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IMPACTS OF GMOS ON ORGANIC AGRICULTURE

UTJECAJ GMO NA EKOLOŠKU POLJOPRIVREDU

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ABSTRACT

Virtually all scientists agree that the commonly used methods for inserting new genes into the genome of a crop plant (genetic engineering or genetic modification): (1) are imprecise and uncontrolled, (2) can impact biological functioning unpredictably, and (3) can lead to unintended harm to health and the environment.

The intentional use of GMOs (genetically engineered crop varieties) is prohibited in organic agriculture and food production. However, the increasing use of GMOs in conventional agriculture in certain countries poses an increasingly serious challenge to the integrity of organic. This is because GMO use by conventional farmers creates substantial risk that organic foods will be unintentionally contaminated with GMOs through cross-pollination in the field and accidental admixture during storage, transport, and processing. Consumers believe that "organic means no GMOs." Yet, evaluation of the actual extent of GMO risk for organic agriculture in Europe, Japan, and North America, leads to the conclusion that the gap between consumers' expectations and industry practice is the most significant challenge facing the organic movement today. We discuss approaches to addressing this challenge. On the micro-level, GMO testing, traceability systems, segregation procedures and sourcing strategies can be used to control the GMO risk in organic production systems. On the macro-level, the GMO challenge can be addressed through industry-wide cooperation to successfully manage over-arching challenges, such as establishing sustainable supplies of non-GM seed and critical ingredients, and through strict regional and national controls on cultivation of GMOs. Examples of such initiatives from both Europe and North America will be presented.

Key Words: Organic Agriculture, Genetic Engineering, Sustainable Agriculture, Environment, Food Safety

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SAŽETAK

Gotovo svi znanstvenici se slažu da su danas uobičajene metode za ugradnju novog gena u genom biljke putem genetičkog inženjerstva (genetičke modifikacije): (1) neprecizne i slučajne, (2) pa je njihov utjecaj na biološke funkcije biljke nepredvidiv, (3) a neželjeni učinci GMO na zdravlje konzumenta i na okoliš mogući.

Korištenje GMO u ekološkoj poljoprivredi je zabranjeno, stoga potrošač vjeruje da oznaka "ekološki" zakonski štiti od prisustva GMO u hrani. Međutim, povećano korištenje GMO u konvencionalnoj poljoprivredi nekih zemalja predstavlja prijetnju razvoju ekološke poljoprivrede: opasnost od zagađenja ekološki proizvedene hrane, bilo putem stranooplodnje u polju, bilo miješanjem s GMO tijekom transporta, uskladištenja ili prerade. Procjena stvarne opasnosti od GMO po ekološku poljoprivredu u Europi, Japanu i sjevernoj Americi vodi ka zaključku da je jaz između očekivanja potrošača i industrijske prakse najznačajniji izazov pred ekološkim pokretom danas.

U radu su razmatrani pristupi proučavanju tih izazova. Na mikronivou, za kontrolu rizika od GMO po ekološki proizvodni sistem, mogu se koristiti: testiranje prisustva GMO, sistem praćenja izvora i sistem segregacije. Na makronivou izazovi GMO preko industrije mogu se nadzirati kroz: održivo snabdijevanje ekološkim sjemenom i kritičnim sastojcima i kroz strogu regionalnu i nacionalnu kontrolu uzgoja GM usjeva. Opisani su primjeri takvog pristupa u Europi i sjevernoj Americi.

Ključne riječi: ekološka poljoprivreda, genetičko inženjerstvo, održiva poljoprivreda, okoliš, sigurnost hrane, testiranje GMO

INTRODUCTION

In this paper, we will consider a wide range of agricultural approaches – from organic, to biotechnology-based chemical agriculture. The paradigms of all these classes of agriculture are very different. Chemical agriculture, takes the perspective that Nature needs help - we give plants chemical nutrients - NPK - and treat them with chemical pesticides, whiled biotech agriculture does all of that but also genetically engineers the plant to produce pesticides, for instance. In both cases, the perspective is that one must do quite radical and aggressive things to "help" the plant be most productive. Organic agriculture takes a very different perspective – Nature knows best—all we need to do is to work with Nature, understand her deeply and work with her.

Working with Nature

Oftentimes people contrast organic agriculture with chemical and biotech agriculture by calling the latter "modern" agriculture. But this is not accurate. It is true that chemical and biotech agriculture are phenomena of the contemporary times, but organic agriculture is just as contemporary; in fact, it is the only sector of the food and agricultural marketplace that is growing and expanding robustly today. But in addition to being contemporary, organic agriculture, in contrast to the other two, has deep roots, roots that go back to the beginning of agriculture, and to the beginning of life, itself. It strives to be in tune with the laws of nature. And if anything could be considered eternal, it is those laws. If we want to select words to contrast these approaches, instead of "modern" I would select a word like "new-comer" or "upstart" to describe chemical agriculture and biotech agriculture "hyper-upstart" agriculture, because not only are these new, but they have not been around long enough yet to say that they have an authentic track record.

The approach of organic agriculture is to work with Nature. This means working with the seed and the soil, in the context of the weather and the environment. The basic principle is that healthy soil gives a healthy crop, because healthy soil gives the seed what it needs to express its potential.

