Green Genetic Engineering in Food Production

The Risks and Benefits of Green Genetic Engineering in Food-Production

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Genetically Modified Crop Plants

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Preface

We have chosen the topic of genetically modified food products. To be more precise the 'green genetic engineering' of food .This is not necessarily a recent idea or technique but it has not yet influenced agriculture and our daily food consumption in Switzerland. Yet it is very much on the upraise, in the US already 93% of the soybeans grown in 2013 were genetically modified. But in Europe we haven't seen this yet, we want to find out why. Also we want to get an overview on how much green GM food is produced and how it is modified. Is it the answer for the future, will it cure worldwide starvation? And if not how is it or will it affect our environment and the organisms that consume it? Genetic Modification in Food is a very controversial subject with the potential to change our entire lifestyle. So we want to find out what's really behind this and if it really could change the world for the better.

Introduction

Genetic Engineering has many different fields in which researchers and private companies are working. One of them is the Food industry or more precisely crops. Especially in the US many such crops are being modified in order to improve their traits or add new ones to them. Worldwide there are about 28 countries who have grown 69.5 million hectares of GM crops in 2012. The leading countries for research and farming are; the U.S, Canada, Argentina, Brazil and India. In Europe there is only one country who has farmed Gm crops on a large scale, Spain. Apart from that the progress is slow in Europe because the EU has had a `de facto` ban on any genetically modified farming until 2004, now all crops are strictly regulated by the EU. One of the main reasons for planting and growing GM crops is the economic benefit that farmers believe to gain. Through genetic modification they can grow more plants in a smaller area and save money because of pesticide resisted plants, Also they may have less losses caused by weather changes and their products can obtain a longer shelf life. Still it is widely disputed if this actually brings benefits to the farmers or if there is really less chemicals involved. There are many scientists and government criticizes these modified crops, saying the potential health risks have not been adequately identified. The concern of the public is that these foods may be more harmful than natural foods, but scientists assure that this is not the case. Still it is not entirely known what sort of effects large scale crops could have on the environment and the natural plants that may be endangered by the modified crops.

Lead questions in short:

- How are crops modified? What are these alterations trying to achieve?
- What methods exist? Which is most common and beneficial? How does it work?
- What are the critic points against GM crops?

Facts and Background Information about Green Genetic Engineering

In Green Genetic engineering, or biotechnology, the genetic markup of a plant is changed in the laboratory in order to serve some beneficial purpose, for instance higher in vital minerals, an improved shelf life, resistance against certain pests and illnesses and even herbicides. It's also possible to make the plants more tolerant towards unsuitable soil conditions like drought, frost, salinity or lack of nutrients. This alteration can happen in a variety of ways and there are a couple of successful methods.

In order to achieve the desired effects, the genes for them are extracted from other organisms, like bacteria for example, and inserted into plant cells. For creating resistance towards different kinds of pests, the plants are given genes that make them produce venom for defense. To make the plant survive on a less nutritive soil, you give her genes that make her use the given nutrients more efficiently. If the plant should be able to grow in dry soil, you give her a better absorption or storage-system, taken from the genes from other plants.

Method; How a parasite becomes a beneficial organism

One of the most successful methods of green genetic modification works with Agrobacteria[1]. This method is mostly used for dicotyledonous plants like potatoes, tomatoes and tobacco. Agrobacteria(are natural plant parasites that have the ability to transfer genes. They insert their genes into plant hosts in order to create the optimal environment for themselves. (See Picture beside; Image 1)

Image 1; the work of agrobacteria - they cause a plant to grow tumor-like structures

The parasite has a plasmid that is encoded with genetic information for tumor growth. This genetic information (T-DNA) is deposited in the plant, and the genes of the plant are replaced by it – the plant changes. In genetic engineering, the bacteria are used as a vector for transport of the desired DNA; the genetic information encoded within the plasmid of the bacteria is removed and gets replaced by the foreign gene.

In order for the bacteria to transport the gene, the plasmid of the bacteria is removed, then the T-DNA is cut with the help of restriction enzymes[2]. The desired gene is extracted from another species and is also cut by restriction enzymes.

