing of at least one protein since the genetic structure that encodes it is being manipulated (see 2). Classical allergies, regardless if hay fever or food allergies are always caused by proteins. More precisely, allergens (proteins) are wrongly identified by the immune system and cause an over reaction as a protective mechanism. Consumerists are afraid that sensitive people will not be able to avoid allergenic foods since the only sure way to determine whether a product contains an allergen is through experience.

4.2 Nutritious food?

As already mentioned in 3.1, genetic engineering has the potential to offer the consumer fruits and vegetables that stay fresh much longer than conventional crops. The first attempt to produce a crop that is not only big and juicy but also storable for several weeks was realized in 1994 when the *Flavr Savr Tomato* was put on the market. The idea was to block the activity of polygalacturonase, an enzyme that is responsible for the degradation of pectin in fruits' and vegetables' cell walls during storage. Scientists did manage to suppress the enzyme activity by inserting the gene that encodes polygalacturonase synthesis in reverse.
The problem with this counterfeit freshness is that luscious-looking fruits and vegetables could be old and more importantly of little nutritional value. That is because the content of vitamins and other essential nutrients such as polyphenols and carotinoides is decreased continuously after the fruits have reached their climacteric – the end of the ripening process. Oxygen and light in particular promote the oxidation of these valuable fruit and vegetable components. Although the *Flavr Savr Tomato* was not lucrative and therefore taken off the market it is conceivable that scientists will try to manipulate other crops in a similar way. As a result, consumers will not be able to distinguish between fruits and vegetables that have a high or decreased nutritional value.

4.3 Concerning the environment

Although green genetics are supposed to reduce the need for pesticides (see 3.2) one has to point out that conventional pesticides are oftentimes at least partially biodegradable whereas Monsanto's and other similar companies' herbicides are highly toxic and cannot be broken down by nature. Additionally, only 30% of all genetically engineered crops being grown world wide have been provided with their own insecticide inside of their cells and therefore

do not require to be sprayed with pesticides.[6] This leaves a great fraction of gene-modified crops still calling for a chemical treatment.

However, this is not even the most crucial issue to discuss when talking about the environmental impacts of genetically modified plants. According to Charles Darwin a key mechanism of evolution is the natural selection, "[…] a process by which heritable traits that make it more likely for an organism to survive and successfully reproduce become more common in a population […]".[7] Natural mutations, tiny and random changes within the DNA, are essential parts of natural selection and happen numerous times everyday, enabling plants and animals to adapt to new surroundings. In other words, genetically engineered plants will not be resistant to the insects they are supposed to be protected from for ever because due to natural mutation and selection the bugs' gene pool will eventually change so that they will again be resistant to the insecticide produced by the plant. A similar scenario can be imagined when regarding crops that are genetically manipulated in order to resist herbicides that are destined for weeds, which follow the same principle of natural selection and mutation as insects. In the long term, more aggressive pesticides will have to be produced which can have severe impacts on the environment and on our health. Another problem is that after years of the establishment of green genetics and the development of new pesticides it might be impossible for any company to estimate what kind of substances which plant or bug species is resistant to, since pollen can be carried away milelong by wind and animals, unintentionally changing the genome of other plants by crossbreeding. Additionally, it is conceivable that green genetics may lead to the development of aggressive weed and bug species that might be capable of not only suppressing essential crops but also push back endangered plants and insects and therefore threaten the enormous diversity of species on earth.

4.4 Developing Countries

Green genetics are said to be the ultimate solution for world hunger and malnutrition. As a matter of fact, "[…] world hunger is projected to reach a historic high in 2009 with 1,020 million people going hungry every day […]".[8] However, the problem does not originate in the lack of food. The world food report 2008 by the FAO (Food and Agriculture Organization of the United Nations) reported that given the current state of agriculture at that

[6] THE FUTURE OF FOOD, a film by Deborah Koons Garcia, 2008
[7] WIKIPEDIA, http://en.wikipedia.org/wiki/Natural_selection, line 1f.
[8] FAO, http://www.fao.org/news/story/en/item/20568/icode/

time, the world could feed 12 billion people with no problem.[9] Therefore, green genetic engineering fails to work on the actual cause of world starvation. In contrast, this biotechnology has the intention to produce even more food.

Over years, experts have come to the conclusion that the self-help principle is the most sustainable concept of developing strategies and has the biggest potential to reduce world hunger because it will actually enable the concerned people to establish an own existence and be independent from industrialised countries. Green genetic engineering however works against this principle because it makes recipients of gene-modified seeds dependent on the company selling the seeds. Normally, farmers save a portion of seeds from their harvest and replant them the following season because they cannot afford to buy new seeds every year. Genetically manipulated seeds however are unable to reproduce so when the crops are harvested all new seeds are sterile. Once planted, the farmers are forced to buy gene-modified seeds every year, making them entirely dependent on the company.

The real problem lies in the mannerism of industrialised countries: fruits and vegetables are mass-produced quickly and cheap in green houses or with the help of green genetics and imported into third world countries where the crops are sold for a give-away price on local markets.[10] Usually, native people do not have enough money to own a very big piece of farmland. Therefore, they only have a little quantity of fruits or vegetables to sell in order to earn their livelihood. Obviously, they cannot market their crops for a dumping price. As a result, indigenous farmers have no chance to compete with imported products from Western countries. Green genetic engineering even intensifies this situation: although farmers might be able to increase their annual yields, they are still forced to buy overpriced gene-modified seeds every year, leaving them with the same or an even smaller amount of money.

4.5 The Consumer's Choice?

Although plants are able to breed fertile offspring even over very long distances since plants naturally cross by wind blown pollen, green genetic proponents claim that the coexistence of organic or conventional and gene-modified crops is possible. Is this parting truly realistic? In order to understand what makes coexistence so difficult one has to have a closer look at what happens when pollen strikes a blossom. Just like in our bodies two reproductive cells called gametes, each containing one haploid (single) set of chromosomes fuse together creating a fertilized ovum with a diploid (double) set of chromosomes and eventually a new

[9] WE FEED THE WORLD, a film by Erwin Wagenhofer, 2006
[10] WE FEED THE WORLD, a film by Erwin Wagenhofer, 2006

plant. Clearly, a transgenic contamination becomes unavoidable as soon as a genetically engineered gamete mates with an unmodified gamete since the manipulated gene is automatically included in the new genome.
For us consumers, this might mean that eventually we will not be able to choose whether or not we prefer to buy gene or organic foods. That is not only because genetically modified pollen is randomly and not traceably spread by the wind but also because the mixing of gene and non-gene seeds and foods be it on the field, within a food factory or at different transition points is uncontrollable.

5 Conclusion

At first sight, green genetic engineering may seem very appealing. However, closer examination shows that commercial reasons are taking precedence with no regard to possible health risks, severe environmental impacts and consequences for people in developing countries. We already have the ability to feed the world's population. Why subject humanity to unnecessary risks? And why lead poor people into an even deeper dependence?
It is unthinkable but realistic that green genetics threaten to wipe out all non-modified crop varieties because gene-plants will spread - nationwide and irreversibly.

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