





## Mark Lynas 고려대 초청강연



### 진행 순서

시 간	내 용
10 : 30	등록
11 : 00	개회식 사회 한재준 교수 김익환 생명과학대학장 인사말 박규택 한국과학기술한림원 총괄부원장 축사
11 : 10	Mark Lynas 초청강연
11 : 50	질의응답
12 : 00	폐회



# Opening address

Good morning ladies and gentlemen

It is my great pleasure to welcome all of you to the College of Life Sciences and Biotechnology, Korea University.

I would like to express my sincere appreciation to the invited speaker Mr. Mark Lynas. I was told that he was one of activists against GMO until last year. He initiated the anti-GM movement in the UK. However, after he realized the science on GMO, he changed his mind and became a supporter for GMO.

Today 2/3rds of all foods in U.S.A. grocery stores are GM products and in the near future it will be raised to 90%. It is true that there are still pros and cons on GMO issue. In Korea, many people have negative opinion against GM products. However, in reality, a lot of GM products are imported from foreign countries. I think it is very timely event for us to hear Mr. Lynas experience and opinion on GMO issue

The College of Life Sciences and Biotechnology in Korea University has approximately 100 faculties and 500 graduate students that cover all area of life sciences and Biotechnology. Several professors and students are working in GMO area. I am confident that this seminar will enrich our understanding of the pros and cons on GM products.

I am really looking forward to listening to the presentation, and to the open discussions on this issue. Finally I would like to express my deep appreciation to Prof. Cherl-Ho Lee and Hyun-Jin Park for having taken this timely event.

Thank you.

Ik-Hwan KIm  
Dean  
College of Life Sciences and Biotechnology



## **Congratulatory address**

It is my great pleasure and honor to deliver a congratulatory remark for the special lecture of Mr. Mark Lynas here in Korea University campus. First of all, I congratulate Korea Food Security Research Foundation and the College of Life Science and Biotechnology of Korea University to hold this important event.

Mr. Lynas is a well-known environmentalist in England. Since he studied History and Politics in the University of Edinburg in UK, Mr. Lynas, as a successful activist, has been leading the anti-GMO movement from mid 1990s, and contributed greatly to the anti-GMO public opinion in Europe and its dissemination to Asia and Africa. He has realized that he led anti-GMO activities without considering scientific findings since he studied about climate change with scientific approach. Recently, he has apologized and confessed to the world on his mistakes for acting as an anti-GMO activist.

He gave a very interesting speech on the scientific truth on GMO last January at the Oxford Farming Conference in England, and also presented anti-GMO conspiracy theory at the Cornell University lecture last April in USA.

Yesterday, he gave a speech on the scientific truth of GMO at the food security seminar, held in Press Center in Seoul. It is a very timely and opportune event for Koreans as inviting Mr. Lynas to hear his lecture on global warming and food security. Now, Korea is critically relying on imported cereals, over 70% of which demands comes from out of country, in fact, it causes very vulnerable food securities. In General, Koreans hold unfavorable thoughts to GMO even though non-GM grains are getting hard to find in the world grain markets. Therefore, we urgently educate people to understand the benefits and the safety of GM crops in order that people accept GM food without any negative thoughts.

I hope that Lynas's visiting to Korea will serve as a momentum to change Koreans' way of thinking against GMO, and also would like to express my sincere thanks to Prof. Cherl-Ho Lee who organized this lecture.

I believe this lecture will bring positive impacts on the food crisis in the future and all participants may truly enjoy the program of this symposium.

Thank you.

June 5, 2013

Kyu-Taek Park, Vice President, KAST





## Profile

### Mr. Mark Lynas

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#### 약력

1973년 피지(Fiji) 출생, 페루와 영국에서 성장  
영국 에딘버러(Edinburgh)대학 정치역사학과 졸업  
영국 옥스포드 거주  
New Statesman, Ecologist, Granta,  
Geographical magazines의 칼럼니스트  
The Guardian, The Observer 신문 기자  
The Age of Stupid 영화제작  
GMO 반대운동가, 환경운동 Activist

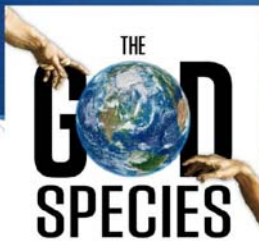
#### 저서

2004 High Tide: The Truth About Our Climate Crisis  
2007 Gem Carbon Counter  
2007 Six Degrees: Our Future on a Hotter Planet  
(2008년도 영국왕립학회 올해의 과학서적상 수상)  
2011 The God Species: How the Planet can Survive the Age  
of Humans (이 책에서 탄소배출을 줄이기 위해 핵발전소를  
늘릴 것과 온난화를 막기 위해 지구공학을 활용하고 기후변화에  
의한 식량난을 해결하기 위해 GMO를 받아들일 것을 제안)  
  