[1] Agrobacterium; a bacterium that lives in the soil

[2] Restriction enzymes; Enzymes that cut DNA

The bacteria are indifferent to the change and inject the foreign DNA into a cultivated plant cell. Eventually, a complete genetically modificated plant is generated out of a cell clone. The cells are cloned in order to avoid failures. The whole process is visualisated in the image below; See **Fehler! Verweisquelle konnte nicht gefunden werden.**

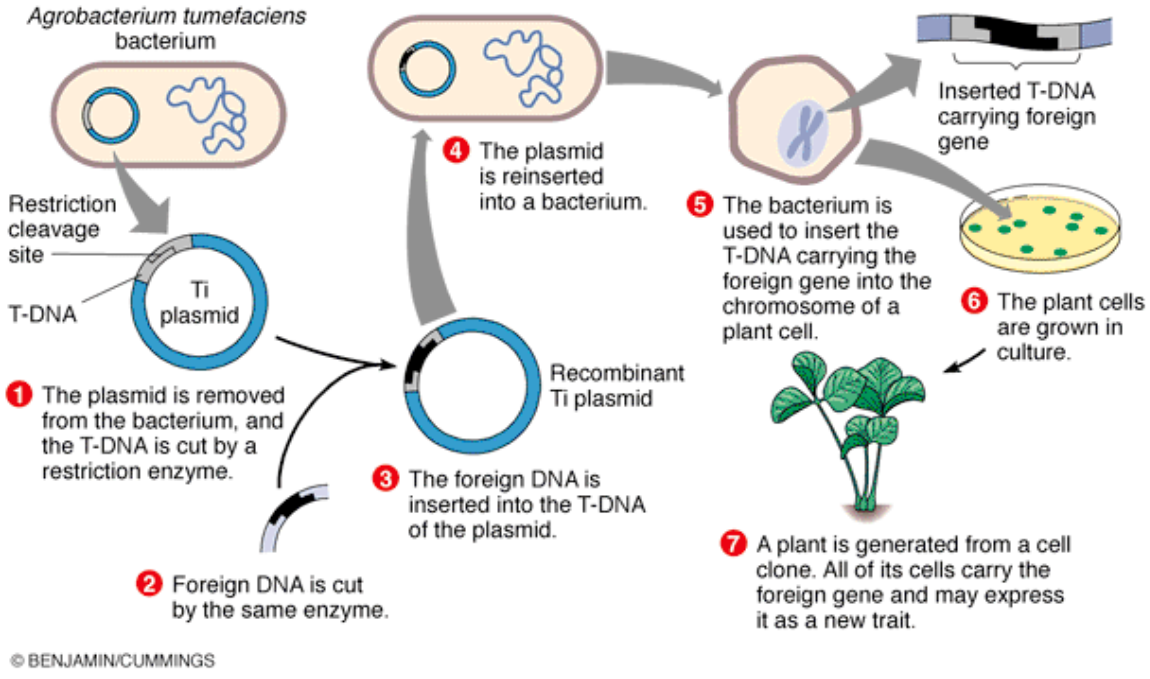

Image 2; Genetic Modification with the help of Agrobacterium tumefaciens

Advantages and disadvantages of this method

The method of using agrobacteria in order to modify the plant cells, has the advantage of being a biological process; there are no further mechanical or chemical "attacks" on the sensitive inner life of the affected cells, so there's less risk of damage or failure. However, agrobacterium does not infect all plant species, but there are several other effective techniques for plant transformation like the *gene gun*[3].

[3] Gene gun; a device for injecting cells with genetic information

Interview with a Criticizer of the Use of Genetic Engineering;

Image 3; "Basler Appell gegen Gentechnologie"

We held an interview with Pascale Steck who is a Biologist and the Head of the organization `Basler Appell gegen Gentechnologie` (See Picture beside; Image 3). It was founded in 1988 after a GTECH-critical congress. It has over 1000 Participants in Switzerland.

1. Which Field do you work in and what is your main focus?

The 'Basler Appell gegen Gentechnologie' is an association that critically deals with all topics in gene technology. We inform the public about advances in the area of genetic engineering and we answer questions, we publish brochures and take part in consultations. For a couple of years now our focus has been the medical area of gene technology.

2. Is gene technology already used in Switzerland? If so, in which Field? Is it used on a large scale?

Agriculture: There is still a moratorium in force that forbids the commercial (and large scale) use of genetic engineering in Switzerland. At the moment there has been only one practical experiment of the University of Zurich in cultivating genetically modified wheat. Only a few square meters are affected by this.

Food: Because of the strong refusal by customers, genetically modified food is not sold in Swiss food stores.

Medical Field: A large part of the consumed drugs in Switzerland is already produced by means of genetically modification. Also the private and medical use of Gentests is growing rapidly.