Resistance to insects, disease and drought are inherent in the potential of the plant. All the farmer needs to do is to give the plant the nutrients that it needs and it can make use of its inner intelligence to fend off any pest or disease and handle any stress—drought, heat, flooding, etc. The genetic resources of every plant trace all the way back to the beginning of life on the planet. In the long scope of time, the predecessors of any given crop plant have been subjected to countless and very varied environmental and biological challenges, and they found within themselves the resources, the capacity to survive those challenges. The blueprint of those survival mechanisms are still inscribed in the DNA of the plant. The job of the organic farmer is simple: empower the plants to access those mechanisms for survival and vital, vigorous growth that are part of their natural potential, that are already encoded in their DNA. This approach works. In April 2008, the report of the International Assessment of Agricultural

Science, concluded that GM crop yields were 'highly variable' and the application of GM outside the lab 'contentious'. In contrast it recommended 'agroecological systems', of which organic farming is a practical, proven example. The extensive evidence exists supporting this approach compared to conventional and biotech farming.[1]

This is quite different from modern agriculture where the model is to create a “safe” place for the plant: You kill the bugs and weeds with highly toxic chemicals, you spray other chemicals to kill fungi, and other diseases, and you load the soil with high levels of chemicals that are supposedly nutrients needed for rapid growth, and then you pray that the weather will be OK. Other than praying, there is not much you can do about the weather. You can irrigate, but what about hail or untimely frosts?

So we see that modern agriculture attempts to create a controlled environment. But in reality this is simply not possible. The modern farmer may think he is in control, but he is living an illusion. You spray for one pest, but another comes up unexpectedly. In reality, Nature is in control. And if you think you are in control, Nature will take frequent opportunities to remind you that you are mistaken. It has been this way and it always will be: Nature is in control, and if you want to succeed, you better do everything you can to encourage her cooperation. Agriculture in its most essential form is simply that: learning to agree with Nature, learning to be in tune with Natural Law.

Another problem with this approach is that the chemicals applied to the crops can actually impair the natural ability of the crop plants to meet their own needs. For instance, pesticides can actually interfere with the ability of the rhizobium bacteria to symbiotically provide nitrogen to legumes.[2]

Where is the Intelligence in AGRICULTURE?

When people contrast organic agriculture with “modern” chemical and biotech agriculture, often times, the implication is that organic agriculture is “primitive.” This could not be farther from the truth. In actuality, organic agriculture is much more “knowledge-rich” or intelligence-rich” than either chemical or biotech agriculture.

One revealing question to ask about any agricultural system is this: Where is the intelligence in that system?

In modern agriculture the intelligence is located in patented technology, such as chemical fertilizers, pesticides, herbicides, antibiotics, special machines, and even the patented genes in genetically engineered crops. The intelligence is imbedded in the physical, objective aspects of the agricultural system.

But in organic agriculture the intelligence is in the farmer. Success in organic farming requires that the farmer have deep knowledge of the environment, the soil in his fields, the seed and crop. The farmer works with the intelligence inherent in the land, the seed, and the environment to produce healthy, nutritious food. The creativity and experience and knowledge of that farmer, the wisdom of that farmer are what make his farming successful.

As long as he/she can drive the tractor and operate the other machinery of the farm, the chemical/biotech farmer can get by with minimal knowledge, but the successful organic farmer must be at least as knowledgeable as any Ph.D. The organic farmer must not merely possess abstract, theoretical knowledge, but must have very concrete specific knowledge of their own farm. In fact they need to know the specific and special characteristics of every field on the farm. What are the differences in the soil, the history of what has been planted where, etc. Each field on the farm must be understood deeply.

The chemical/biotech farmer does not really need to know a great deal more than how to operate the machinery that is part of the farm operation, and how to calculate how much of various chemical inputs that they need to buy. They usually choose the chemicals by taking the advice of the salespeople for those chemicals. So all they need to do is to figure out how much of each chemical they need to buy, and they hope and pray that the chemicals will do their magic and deliver high yields. It is not surprising that intelligent young people leave the farm and take other careers when they see the prospects of the life of such a farmer. That kind of farm life is simply not fulfilling.

Where as the traditional mission of the farmer is to feed humanity, the mission of the chemical farmer—the agro-businessman—is to profitably produce “product.” And because of the toxic nature of the chemicals that they use, that product is not nourishing but can actually be hazardous.[3]

Sustainability

Organic agriculture is sustainable. It uses renewable resources to the greatest extent possible, it builds and improves the soil, and a good organic farm generates more energy than it uses. In principle, the organic farm is self-sufficient. It uses only "on-farm" inputs; all of the fertilizer, all of the soil amendments that the farmer uses are generated right on the farm. Ideally there is no waste and no loss, everything is recycled and reused. Of course, few farms achieve this ideal, but the organic farm is typically structured around cycles—rotating crops, recycling manure and crop residue as fertilizer, employing renewable resources.

Chemical/biotech agriculture is non-sustainable. Instead of resources flowing in a cycle, the flow is linear. Energy and chemicals are produced from non-renewable fossil oil, much of the water is also "fossil" water, extracted unsustainably from deep in the earth for irrigation, patented seeds are purchased that may have been produced half way around the world, all the ingredients for farming are obtained off-farm. Waste is discarded, excess chemicals wash into the watershed, and the internal combustion engine of the tractor converts long-captured fossil carbon into carbon dioxide, which contributes to global warming. In addition, through the inevitable erosion that chemical agriculture causes, even the soil is washed into the streams. This one-way flow of resources makes this form of agriculture inherently unsustainable. These limitations are made very clear in the IAASTD report.[1]

Essentially, when you eat a modern vegetable or a modern grain, one is eating petroleum. It is petroleum that makes it possible to produce crops in the modern way. What happens when the petroleum runs out? We have already reached peak petroleum production on earth. The short answer is that we will not be able to continue to operate this way in the future. That means it cannot be sustained. It is not sustainable.