2013년 1월 옥스포드 농민대회에서 GMO 반대운동을 해온 자신의  
잘못에 대해 공개 사과



# Sustainable agriculture: Organic, GMOs & feeding the world

Mark Lynas



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## The Anthropocene – a new planet



## Planetary boundaries: Freshwater use



Photograph by Mitch Epstein

**Aral sea – destroyed  
by cotton**



## Planetary boundaries: Nitrogen cycle

**Gulf of Mexico 'dead  
zone'**

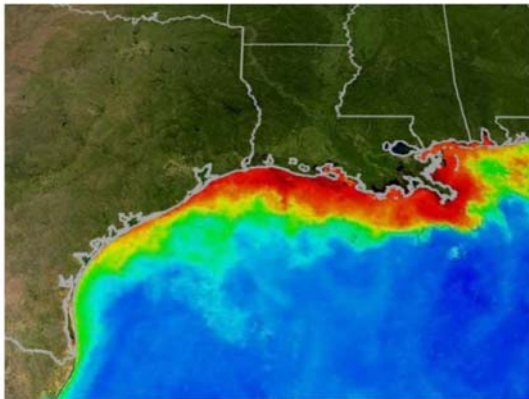


Image courtesy of Eglisha

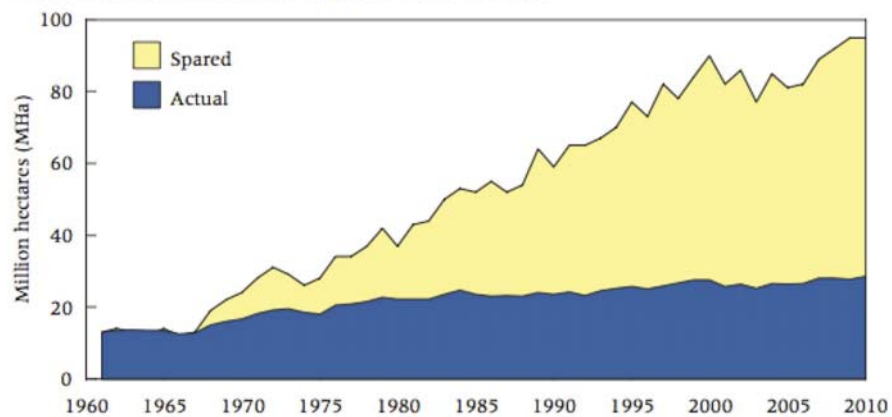
# Land use



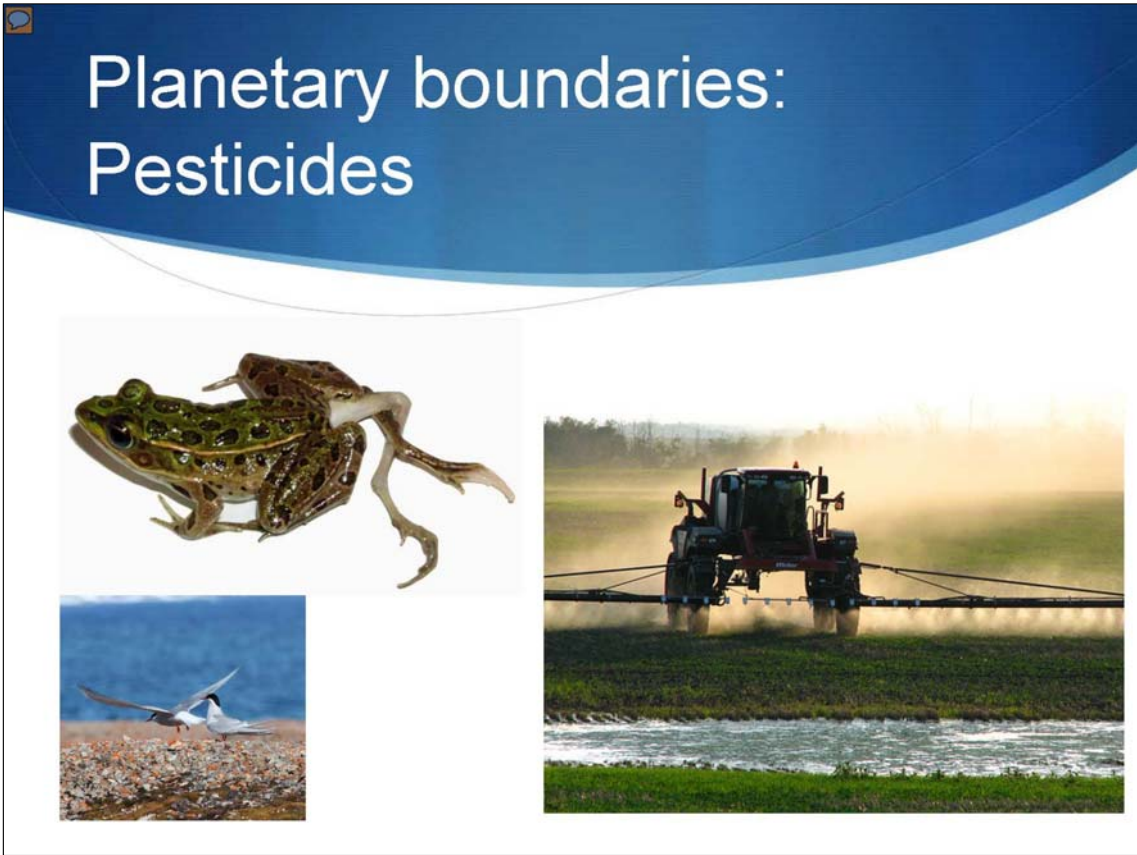
# Current land sparing

**FIGURE 1 Actual and potential land used for wheat production, India 1961–2010**

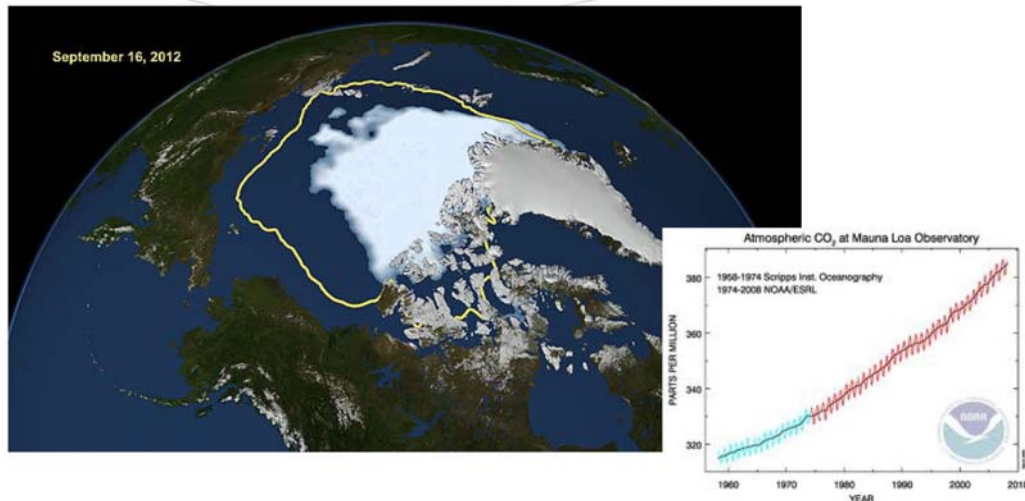
Upper segment shows the hectares farmers would have tilled to produce the actual harvest had yields stayed at the 1960 level.



SOURCE: FAO (2012).



# Planetary boundaries: Climate change



## The scientific consensus: climate



ADVANCING SCIENCE. SERVING SOCIETY

“The scientific evidence is clear: **global climate change caused by human activities is occurring now**, and it is a growing threat to society. Accumulating data from across the globe reveal a wide array of effects: rapidly melting glaciers, destabilization of major ice sheets, increases in extreme weather, rising sea level, shifts in species ranges, and more. The pace of change and the evidence of harm have increased markedly over the last five years. **The time to control greenhouse gas emissions is now.**”

## The scientific consensus: GMOs



ADVANCING SCIENCE. SERVING SOCIETY

“The science is quite clear: **crop improvement by the modern molecular techniques of biotechnology is safe.** The World Health Organization, the American Medical Association, the U.S. National Academy of Sciences, the British Royal Society, and every other respected organization that has examined the evidence has come to the same conclusion: **consuming foods containing ingredients derived from GM crops is no riskier** than consuming the same foods containing ingredients from crop plants modified by conventional plant improvement techniques.”