3. Where do you stand on genetic engineering in general? What are the main problems? Is it more an ethical problem?

The Basler Appeal rejects the use of genetic engineering. Genetically modified crops in agriculture only bring profit to the large corporations that sell these plants. Farmers do not benefit from it in any way that's what the experience of the global GM use has shown. In addition, the ecological consequences of global GMO use are still unclear; also the risks for consumers of GM foods have not been estimated sufficiently.

In the medical field the acceptance of genetic engineering is much higher than in the agricultural field. However, despite the use of enormous sums of money especially in the field of pharmaceutical research, there has not been more than a handful of successful genetically engineered drugs produced that have been able to convince, for instance in the field of oncology.

The situation is different in the manufacturing of drugs that can be produced using genetically modified microorganisms, so that costs can be saved. Insofar as the production is done under controlled conditions in a closed system, we have hardly any objections.

Ethical problems are mostly seen in the field of reproductive medicine, where we can increasingly find embryos being genetically tested and sorted out so that unwanted characteristics can be avoided by PID or abortion.

4. How do you feel about their use in the food industry?

See above: Neither agriculture nor consumers benefit in any way from GM foods, so the use is unnecessary. On the contrary, the flow of goods separation becomes more difficult, the costs are passed on to consumers.

5. Are there fields where you feel that genetic engineering is particularly reprehensible and why?

Genetic optimization of human individuals is ethically particularly questionable. Who decides what should be the norm? Discrimination against people who do not meet this standard is inevitable.

6. Do genetically modified plants have a direct negative impact on the environment or the consuming organism?

Environment: On the one hand genetically modified crops and their pollen and seeds spread themselves uncontrollably in the environment and mingle with their natural relatives. Long-term effects are still unclear, the fact is that original species are displaced in this way and disappear completely. GM plants that produce insecticides, also damage „non-target organisms. “

Consumer's organisms: negative effects were observed by the consumption of GM crops in different feeding trials - but these results are controversial in the scientific world.

7. What genetic changes are made to plants (or: What is to be achieved with it)?

The main targets are still insecticide production and herbicide tolerance.

Look here: http://www.transgen.de/datenbank/pflanzen/

8. Do genetically modified animals have a direct negative impact on the environment or the consuming organism?

There are no studies on this topic - presumably the environment does not suffer if a cloned cow or a GM pig is standing in a shed eating silage. It was only shown that components of genetically modified foods, including the „alien genes " can pass through the intestinal wall of humans and thus reach the consuming organism. However, what happens to it then is unknown.

If genetically modified salmon as they are to be brought to market in the U.S., are released into the wild or leak into the environment, these individuals will reproduce with individuals from natural populations. The consequences are difficult to estimate.

9. What genetic changes are made to farm animals (or what is trying to be achieved?)?

Usually the growth is to Growth accelerated, or the maximum weight gain should be further increased. There are also experiments with farm animals for example, so that they produce milk with medical agents.

10. It is rumored to be a solution to the problem of growing problem of worldwide starvation – From a biological point of view; do you feel differently about this?

Because it has not yet been possible to increase the productivity of agriculture through the use of genetically modified crops, the solution to the global problem of starvation must probably be sought

and found elsewhere. The worldwide use of pesticides, however, continues to rise and the problems associated with it are rising visibly. In our opinion only an ecologically aligned agriculture is sustainable.

11. Does genetic engineering have a future in your eyes? How do you expect its development?

No, in agriculture genetic engineering is certainly not effective. However, seed production is increasingly being monopolized, so it is to be feared that that the global use of GM crops will continue to rise. In the medical field, the same tendency can be observed, however next too many flops there are some small successes to be seen.

12. Are there any conditions or applications in which you would advocate the use of genetic engineering?

No, there are preferable alternatives in all areas, except for the microbial production of substances (this includes vitamins and enzymes, see above), towards which we are neutral. The few drugs that have been produced on the basis of genetic findings, one must consider as individual cases in order to make an assessment.

Discussion;

Green genetic engineering seems to be very promising; crop plants can be made resistant, more tolerant and of higher quality or easier to process further – scientists often even praised it as the only solution problems such as world starvation, environmental pollution or the lack of natural resources. In the US the use of gene technology in food-production is already very common, while in Europe genetically modified plants are at the most permitted for medicine-production. But why is this? This is because even this incredible invention has its shady side, like an inevitable decrease of biodiversity or unpredictable health hazards for consumers, especially as no long-term studies exist so far. It is also said that, with exception of the big companies, no one will profit from the use of GM-plants in agriculture.