The sustainable approach, that we call organic agriculture today, has been with us since the beginning of life on earth, since the beginning of humanity, and it can go on forever, because it is cyclic, it gives back to the source.

Biotech AGRICULTURE

Biotech AGRICULTURE is the most extreme form of chemical agriculture. It builds on the apparent successes of chemical agriculture; it is a component, a module in that system of agriculture. In addition to chemicals, biotech agriculture uses strategies that re-program the crop plant to operate in novel ways. For instance genetic engineering can be used to force the plant to produce a pesticide - Bt crops - or it can make the plant resistant to herbicides. In the case of herbicide resistant crops, the genetically engineered seeds are just a means for selling more chemical herbicides. The chemical company says, “Buy my Round-up Ready seeds,” and then the farmer has to buy Round-up Ready herbicide to go along with the seeds. In fact, they make more on the herbicide than they do on the seed. The seeds are part of their strategy for selling chemicals.

Biotech agriculture introduces altered genetic information into the seed, into the DNA of the organism. It disrupts Nature at a most fundamental level. The most fundamental aspect of any living organism is its genome, the collection of genetic blueprints carried in the DNA of its cells. The organism’s genome is the basis for the organism’s individuality. Of course, experience and environmental interactions influence that as well, but the genome is very central. Genetic engineering is a technology that intentionally alters the information in the organism’s genome. Different and supposedly better information is inserted, but the questions are two:

Who says it is better? What is the evidence for better?

Are there any unanticipated side-effects of inserting that information?

We will be looking more deeply into these questions in the paragraphs below. We will look in more depth at how genetic engineering is done and then at its effects and side-effects.

A cautionary tale

We begin with a cautionary tale. Figure 1 is from *Time magazine* around 1947, the year before I was born, and this is how they saw DDT at that point in time.

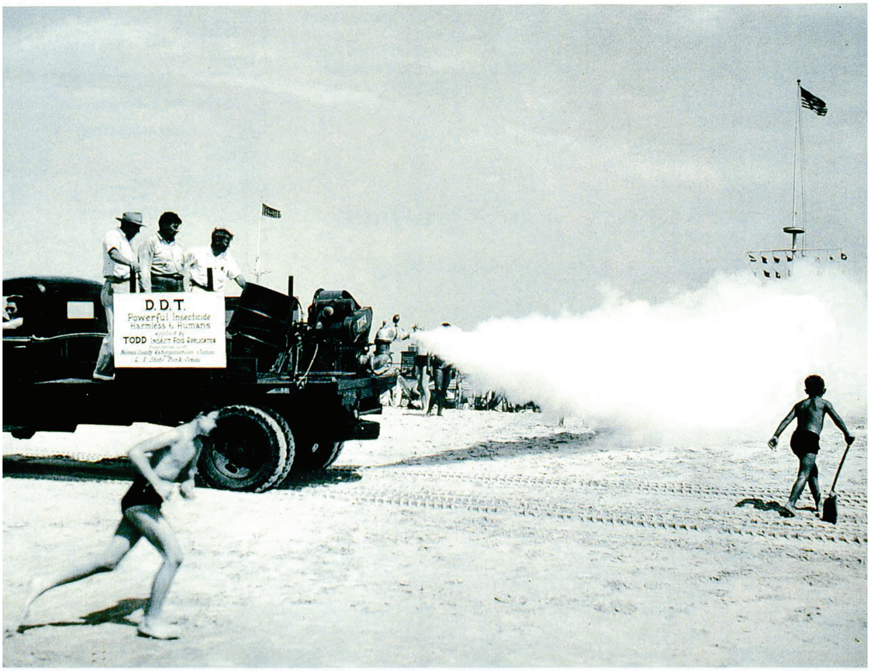
Fig. 1. DDT in public perception around 1947.

We have all of nature saying “Oh yes! This is good for us and good for the world!”.

Figure 2 presents another image for DDT. This is from the National Geographic, 1945. Here you have a truck spraying Jones Beach just outside of New York City. This is a huge beach where, in the summer, there are more people than grains of sand. And through that teeming crowd rolls a truck fogging the beach and everyone on it - kids, pets, grandmothers, etc. - with DDT, and the children are even running through the fog for fun.

This is where humanity started with DDT. We new it killed bugs, and we assumed that it was totally harmless, because people could eat powdered DDT by the spoonful and it didn’t seem to harm them. Little did we know that the effects were more subtle, and they were slow in onset and were cumulative. But by 1970 - 25 years after these pictures were taken -there was a huge body of evidence indicating that the damage that DDT does to human health and to the health of the ecosystem is too great to justify its continued use.

FLASHBACK



UPI/BETTMA

■ FROM THE GEOGRAPHIC ARCHIVES

An ill wind

A cloud of the insecticide DDT billows over the beach—and beachgoers—in 1945 as part of a mosquito-control program at New York's Jones Beach State Park. Used in Europe to ward off bug-borne disease during World War II, DDT was once hailed as a miracle product. This photograph was published in the October 1945 GEOGRAPHIC article "Your New World of Tomorrow." But by the time "tomorrow" came, evidence showed that birds from sprayed areas accumulated high levels of DDT, damaging their ability to reproduce. Other research pointed to the chemical as a human carcinogen. Use of DDT was banned in the United States in 1972.