## Public attitudes

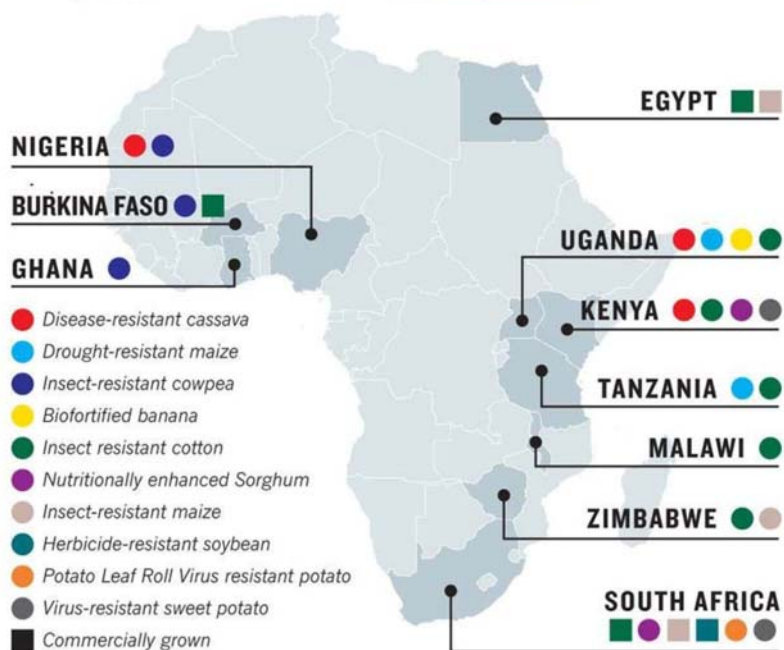


*That's me, third row, second from left*

## Aphid-resistant wheat



## Pro-poor GMOs in Africa



## Pro-poor GMOs



**Orange sweet potato**  
– saving lives/sight in Uganda & Mozambique



**Golden rice** – will Greenpeace ever stop opposing it?



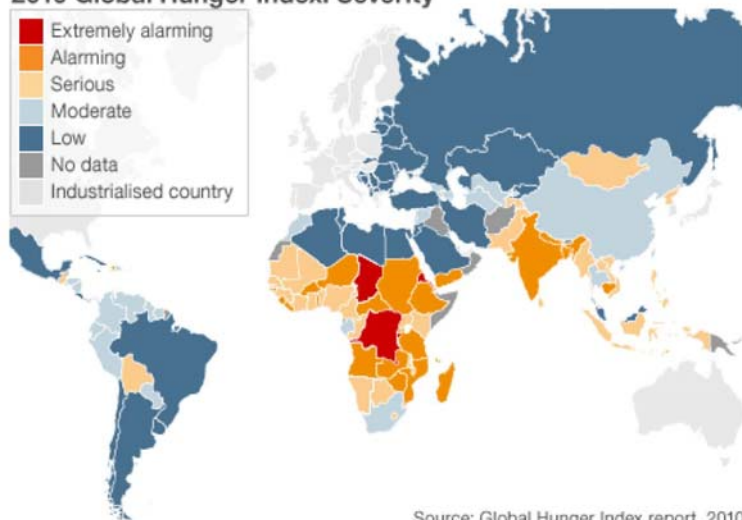
## Hunger in today's world

**240 million in Sub Saharan Africa,**

**360 million in India**

**In both 30% of population**

2010 Global Hunger Index: Severity

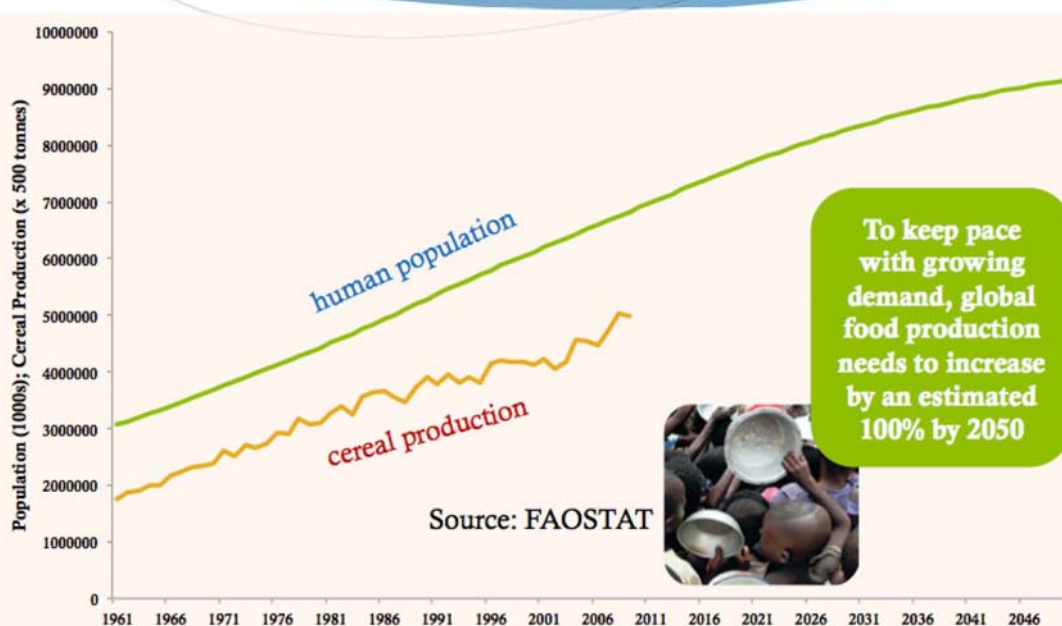


Source: Global Hunger Index report, 2010

## Food price spikes

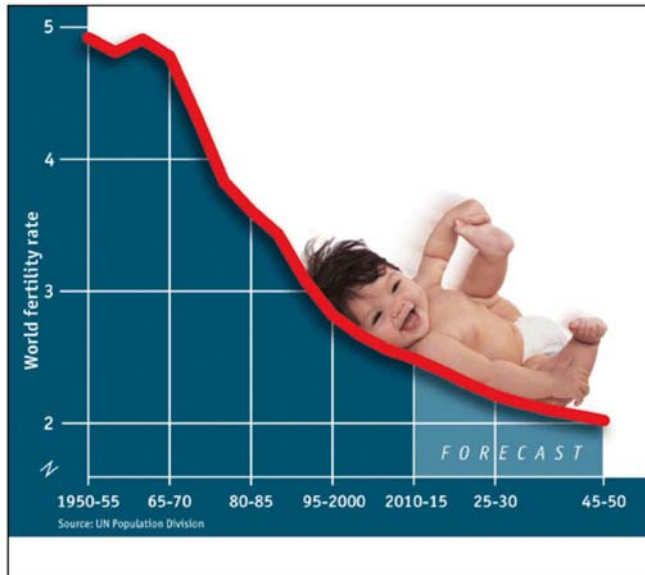


## Meeting future demand



Bruce (2010) *Food Security* 2: 133-141

## Population growth



Average global fertility = 2.4

Natural replacement = 2.1

*Source: The Economist*

## The warning

“England and all civilised nations stand in deadly peril of not having enough to eat.

As mouths multiply, food resources dwindle...”



William Crookes  
(1832-1919)

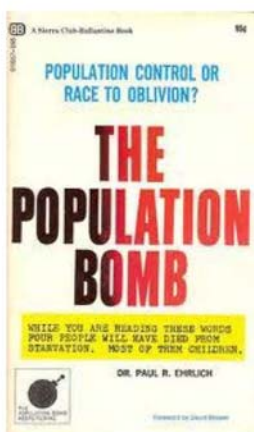
## The breakthrough



### Fritz Haber and Carl Bosch, the Haber-Bosch Process

Nobel prizes 1918 and  
1931

## The warning



“The battle to feed all of humanity is over. In the 1970s hundreds of millions of people will starve to death in spite of any crash programs embarked upon now.”



Paul Ehrlich, 1968

## The breakthrough



**Norman Borlaug**

Nobel Peace Prize  
1970

Saved 1 billion lives

## Yes we can!



# Thankyou!



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# Korea keynote text

Slide 1

Slide 2

