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The Devastating Effect of Regulation and the Nobel Laureate Campaign in favor of GMOs

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In this talk, I will describe the Nobel Laureate's Campaign in support of GMOs (Genetically Modified Organisms) and touch on a few key points that highlight the reasons why GMOs are important and mention some of the misleading statements that the anti-GMO activists use to try and discredit this technology, which arguably is one of the most exciting outcomes of the modern biotechnological revolution.

Let me begin by explaining how I came to start this campaign. I was invited to a Symposium in Ghent four years ago (2013) celebrating the 80th birthday of Marc von Montagu (World Food Prize Winner and one of the inventors of the GM method). The result was that I spent a day listening to people talk about plants and in particular, hearing people talking about the difficulties that they faced as a result of opposition from the Green Parties. Frankly, I found it hard to believe what I was hearing. I had read a little about it, but I just couldn't believe how bad things really were. The next day I had been invited to talk to the European Commission about the future of medicine and had originally planned to speak of some of the major lines of research such as the advances in cancer immunotherapy that were looking extremely promising. However, I decided to change the topic of my talk the night before and instead made GMOs the theme of my talk.

I started by explaining that medicine for developing countries was rather different from medicine for developed countries. I pointed out that in addition to needing all of the things that we usually think of such as vaccines, common drugs and basic care, the thing that they most cared about in many countries was food. People who go to bed hungry at night, don't really worry so much about medicine, but they do worry about food and whether they are going to have a good meal inside them. Of course, food means agriculture.

For the last 10-12,000 years, since agriculture first got started in the Middle East, things were pretty crude – people went out and gathered the plants they could and put them in the backyard and hoped they would grow, and then they started to figure out how to cross them and how to make better breeds and so on, but in the 1980's thanks to Marc van Montagu, Jeff Schell and Mary-Dell Chilton it suddenly became possible to manipulate these plants and to enhance breeding possibilities in a way that was far more precise and far simpler than had been available previously.

So, what I decided to do after the talk was to try and mobilize the Nobel Laureates to support GMOs and counter the misleading statements being propagated by the Green parties. Of all of us, there was not a single Nobel Laureate who was a professional plant scientist. There were a couple who had distant connections to industry, but all of the scientists who had previously been talking about plants usually had connections to agri-business and were criticized heavily for it as being compromised. Of course, the reason they had agri-business ties was because very often governments wouldn't support them. Government support for academic plant research has been pretty pathetic. However, the big agri-businesses had been interested in the results of their research and so were prepared to support them. And of course as soon as you get money from business, along come Greenpeace and the Green Parties and they say well, we can't believe anything you say because you are tainted by industry. However, apparently, they themselves are not tainted by contributions from the organic farming industry.

In the U.S., another problem came because of the Freedom of Information Act, which allowed the anti-GMO people to request documents and emails from scientists working at public universities about their GMO plant work. These have to be made available and then the opponents select those parts that they can use to tell a misleading and inaccurate story and harass the scientists in ways that I think most of us who are not in the field can't imagine. But when you ask plant scientists who speak about GMOs then they will tell you exactly what's going on – how they are constantly harassed because of their Pro-science statements.

So, it was really after Marc's birthday party that I started to think about this issue, but it wasn't until 2015 that I decided to get going and start to recruit the Nobel Laureates to support GMOs. I had some ideas of what a campaign might look like and so when I went to a Lindau meeting in southern Germany where there are a lot of Laureates, I began asking them how they felt about GMOs and the idea of a campaign. With just one exception, every Laureate who was at that meeting said this was a great idea and would like to join. This led to

about 20 initial signatures just from that one meeting and then I began to send out requests to other Laureates. Eventually, I collected about 100 signatures, which I thought was a respectable number of Nobel Laureates for a campaign and decided to launch it. We held a press conference in Washington, DC on June 30th 2016 that received a lot of publicity. More than 25,000 blogs and news articles came out almost immediately following the news conference. The idea was that here we were, a group of Nobel Laureates that have good credibility with a lot of people including the general public. We are listened to and taken seriously. In particular, we thought we were reasonably immune from the usual attacks from Greenpeace because we didn't have any connections with agri-business.

Just before the press conference I sent a fax to Greenpeace and to every United Nations Ambassador, calling on them to stop scaring the public by pretending that GMO foods were dangerous. Please stop making all of these misleading statements, which you know are false, because after more than 20 years of the use of GMO products in the field there is not a single case of an accident or any problem that can be honestly attributed to GMOs. The time had come for Greenpeace and the Green Parties to admit this was one issue that they just got wrong. Perhaps, when they started their activism they could argue they were right to draw attention to the possible problems, but by now they know the fears are groundless. But instead of acknowledging they were simply wrong in claiming GMOs are dangerous they are now trying to spread this fear of GMOs to the developing world. Figure 1 is a cartoon that I use to illustrate the problems the activists are now causing. It's by a man called Brian Duffy, who resides in Iowa. I think it's rather good – on the left is Greenpeace who are portraying GMO foods as being really dangerous, calling them Frankenfood. In contrast on the right is a hungry little boy who truly appreciates the value of GMO foods. I find it very difficult to look at this cartoon and not feel that you know here is a technology, which can help the developing world in major ways. Why would anybody be against it?