Fig. 2. A truck spraying Jones Beach with DDT.

Fig. 3. The words on the side of the truck: "DDT powerful insecticide, harmless for humans."

We had discovered that DDT and other pesticides disrupt the immune system, which causes reduced resistance to disease. They disrupt the endocrine system which means that eagles produce eggs that are so fragile that when they sit to incubate them they crush. They disrupt the development of many physiological systems. The result is birth defects, reproduction problems, sterility. They cause cancer and interfere with higher functions such as cognition, memory, motor coordination, behavior and emotional problems. All of these problems occur when you have high levels or even moderate levels of these types of toxins in the physiology. Much of the attention deficit disorder and hyperactivity dysfunction that is common with children these days is likely due to pesticides and other chemicals in our environment.

So, this is what we have learned about DDT and as a result, in the early '70's when all of this evidence began to accumulate after 25 years of use, DDT was banned. But unfortunately, it is still dumped on the Third World as a cheap fix for insect infestation.

We are now hearing things about genetic engineering that are very similar to what was being said about DDT in 1947. Proponents are saying there are no problems with this technology, it's just innocently and benevolently making better fruit and vegetables for all of us.

But the lesson we learned from DDT and from many other technologies is that we need to examine new technologies very carefully and systematically to make sure they are safe BEFORE we put them into wide use. This lesson needs to be applied to genetic engineering as well as everything other new technology, especially when it is the case, as it is with genetic engineering, that there are scientific reasons and empirical evidence indicating that genetic engineering may be harmful, may be risky.

> "The processes of genetic engineering and traditional breeding are different and according to the technical experts in the agency they lead to different risks".
>
> — Dr. L. Kahl, FDA Compliance Officer, 1991

The Basics of Genetic Engineering

What do we mean when we say "genetically engineered"? I'm going to take you through a few slides that explain the process.

The first step, as shown in Figure 4, is that you isolate genes, each of which you can think of as being the blueprint for some part of the cells of the physiology of an organism. You can isolate genes from any living thing, from bacteria, viruses, plants or animals, or you can even synthesize genes or pieces of genes chemically. Once you isolate the genes you cut and paste them together in the test tube using special enzymes that cut DNA in specific locations and other enzymes that can connect different pieces of DNA together. The result if this cut and paste process is what is called a *recombinant gene* or *transgene*.

The process of making a transgene is quite precise. You can cut splice these DNA fragments together with the same precision with which you can cut and splice sentences with your word processor - word by word, letter by letter precision.

Proponents of genetic engineering proudly point out this precision. They say, 'Look at how precise it is!" It is true. This step in genetic engineering is quite precise.

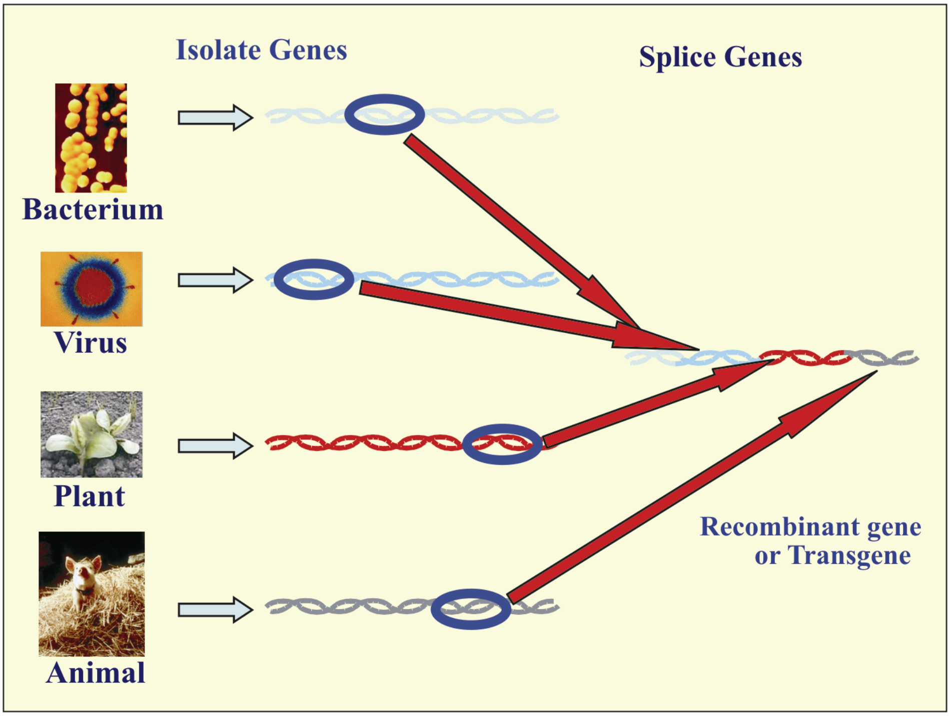


Fig. 4. The first step of genetic engineering resulting in a recombinant gene or transgene

This first step is very precise but the proponents of genetic engineering forget to tell you about the next step because it turns out to be far from precise. This step is to take the transgene, which you have created with such precision, and introduce it into cells from the plant species that you want to engineer, where it must enter the nucleus of the cell and be incorporated into the DNA of that cell, as illustrated in Figure 5. After the DNA is integrated into the plant cells (contained in a petri dish in the lab), the biotechnologist adds some chemicals to the dish that stimulate the plant cells to divide and differentiate into a small plantlets. When these are planted, they grow into full-size plants. In this case, corn plants.