In the modern era we are now facing a serious planetary crisis. The human species is overwhelmingly dominant now in the Earth system. Scientists are now discussing whether we have entered a new geological era, named the Anthropocene after humanity. There are now 7 billion people, and collectively we will decide on the future state of the planetary system. We will decide on the temperature of the planet. We will decide the chemistry of the atmosphere. We will decide the acidity of the oceans. And we will decide the composition of species that will continue to share this planet with out.

In some ways humans are not the creators of life, in a way that has never been seen before since the initial appearance of DNA 4 billion or so years ago. Scientists are now able to fabricate new life-forms out of synthetic DNA. This is only the second time in the history of life on Earth that new life forms have appeared which have no biological ancestor. No-one can doubt that genetics is a very powerful tool; we have to ensure that it is used to benefit both humans and the environment going forward. Giving it up is not an option - you cannot and should not try to destroy new knowledge which can have useful applications. What we need to do is control it, and control it democratically.

Slide 3

So the totality of this overwhelming human impact is probably best brought together in the concept of planetary boundaries, which was produced by a stellar team of Earth scientists led by the Swedish professor Johan Rockstrom a couple of years ago. They came up with nine key areas where there might need to be a limit to human interference in order to protect the safe functioning of the biosphere, or what they call planetary life support systems. Nearly all of them directly impinge on food and agriculture, which is not surprising as farming is the single most environmentally destructive - as well as being the most necessary for us - thing that humans do.