If we think about what has happened in agriculture since it was first developed, how man's efforts to breed better crops have resulted in the foods we consume today, it is clear that crop improvement has been essential for our welfare. One example is provided on in the left panel of Figure 2, where the original ancestor of corn, called teosinte, was slowly bred from its original very thin and stringy cob to the good-looking and healthy corn cob on the right. In the right panel is a cartoon I love from the *New Yorker,* which shows a very happy big corn cob and the lady is wondering which is the genetically modified corn. I think it is not difficult to figure out which that should be.

When I give talks in this area I always try to find analogies that will be easily understood and that will be immediately comprehensible to people who know little or nothing about the science of genetics. The approach I use is to begin by talking about the traditional methods of breeding. For instance, improved plants can be made by mixing the genes in the same way we make babies. Two people get together and they produce an embryo, which is a mix of the genes in the two parents. This is the old-fashioned or traditional method of plant breeding. In the case of plants if one of the parents has a trait (perhaps caused by one gene) that is desired, then we can look at the offspring and just select the ones that have this trait. By constantly crossing back to the original, preferred parent plant, then we can slowly eliminate the genes we don't want while retaining the gene we do want. Now though, we know that thanks to the GMO approach we can simply identify the gene responsible for the trait we want and move it directly into the preferred parent plant.

One analogy I have found very effective concerns how one might move a GPS system from one car to another. Do I take the cars apart, mix the components and then put everything back together and hope that I'm going to get something that works, or do I just take the GPS from one car and move it into the other car? The precision method of plant breeding looks exactly like taking the GPS from one car and moving it to another. I always then ask, "Do you know, Greenpeace would have you believe that if I took the GPS system from an airplane and put it in the car, now it's going to fly". And Greenpeace is also claiming that all flights inescapably end in crashes. We all know that is just nonsense. This is typical of the misleading information that they're putting out and through which they have been very successful in scaring the public and in raising funds to support their activities. But the problem is once people get scared, it is very, very difficult to reassure them. At this point it's all about emotion. It's about fear and not about facts and it's certainly not about science. The science is clear, the science is safe, the science says everything is good and it's all about how we deal with these emotional issues. Of course we always feel as scientists that all we have to do is explain the science to everybody and they'll understand it and realize they have no reason to be scared. Unfortunately, it's not enough. Just explaining the science doesn't usually work. Consequently, I like to try an additional approach of pointing out that what is important is the product.

GM (genetic modification) refers to a method; it's a way of doing something. We've been genetically manipulating plants for many thousands of years. There is very little that we eat that has not been genetically modified by so-called traditional or "natural" methods, but it is hard to understand how deliberate mutation is natural! But now we've learned how to breed plants in a much more precise way, but it is very important to

remember that it is the product of plant breeding that is key not the method by which the breeding took place. This is also true for traditional breeding and it's important that we remember that. Again, I have an analogy. Figure 3 shows a production line that is making a means of transportation, but what is it making? Well two options are shown in Figure 4, one is a car, another is a tank, but it could easily be something else. We cannot gauge the beneficial or harmful results on the product just based on how the production is being carried out. The product is what matters here, not the way in which we made it. I think we can all agree that if you want to be driving down the highway you'd prefer the car, rather than the tank. We should neither condemn nor praise the product just on the way it is produced. So with traditional plant breeding and GMO methods, it is the product that is important and that needs to be tested. A label saying it has been produced by a GMO method tells us nothing useful about the product.