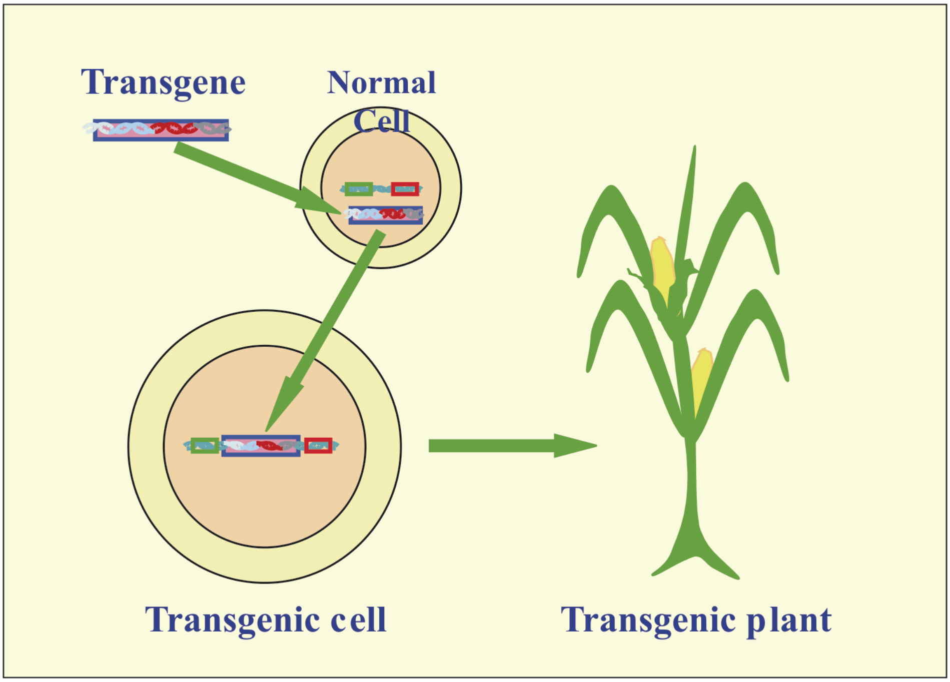


Fig. 5. The second step: the transgene introduction into plant cell resulting with transgenic plant

Now, if this were all there was to the process of genetically engineering a plant, we would all be saying, “This is wonderful!” What is not apparent from Figure 5 becomes very clear in Figure 6, which shows is that the process of inserting the transgene into the plant cell’s DNA is NOT precise. It is, in fact, a random, highly imprecise process over which the biotechnologist has not control.

In fact, no one even knows how it occurs and if we do not know how it happens, we cannot control it. All we know is that if you succeed in introducing transgenic DNA into the nucleus of a cell, once in a while it will become incorporated into the DNA of the plant. Unfortunately, we don’t how this happens; nor can we control where within the genome the DNA will be inserted.

The figure depicts two natural genes within the cell's DNA, a green one and a light blue one. If the red transgenic DNA is inserted BETWEEN these two genes, then they continue to function and the transgenic gene can function too, as shown on the right. But if the red transgenic DNA is inserted into the middle of the green gene, as shown on the left, the function of the green gene will be impaired and the function of the plant as a whole can also be impaired. This is called insertional mutagenesis, when insertion of a piece of DNA into the cell damages or mutates some gene, thereby interfering with some function of the plant.

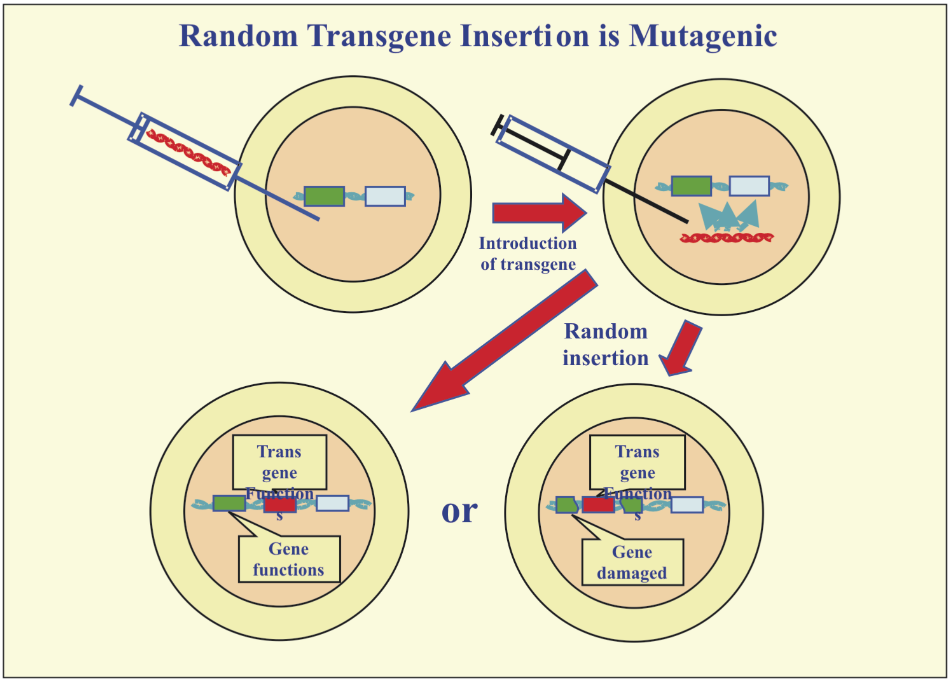


Fig. 6. The third step: the process of inserting the transgene *into the plant cell's DNA is NOT precise.*

So this very imprecise process carries with it the risk of seriously damaging the functioning of the cell and the plant as a whole.