Starting off with water, humans now impound 10,000 cubic kilometres of water behind our 800,000 dams large and small, which is a quantity large enough to measurably reduce the rate of sea level rise, and a redistribution of mass sufficient to slightly alter the Earth's axis and speed of rotation. The planetary boundaries team propose that at most humans can use another 2,000 cubic km of water globally, and none at all in the most stressed watersheds like the Colorado, the Yellow river and the Murray-Darling system in Australia.

Now that water is a scarce resource, we have to think about how we can use it most efficiently. What market incentives can there be to stop water being wasted, and ensure that the ecological value of water is priced into its use? How can new crops be as water-efficient as possible? Drought-tolerant crops are now being produced, and were trialled commercially in the US for the first time last summer. These are GMO corn crops mainly. Some varieties are also being produced for African farmers - the Gates Foundation is supporting a program called Water Efficient Maize for Africa, aiming to increase yields for those who do not have access to water for irrigation. These are also GMO plants and are aimed to be available to African farmers by 2017.

#### Slide 4

Now we are all accustomed to talking about the changes in the carbon cycle, but human impact on the nitrogen cycle is actually even more profound relatively. The 130 million tonnes of N that humans make biologically available per year mostly through the Haber-Bosch process represents a doubling of the terrestrial nitrogen input, whereas the CO<sub>2</sub> increase is only around 30% above preindustrial. Remember, in nature the only two main ways that N<sub>2</sub> becomes reactive and available to plants is the creation of nitrogen oxides in lightning, and via the actions of nitrogen-fixing anaerobic bacteria in the root nodules of leguminous plants. So it is hardly surprising that all our extra nitrogen is causing over fertilisation in rivers and dead zones where it runs off into the oceans. The system simply can't cope with all of this extra nutrient and basically runs out of oxygen, suffocating higher life forms.

Having said that, fertiliser production is essential to feed humanity. The Canadian academic Vaclav Smil, whose book on the nitrogen cycle is basically the go-to text on this issue, reckons that the invention of the Haber-Bosch process was the key human innovation in chemistry for the whole of the 20th century, and that three to four billion of us would not be alive today without it. Our bodies have about 2kg of nitrogen in them, and Smil reckons half of this on average is synthetic, produced in an ammonia factory.

In environmental terms, as with water, the challenge today is to get more with less, and there are all sorts of ways that this is being prioritised - nitrogen-efficient crops, precision farming techniques, and ultimately the development of nitrogen-fixing non-leguminous crops. At the John Innes Centre in the UK there is a multi-million dollar programme, again mostly funded by Gates, to create nitrogen-fixing maize for African farmers. This will also necessarily be transgenic - there is no way you could do this by conventional breeding.

#### Slide 5

On a planetary scale perhaps our most fixed planetary boundary is land-use. As someone said, they aren't making any more land, so our only option if we want to protect the rainforests, remaining wetlands and other ecologically important areas is to improve the efficiency with

which we use land. And here it is all about productivity.

You might notice that I am not talking much about organic farming here - there seems to be overwhelming evidence that if you take all factors into account organic is only half as productive as most conventional agricultural systems. In a Q&A on my blog a few weeks ago, the former chair of the AAAS, a prominent molecular biologist called Nina Fedoroff called organic 'a massive hoax' - remember this is one of the world's top scientists speaking.

People tend to buy organic because they believe it is healthier, but this is not necessarily true either. One of the worst food disasters in recent years took place in Germany in 2011, when 50 people died and 3000 were made severely ill because of bacterial contamination in organic beansprouts. It is likely that manure used in the cultivation of the parent plants had contaminated the seeds - this is an extra risk that you run if you consume organic food.

I am not saying organic is all bad. I think there is much to learn from the principles of agro-ecology. But in terms of land use the low productivity of organic agriculture means that to produce an equal amount of food you have to use twice as much land. This means that there is less available elsewhere for nature conservation.

Slide 6:

Scientists have recently tried to quantify how much land has been spared by agricultural innovation in recent decades. These are genetic improvements to crops, better crop protection via chemical treatments, and also the wider use of synthetic fertiliser. All these have environmental impacts, but in land use terms, as this graph shows, if farmers were still using the technologies of 1961 to produce today's total harvest, they would have had to cultivate tens of millions of additional hectares.