To illustrate the importance of testing products and not just the methods by which they arise there are many examples in the plant world where traditional breeding, widely considered perfectly safe, has resulted in plants with harmful chemicals in them. Plants have one major obstacle to their existence – they cannot run away when a predator comes along wanting to eat them. So their solution has been to evolve to produce pesticides that will kill their predators; chemical warfare. This means that if you look in almost any plant you will find a lot of chemicals that act as natural pesticides as exemplified in Figure 5. In some cases, these chemicals are also carcinogenic to humans. One good example is celery. If you cut up celery and don't wear gloves, you will get celery juice on your hands. People who used to harvest celery or cut it up in preparation for sale, would often find they were developing a skin dermatitis that would occasionally turn into skin cancer. This is because of some carcinogens, notably psoralen, that are naturally present in celery. But we all eat celery so why don't we all get cancer from it? The reason is that the quantities are very small. If your entire diet was celery, you'd be in trouble. But it's not. Our bodies know how to deal with small quantities of many dangerous chemicals, psoralen included. The lesson here is that what is important is what are the ingredients in the food we eat and in what quantities. It does not matter whether the plants have been bred by traditional means or by the more precise methods using GM techniques. In the case of celery any organic farmer or any member of Greenpeace would tell you it is perfectly safe, you don't need to worry about it. It's natural, and so it must be okay. This is just wrong-headed and unscientific thinking. I'm inclined to think that if we are going to do something about regulating foods, then we have got to examine the product and forget about the method by which it was generated. The methods don't matter at all.

You might ask why did Europe get behind the "GMOs are dangerous" movement? Well history can give us some clues. In Europe and the USA, we don't need GMOs. We have plenty of food because the major agri-businesses have focused almost all of their breeding efforts on crops we consume in the developed world and where high profits can be made. As a result, we are all well-fed to a point of often being overfed. You don't see a lot of thin Europeans walking around unless they are recent immigrants from Africa. And so why doesn't Europe endorse GMOs? You know, it makes no difference to us and so I ask is it politics, is it money, or is it both - and I think the answer is that it's both. The real problem is that the Europeans didn't want U.S. companies to control their food. So how could they stop that? Well, of course the easy thing to do would be to ban Monsanto and the other American agri-businesses. But there lies a major problem. In Europe an awful lot of seeds that have been produced by traditional breeding are bought from U.S. companies. And so if we say we're not going to buy them anymore, then we really will start to see some thin Europeans. So a direct ban was not possible. So what did the Europeans do? They began arguing that precision agriculture, or GMOs must be dangerous and so they should be banned from Europe. This would indirectly affect the American agri-businesses and given that GMO technology was spreading and was likely to be very profitable it would hurt their bottom line. Thus began a campaign by the anti-GMO activists to discredit GMO technology. They would make up stories up about the possible dangers of these "Frankenfoods". It was very easy to think of horror stories based on moving genes from one source to another. It becomes simple to imagine dire consequences. If I take genes from a salmon and put them into a plant, then perhaps the plant will start swimming. Equally crazy stories were manufactured with the deliberate intention of scaring people.

And of course they had very good advertising agencies working for them and I think you know as well as I do that a good advertising firm can sell pretty much anything. When the plant scientists tried to defend themselves from this they didn't stand a chance because they lacked the money to pay for the same quality of advertising. The result was that Greenpeace were incredibly successful in scaring everybody. This led to financial support from their donors to help demonize GMOs and then they were able to gain political power using the well-worn technique of identifying a danger and then saying "we will protect you from the danger, vote for us". In this way Greenpeace gained both political power and they also gained money. They became one of the richest NGOs with an annual budget in excess of $500 million a year. And the real beauty of this approach was that a ban on GMOs would have few economic consequences for Europe. Europe didn't need GMOs – they already had more food than they could eat.

However, it turns out that in the developing world there is a desperate need for crops with higher yields, higher nutritional value and the ability to grow under drought conditions. They have not had the benefit of big agri-businesses improving the crops they like to eat. Thus, the really tragic consequence of the anti-GMO parties' declaration that GMOs should be banned is they took this same message abroad (Figure 6). They couldn't say that all GMOs are dangerous only in Europe, but they are perfectly fine for the developing countries. So now we have the situation where European activists are going around the world telling the developing countries that GMOs are dangerous there too. This has reached the point where they are now causing serious harm to people in the developing world by trying to deny them the benefits of better crops prepared using GM methods and grown widely in the Americas and Australia, imported and consumed around the world. This is both ridiculous and frightening. We MUST find a way to stop it. All of the major professional scientific societies have come out and said that GMOs pose no danger (Figure 7). The only people who are negative are the people who were anti-GMO to start with and in general they have no credible scientists associated with them. My feeling on this, and one of the sentiments that was expressed in the letter that the Nobel Laureates sent to Greenpeace and every U.N. Ambassadors was this: How many people and especially how many kids have to die before we consider this anti-GMO movement to be a Crime Against Humanity? I believe we've already gone way past that point. I think what the anti-GMO activists are doing is criminal and they have to be stopped. It is time for Greenpeace and their allies to admit that they made a mistake when they began their opposition to GMOs. We now have almost 30 years of experience in the area and the science is clear. Some of their former leaders have done this; it is time for the rest to follow. The method is not "dangerous" and if anything is "safer" than traditional plant breeding.