With the help of green genetic engineering, it is possible to breed plants that show resistances towards herbicides; these are usually quite useless because either only few or all the plants in the treated field are affected by it. With GM plants farmers can use it freely without worrying about their crop fruits, because those will be the only ones surviving. This might also mean less pollution because farmers don’t have to use chemicals for each type of weed, but they can use one for all of them. This looks quite beneficial at first; however, we have to consider that there is still a huge amount of chemical pollution if the farmers have the possibility of just treating their fields quickly with some chemical instead of getting rid of weeds through more complicated methods. It is a fact that chemicals never stay in the place they were applied to- they end up deep down in the groundwater, in our food as well as in the surrounding soil. We must also consider the property of these chemicals of inhibiting the metabolism of almost all natural plants - sooner or later this will result in less biodiversity.

With gene technology, we can give the plants themselves resistance towards any kind of pests like fungi, insects and viruses, so that farmers don’t depend on pesticides anymore. This is a very positive fact actually, but for example if insects can’t find another food source they will die out or attack other plants leading to them being eradicated as well.

One of the other main facts to be considered is that no long-term studies exist so far, so we have no idea of any hidden risks of consuming these plants.

Another beneficial fact for farmers is that with genetic engineering you can make plants more tolerant towards unsuitable environmental conditions as salty, dry, nutrient-poor or aluminum-enriched soil. This is one thing that leads scientists to the conclusion that genetically modified plants might be the solution for world starvation. Crop fruits can now be made available in poorer regions that usually couldn't grow them because of the unpleasant conditions of their fields. It's now also possible to create crop fruits that contain more nutrients and less allergen than the natural ones and it's possible to raise the content of vitamins and healthy fats. But other factors like the climate should be considered as well, so just because the plants are more tolerant towards bad soil conditions, it doesn't mean, that they can grow in the given climate. But quite certainly there is big progress being made to eradicate starvation in poorer countries (see, Image 4), we are not quite there yet but there have been many promising advances.

Image 4; genetically modified soy - is it the solution?

Conclusion

Green genetic Engineering seems to be very promising but also has its shady side; it can make the plants easier to grow and to care for but it has also a strong potential of being an environmental or health hazard;

Advantages in short:

- Crops are modified to have a higher resistance to weather, soil conditions, illnesses and insects
- Crops can be modified to have higher contents of vitamins, oils etc
- Farmers can achieve large scale farming without great losses through space or pests
- Pesticide use is limited, therefore there is less pollution
- GM products can have a longer shelf-life
- Could be the beginning of a solution for starvation in poorer countries

Disadvantages in short:

- The effects on the consumer (i.e human and animals) is unknown
- The effects on the enviroment (biodiversity) are unknown
- The economic gains from it are disputable
- GM crops have not yet been modified to withstand certain climates

Summary and Closing Words

Green genetic engineering, or biotechnology, is all about changing crop plants in a favorable way - crop plants can be made resistant, more tolerant and of higher quality or easier to process further – scientists often even praised it as the only solution problems such as world starvation, environmental pollution or the lack of natural resources. But it has also a strong potential of being an environmental or health hazard, that's why it is heavily criticized and almost completely prohibited.

It is also criticized for not being of any benefit for consumers or farmers, but for big concerns. Pascale Steck, for example, is one of those critics.

One successful method would be, to replace the plasmid T-DNA of agrobacteria by the desired genetic code, so they will inject is and cause the change.

After working on this project we have a fairly good overview of the advantages but also the difficulties that come from genetically modified crops. From how the farmers benefit to the people who are opposing it. We have learnt much about the possibilities and methods that are beeing applied,in particular the use of Agrobacteria, yet there is still unbelievably much that we do not know. The hope that it will help the world change for the better is certainly here but we think that a lot more research should be done and we think that we will be far more critical next time we hear about advances in genetic modification. As with so many inventions the scientific advances that have been made in recent years are to be feared as much as to be celebrated. But eventually, we still think that genetic engineering might help to reach the next step towards a better future.

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Image Sources

Image 1; the work of agrobacteria - they cause a plant to grow tumor-like structures
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Image 2; Genetic Modification with the help of Agrobacterium tumefaciens
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Image 3; "Basler Appell gegen Gentechnologie"
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Image 4; genetically modified soy - is it the solution?
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