Here is an analogy that can give you a sense for this problem. Remember that first step where the transgene is made with great precision? Think of an artist who spends 6 or 8 months carefully and precisely forming and shaping a beautiful sculpture—a beautiful, intricate, precisely made statue. Now the artist has finished creating the statue, and wants to have it displayed in the art museum. Well, this particular artist is a little bit impatient and wants to get it into the museum very quickly. So instead of going through all the formal procedures, they say, "I'm not going to wait all that time, I'll just toss my statue through the window of the museum, and there it will be!"

Now what happens when the artist does that? The sculpture gets into the museum, and there is even a small chance that the sculpture will fly through the air and land perfectly on a display case and stand ready for everyone to see. But what is the probability of that happening? What is much more likely is that it will end up in a corner under a table where it will never be seen or it may strike another piece of art and damage it.

But if the artist throws enough sculptures through enough windows, one or two will be properly displayed. This is exactly how genetic engineering works. They coat the transgene on tiny tungsten particles and shoot them into hundreds of thousands or even millions of plant cells. The DNA reaches the right place in a tiny few of these, and then the biotechnologists spend weeks, months, and sometimes years sorting them all out to identify ones that have the desired characteristics. In this process they look for certain traits and select for those, but they cannot look for all possibilities and therefore they can never know whether the transgene happened to damage some important gene that protects the plant from a certain pathogen or pest, or makes it resistant to drought.

These are some of the problems associated with genetic engineering of plants and these problems raise serious concerns with many scientists.

There is another class of problems associated with genetic engineering of food crops, as shown in Figure 7. The left side of this figure illustrates the model that genetic engineers use when they describe the genetic engineering process.

According to this model, the genetic engineer inserts a single gene into the DNA of a cell. This new gene then gives rise to one change in the metabolic network of the cell. This, in turn, gives rise to one change at the cellular level, one change at the level of tissues and organs, and one change at the level of the plant as a whole.

This is a nice model, but it is not how Nature really operates.

In reality, genes are not isolated and independent in their functioning. They are all interconnected. When you change one gene, it influences other genes, and each of those genes influences, not just one element in the metabolic network, but several. That network is interconnected. When you alter one element, the whole thing shifts. The result is that introducing a single gene by genetic engineering methods alters the functioning of several or other genes, which in turn alters many elements in the metabolic network and biochemistry of the cell, which alters several functions at the cellular, tissue, organ, and organismal levels. All of this happens as a result of inserting one single gene into the cell. The problem is that it is impossible to predict all of the effects resulting from that single insertion.

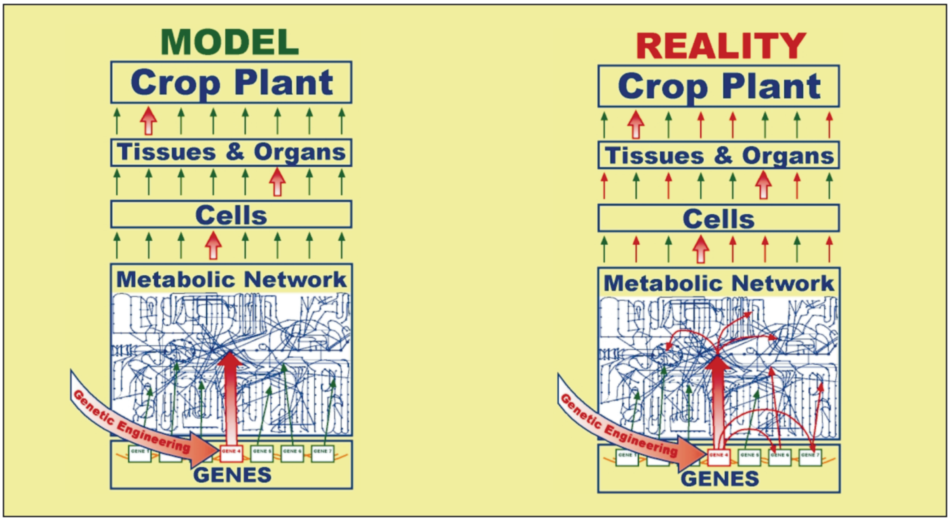


Fig. 7. The model that genetic engineers imagine describing the genetic engineering process (left), and the way how it really works in Nature (right).

There are studies that have shown that inserting a single gene into the genome of a plant will alter the expression of literally hundreds of messenger RNAs in the plant cells.[4] It is shocking.

To a molecular biologist this is a humbling experience. Whether you have a PhD or even a Nobel prize, the complexity and scope of interconnectedness is so great that you simply cannot to predict the effects of inserting even one single gene.

In practical terms, this means that when you engineer crops it can disrupt the environment, and it can create dangers to human health; biotech crops can be allergenic, or toxic, or even reduced in nutritional value.

Examples of each of these consequences have been observed.