There are several important projects that are underway. One concerns bananas in Uganda (Figure 8). The bananas have a particularly interesting problem that is very difficult to deal with. They have a disease called *Xanthomonas* wilt for which there is no known non-GMO solution. There is no way of fixing this by traditional breeding, but there's a beautiful GMO solution. It turns out that sweet pepper is naturally resistant and there are two genes that are responsible for the resistance. Ugandan scientists have put these genes into bananas and the bananas are now resistant to *Xanthomonas* wilt. This is perfect, because 30% of the calories in the diet of Ugandans come from bananas (which they call "matoke") and in many other parts of sub-Saharan Africa this is also a very important food source.

Another interesting case concerns papayas, which are already being produced from GM plants for many years in Hawaii, because this was the only way to combat a disease caused by a ringspot virus (Figure 9). As you may know there has been as a strong movement in the USA and elsewhere to label foods containing GM ingredients. When this issue came up in Hawaii and the politicians wanted to introduce laws saying that GMO crops could not be grown, the farmers were up in arms. They protested vigorously arguing it would destroy their ability to export their papayas. So what did the politicians do? They said they would "grandfather" papayas and exclude them from the laws thereby pretending they were not GMOs. Only the newly developed GM crops would have to be labeled. So, GMO papaya wound up saving the Hawaiian crop and now 77% of all the papayas that we eat in the US are GM, with no problems having been reported. In Thailand the same ringspot virus is also causing problems, the GM solution is banned and so what have the farmers been doing in Thailand? They have been getting the GM papaya plants on the black market from a local University laboratory and then growing the GM papayas on their farms without telling the government.

The take home message from this talk should be that we have been genetically modifying crops for tens of thousands of years, without excessive regulation and without the paranoia that has been created by environmental activists and is now surrounding GM crops. The so-called GM method that the activists are so concerned about is just the latest improvement in plant methods to enhance the productivity of the crops that form the basis of our food supply. It is time to realize that if you don't want to eat foods that are derived by GM methods, well that's your choice, but recognize it's a choice. Don't pretend that they're dangerous because if anything, they are probably safer than traditional foods. You know, traditional foods are never tested for all of the things that one has to test for if you are looking at GM foods. For most developed countries food isn't a problem, but for much of the developing world it is. When we make statements about the dangers or otherwise of food here we must remember that those statements are quickly transmitted around the world and can have disastrous consequences for the populations there. We can't pretend that disingenuous claims about the safety of food are just for our own political purposes. We need to make sure there's a lot more science in politics and ideally, less politics in science. Politicians should listen to the scientific community. If they are not going to listen to us, why do they fund us to do the research? They should listen to what comes out. Stop pretending that GMOs are dangerous. I don't know if any of you have seen paragraph 72 from the EU report, urging G8 member states not to support GMO crop development in Africa (Figure 10). To try and get such an article into the European constitution is bordering on criminal behaviour as far as I am concerned. Africa of all places is in desperate need of the improved crops that can be generated by GM methods.

I think civil society outside of politics has to play its role too. I think it's important for the major religious leaders to speak out and this is why I am pursuing an opportunity to talk directly to Pope Francis and to persuade him that he should say something very positive here. I talked earlier this year to the leader of the Chinese Buddhists, at a big convention in China. The Buddhists are 100% behind GMOs, but I am still trying to figure out how to get them to make a statement on the issue. But I think there are many religions that should come out and speak about the importance of GM technology to help the poor around the world. These are leaders who in principal support the poor, they want the poor to do well and they should do everything they possibly can to make sure they live healthy lives.

The Rotary Clubs also present an interesting opportunity. I've spoken to several rotary clubs now and they are very interested in this issue and I am hoping that support for GM technology will become a major agenda item for Rotary International. That would be huge because Rotary clubs are around the world and they specialize in trying to help the poor. It would also be good if influential celebrities would speak out in favor of GMOs; we certainly need to make sure that the media do a much better job than they did with a recent article in the *New York Times* which was appalling in its dismissal of scientific fact. I actually wrote to the editors of the *New York Times* and suggested that they might want to meet with some of the Laureates and myself and discuss this. Additionally, I think we have to make sure that knowledgeable plant scientists do not get silenced. They are the people who know most about plants and many are very articulate. They are good at explaining what's going on and can put the modern GM methods into the perspective of other methods that have been used over the millennia. We have to help them when they get attacked by Greenpeace and my hope is that many of them will join the Nobel campaign and use us to provide them with some protection.

Finally, Figure 11 is my message to Greenpeace that says "Have a Heart". You know as well as any of us that avoiding GMO foods are a western indulgence of the rich. When you look at the little boy on the left, he's obviously well fed and has plenty of money to buy food. He has a choice in what food to buy. But the boy on the right has neither money nor much choice in his food. Non-GMO just doesn't work for the poor in the developing countries.

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