This graph is just for wheat. I took this figure from a paper by Jesse Ausubel and colleagues at Rockefeller University, who also looked at the global picture. They calculated that the land spared by agricultural improvements since 1961 adds up to 3 billion hectares, or the equivalent of two South Americas. So there would have been no Amazon rainforest left today without this improvement in yields. Nor would there be any tigers in India or orang utans in Indonesia. We would be farming just about every scrap of land, right up to the ice caps, and food would be much more expensive for everyone. This is why we must continue improving yields in the future, and continue innovation. We cannot freeze production in a museum, or nature will suffer, and poorer people will go hungry.

Slide 7:

This matters because biodiversity is one of our top-level planetary boundaries, one which is

influenced most importantly by our use of land. This is because habitat loss is the number one cause of extinction or threat to species - this is the main reason why a 1/4 of mammals, 1/3 amphibians, 1/6 birds, 1/4 corals, 1/4 freshwater fish are classified as threatened or endangered.

In Darwinian terms, humans are now the key agent of natural selection. We select for species that we find convenient, or we select by accident for weedy and invasive species. Fragile species, especially top-level predators like sharks and tigers, are being eliminated because they need a lot of habitat, or because we hunt them directly for parts. Tiger parts are used in traditional Asian medicine, which has no scientific basis and leads to great threats from poaching to big cats around the world.

Slide 8:

I don't think there's much doubt that the use of particular pesticides is at least a part of the reason why we are seeing major declines in pollinators, other insect, amphibian and bird biodiversity. One of the clearest features of the Anthropocene is that humans have synthesised novel molecules not seen in nature, although it is also true that many of the most successful insecticides for example were plant-derived originally - which is why they are so potent - pyrethroids and nicotinoids have evolved in plants precisely in order to protect themselves against insect attacks. I've never met a farmer who enjoys spraying, not just because most farmers actually do want to preserve some biodiversity on their farms, but also because pesticides are an expensive input.

One of the reasons why I find planetary boundaries so useful is that it forces us to address trade-offs - so if you eliminate the use of pesticides you will generally get a lower yield due to pest attacks and therefore you are using more land to produce the same amount of food, affecting the land and biodiversity boundaries. This is yet another reason why biotechnology is important - Bt crops have reduced pesticide applications by 474 million kg since 1996, which is a reduction of about 9%, and the yield improvements from all GMO crops worldwide have meant a land area saving equivalent to 25% of the area of Brazil. GMO crops are especially important here because plants can protect themselves against pest infestation, so do not need spraying as often.

Slide 9:

Humans emit about 34 bn tonnes/yr, or 1100 tonnes/second of carbon dioxide. You can see this accumulating in the atmosphere in this famous graph called the Keeling curve, recorded on the summit of Mauna Loa volcano in Hawaii. You can follow them on twitter and get live updates of the carbon increase - the record recently passed through the 400 parts per million barrier, which will mean that CO<sub>2</sub> is definitively higher than it has been for at least 3 million years. So we're winding the clock back to much earlier geological eras - by the end of this

century the planet could be hotter than it has been since the Eocene, about 50 million years ago. So our species will never have lived in this climate, because we evolved during a cooler and more stable period of temperatures.

Can we feed 9 billion people on shrinking areas of agricultural land? One of the most important challenges will be to raise the thermal tolerance threshold of key food crops, so that global warming does not reduce harvest so dramatically. Again this will require genetic changes, for which GMOs will play an important part.

#### Slide 10

Not everyone thinks that global warming is real, and when I am confronted by people who deny the reality of climate change I point out that 97% of experts agree with the scientific consensus in this area. This is critically important because most people who are not scientists would otherwise not know who to believe when faced with competing claims from people who claim to be experts. So it is very useful that major academic and scientific institutions like the American Academy for the Advancement of Sciences produces statements like this one. As it says, “the scientific evidence is clear, global climate change caused by human activities is occurring now”. So let there be no doubt about this. Climate change is real, and all environmental groups I know of would agree with this and defend the importance of consensus science on this issue.

#### Slide 11

But now let me show you an equally strong consensus statement made by the same institution, the American Association for the Advancement of Sciences. Again the experts specifically say the ‘science is clear’, yet this time they are speaking about the creation of GMO crops and foods. All the major scientific institutions in the world have said that GMO foods are safe, and yet millions of people around the world believe misinformation which has been circulated by environmental groups that these crops are somehow dangerous to your health. It is vital that people understand that this misinformation is using the same techniques as that which is used to deny the reality of climate change. Both are scientific facts to the best of our knowledge today. So the environmental groups that deny this are entirely hypocritical because they support science in one area and then deny it in another.

#### Slide 12:

Speaking personally, I was forced to shift my views on this issue when I realised the strength of the expert consensus. I was one of the original activists against GMO crops back in the mid 1990s, but recently I have apologised for this activism because it was scientifically incorrect. Many other environmentalists are also waking up to this - not just that current generation GMO

foods are entirely safe, but also the potential for GMOs to be used to improve the environment and human health in many different areas.