- Pioneer Hybrid developed an allergenic soybean about a decade ago.[5]
- Professor Arpad Pustai demonstrated many years ago that genetic engineering can make potatoes toxic to rats. Even though the natural protein that is produced from the transgene was not toxic, when that gene was inserted into potatoes, it interacted with the rest of the plant's biochemical machinery in such a way as to cause the potato to be toxic.[6]
- Bacteria genetically engineered to produce large amounts of tryptophan also produced a toxin that actually killed people and made thousands ill.[7]
- It has been found that the most common genetically engineered soybeans have reduced levels of micro-nutrients called isoflavones.[8]

These are just a few of the many examples of hazardous genetically engineered foods.

There is also significant risks to the environment. Transgenic plants carry the risk of disrupting the ecosystem, causing loss of bio-diversity, and disrupting the food chain. Ultimately there could damage not only the environment, but consequently the economy, food security, and other related and essential areas.

Potential environmental disruptions include the reduction of soil fertility. Loss of species diversity can impact both the natural environment and agriculture. Disruption of centers of origin for important food crops can be lead to serious loss of highly precious genetic resources. It is from these centers of origin that plant breeders obtain new genetic resources that allow them to find traits that protect from new plant diseases or pests or environmental threats.

Use of GM crops, particularly herbicide-resistant GM crops has significantly increased use of these pesticides.[9] This increased use of toxic, carcinogenic, and mutagenic chemicals can also increase everyone's exposure to these harmful agents. This translates into increased risk that subsequent generations will suffer from cancer, birth defects, cognitive problems and other functional human defects.

Another problem is that interaction of transgenic crops with the environment can lead to creation of new plant diseases, new pests, new weed varieties that are resistant to antibiotics and herbicides - super-weeds.[10] Already, examples of each of these has come to light.

One crop that was engineered to produce insecticidal genetically engineered proteins, not only killed the intended pests, but also killed innocent and beautiful butterflies and other lepidopteron insects[11], many of which may play important roles in the web of the ecosystem, such as serving as the pollinating agents for important crops. The scientific study only looked at monarch butterflies, but we consider those butterflies as being a "marker" species, indicating that there may be literally hundreds of other lepidopteron insects in the environment that are damaged. No one has taken the time to assess what the damage could be of reducing the populations of these many insect species. In many cases, we do not understand enough about them to be able to make such an assessment.

There is also growing evidence that so-called "Bt crops" can have direct human health impacts. Immunological effects have been observed in the Philippines that indicate with high likelihood that Bt corn pollen caused allergic reactions in people who inhaled it. There are now serious problems in India with GM cotton. Workers report skin irritation resulting from picking the GM cotton. When the Bt crops are fed to sheep, and other livestock, a significant increase in mortality and morbidity is observed.

There are problems with corn in Central America, which is the home of corn, the center of bio-diversity for corn. That corn is now becoming contaminated by neighboring GMO corn, threatening the center of biodiversity of that crop.[12]

Round-up Ready resistant weeds have resulted from the massive increase in use of Round-up Ready herbicides. The increase of such weeds renders Round-up Ready herbicide useless in attempting to control weed infestations of crops. To date, 8 different Roundup Ready resistant weeds have been reported: water hemp, common ragweed, buckhorn plantan, goosegrass, hairy fleabane, horseweed (marestail), and Italian ryegrass.[10]

These instances represent increasing problems for the chemical agriculturalist.

Not every genetically engineered crop will be harmful. But there is real risk that any one of them can be harmful either to human health or the environment. Sufficient testing is not required in any country around the world to verify that GMOs are safe.

In fact, the United States government has never declared or certified that any GMO is safe. The Food and Drug Administration "deregulates" GMOs but they never say that they are safe. Any safety testing that is done, is done on a voluntary basis by the biotech companies themselves. Virtually none of that research is ever published. It is a very superficial approach. The European Union is a little better, but it is still much deficient from what is needed.

The Biotech Challenge to Organic Agriculture

As the use of GMOs increases in chemical agriculture, the risk that organic products will be contaminated with GMOs rises very significantly. The GMOs from conventionally grown plants contaminate organically grown plants in several different ways. This is a problem, because it compromises the fundamental principles of "organic" as a system that delivers natural food, and it conflicts with consumers' understanding of what organic means.

To the consumer, "organic" means healthier food, more nutritious food, better tasting food, food that is produced in a manner that benefits instead of degrades the environment. That is the image of "organic." Part of that image is that consumers believe that organic means "NO GMOs."

The United States Government tried to slip GMOs into the US organic standards when the regulations were first being established. They learned very quickly that they were not acceptable. There was a huge outcry. Hundreds of thousands of consumers wrote protests, forcing the regulatory agency to reverse its stance. At the same time, they were trying to get approval to use sewage sludge as organic fertilizer and radioactive irradiation to sterilize foods. These initiatives were also blocked.

So consumers believe in and see organic as "No GMOs".

However, contamination of organic foods with GMOs is now happening. For example, in Canada it is literally impossible to grow organic canola in most areas due to massive GMO contamination. Many of the countries where GMOs are being grown, like the United States, Canada, Brazil and Argentina are having a hard time sourcing organic corn, soy, canola, and cottonseed (used in animal feed) that are not contaminated with GMOs.

There is one large but very high-principled organic company that, for many years had a very successful line of corn-based products, including chips and other snack foods. A few years ago, all those products suddenly disappeared from the grocery shelves. What happened is that, despite the fact that these products were among their most popular, they discontinued them, because they were finding it impossible to obtain corn that was not contaminated with GMOs. The company faced the choice of either lowering their standards regarding GMOs, or discontinuing the products. They chose the latter out of respect to their customers and their desires and expectations.

This is just one of many sad contamination stories that have played out over the years, not only in the United States, but also in Europe and Japan. For instance, Spain grows a little bit of GM corn, and European scientists have recently revealed that a significant portion of Spain's organic corn has been contaminated with GMOs. The contamination is at low levels, but it is there.

Another aspect of this contamination also needs to be examined. If you ask an organic farmer where he bought his seed, he will be able to name a specific seed company. If you then go to that seed company and ask them where they got the seed from which they produced the seed they sold to the farmer, they will almost always confess that they lease the genetics from other suppliers. If you ask who those suppliers are they will say, with maybe a little embarrassment, that the supplier was either Monsanto, Syngenta, Bayer, Dow, DuPont, or a subsidiary of one of those companies.

Literally 90% of the commercial corn genetics available around the world is owned by one of those five companies. They lease their genetics to organic seed producers. Most of the organic seed produced in North America is coming from these manufacturers. Globally, these same five companies produce most of the maize seed. It is not surprising that the this seed might be contaminated with GMOs, given that it is produced and processed in facilities where huge amounts of GM seeds are also produced. This is not a sustainable situation. The organic community must have control of their own seed resources. Shockingly, at this point in time, they do not, but are seriously dependent on the biotech industry.

Biotechnology Threats

Beyond the issue of contamination is the issue of organic regulations and standards. They are all what is called "process-based". That means that, in the process of producing organic products, the farmer may not intentionally use GMO inputs, but, in cases where the farmer did not intentionally use GMOs, if accidental contamination takes place by cross pollination or admixture in storage or transport, the organic status of the product may not be invalidated. In essence, accidental contamination is ignored.

So, if there is a little cross-pollination, or if organic and GMO corn get mixed at the mill, that is not considered to be a problem. It is considered to be an accident. Therefore the contaminated grain is still considered to be organic according to regulators.

The U.S. Department of Agriculture, which administers organic standards in the U.S., simply says, "Don't intentionally use genetically engineered inputs or anything derived from GMOs, but if there is a little contamination – no problem!"[13] The EU is a little better but all of these regulations are basically identical. For example, the current EU regulations allows as much as 0.9% genetically engineered material in organic products. That is significant contamination.

The real solution, in the face of widespread global GMO contamination of organic foodstuffs and the looseness of the regulatory environment, is that the organic industry itself needs to take on the responsibility of maintaining purity of organic food.

The alternative is that someday Monsanto will approach the organic industry, saying "You have two choices. Either you can have genetically engineered organic corn products, or you can have no organic corn products at all. You can choose." The ethical organic company cited above chose to discontinue corn products. But others may settle for the Monsanto proposition. We need to deal with this now so that such an eventuality never comes.

I would now like to give you an example of such a project, The Non-GMO Project, which is happening in the US where GMO contamination of organic and natural products is already very serious.[14] This example shows how we have been able to deal with this issue and it's actually quite exciting. We have been working with these people for the last 3 years and the result is a program that is going to meet the challenge and make organic sustainable in the US.

It started with a group of small organic retailers who were confronting the problem of GMO contamination every day, because they were receiving questions from their customers asking, "Is this product OK? Is this product genetically engineered? Is this one clean?" Most of the time, the owner of the store would have to tell the customer that he really did not know and was unable to find out. These store owners decided that they wanted an accurate, consistent system for informing their customers whether or not any given product was or was not contaminated with GMOs. They wanted to create a standard for what "Non-GMO" meant, and to set up a verification program that would allow companies to assess whether their products met the standard or not.

Although the project started with the store owners, soon all the brand owners and manufacturers got involved. The brand-owners said that there was something that needed as well—a system for monitoring and controlling GMOs in their products. That would allow them to consistently, reliably and sustainably deliver products that meet consumer expectations.

All of these elements have now been created and are in operation. The whole industry has worked hard to put together the standards and the systems and procedures for verification. They have also joined together to create working groups to deal collectively with common needs and challenges like assuring high quality, organic seed that is not contaminated with GMOs and sourcing supplies of certain critical ingredients. To complete the process, there is an official seal that will enable companies to show consumers that they comply with the standard.

The basic requirements for the verification process is that you need to keep products separate from GMO contamination risks, you have to have traceability, and you have to source ingredients that are not contaminated with GMOs. There are also administrative activities such as training, record keeping etc. that need to be handled properly. A company can use GMO testing to verify that an ingredient is non-GMO. Then they use traceability to track the product through their production system and they use segregation to protect the product from potential contamination. All these elements work together to deliver a verified non-GMO product.

This whole program has been designed in concert with operations experts in the organic industry, such that it is economical, efficient, vendor friendly, protective, confidential, user friendly, fast, reliable and secure. The whole program is controlled by the organic and natural products industry itself. It is a non-profit program that supports integration and cooperation within the industry to achieve the goal of delivering non-GMO foods to the consumer.

In conclusion, we have considered in this paper what "organic" means and what the industry is doing to maintain the integrity of organic so that consumers can continue to trust organic products as being pure, safe and healthy, and good for the environment and for society. We have discussed the threats to organic posed by GMOs and have demonstrated that there are effective counter-measures that can be taken, even under the worst of circumstances, such as those in North America.

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