This is especially the case because many of the activists ignore the fact that not all GMO crops are produced by Monsanto. In fact there are hundreds of new crops being produced now which are funded in the public sector. This conspiracy theory that all GMO is somehow intended to benefit Monsanto is entirely wrong - and conspiracy theories do a lot of damage to public trust both in science and food safety. If we are to use GMO crops for the good of the planet and people then we have to tell the environmental campaigners to stop spreading unfounded fears about GMOs.

Slide 13:

In my experience the activists are unable to make this key distinction between Monsanto and public sector research in universities, which is why you know their case is not rational. They are in fact against this entire technology in all its forms, which is like being against all computer software because of the dominant position of Microsoft Office. The rational way to approach a technology is to assess it on a case by case basis to understand the potential benefits and any possible negative impacts. This is why all GMO crops undergo extensive field trials.

An example of public sector scientists developing non-patented open-source GMOs for environmental good is here at Rothamsted Research. The scientists have developed a new breed of wheat which has been engineered to contain the aphid alarm pheromone (E)- $\beta$ -farnesene in order to combat aphid infestation without the need for agrochemical sprays. There is no issue of cross-pollination because wheat is self-pollinating, so the pollen does not travel far from the plant. Activists tried to destroy this crop but failed because of public support for it in the UK, and the trial is now being repeated at the moment in a summer wheat crop.

Slide 14:

This is a list of some of the pro-poor public sector GMOs which are being developed around Africa, for example. These could dramatically improve productivity for farmers who are losing their harvests due to pests and diseases, and yet cannot afford expensive chemicals. If they can get new seeds which are more resistant then they can have more reliable harvests, and can feed their children and send them to school.

Unfortunately many of these same countries have very restrictive biosafety legislation which means that any scientists who take these life-saving new seeds out of the laboratory could face ten years in jail. These countries have taken their lead from Europe where GMO cultivation is banned across the entire continent because of pressure from the green parties. In Europe this means that more food is imported from elsewhere because productivity is lower, but in a rich

continent no-one goes hungry. In Africa stopping agricultural innovation means that people will continue to suffer malnutrition and lower life expectancy. So it is very important that other countries realise that Europe is backward on this issue, and is not following its lead from science - in fact European scientists are asking that the regulations be relaxed, but the politicians are ignoring them due to pressure from activists who are ignoring the scientific consensus and continually trying to scare the public with misinformation.

Slide 15:

One of the main challenges in Africa and South and East Asia is doing something about vit A deficiency, which kills hundreds of thousands of pre-school children every year. In eastern Africa activists have allowed the introduction of orange fleshed sweet potato because it is non-GMO, with the necessary beta-carotene genes coming from other varieties. When it comes to golden rice, however, which could save millions of lives in Asia, Greenpeace has mounted a vociferous campaign of opposition intended to stop this nutritional supplement ever reaching its intended beneficiaries - small children who are either going blind or dying because they are short of vit A.

I think this shows that the anti-GMO case is essentially anti-humanitarian - it is entirely unconcerned with solving real-world problems, either environmental or social, except insofar as this fits an ideological anti-corporate agenda. I am now asking people to send petitions in to Greenpeace asking them to stop denying life-saving technology to poorer children around the world. I think what the activists do here is the same as those who raise scare stories about vaccination campaigns, and have led to a resurgence in polio and other preventable diseases as a result.

Slide 16:

Although micronutrient malnutrition like Vitamin A deficiency, and other deficiencies like iron, are still major problems in the developing world, overall shortage of calories also affects close to a billion people worldwide. Even though the world has seen dramatic reductions in poverty in recent decades due to increasing prosperity and economic growth, because population growth has continued we probably have the largest absolute number of hungry people on the planet ever in human history today. This is about 1 billion people, though estimates vary. That means about 130 million children without enough to eat, suffering from malnutrition which can stunt their growth and affect cognitive development in ways that will reduce their lifetime potential. Undernutrition causes the deaths of 3.5 million mothers and children each year. Every single one of those deaths is preventable - we should not tolerate hunger and starvation deaths in the modern world.

Slide 17:

In a globalised food system shocks in one place affect everywhere else, so a poor harvest combined with a high oil price and rising demand in Asia has led to higher and more volatile commodity prices overall. This is a signal from the food system that we need to refocus on

absolute production totals - the days of surpluses are over. Countries like Korea which are highly dependent on food imports are arguably more vulnerable because they do not have a domestic production buffer. I do not think countries should aim to be self-sufficient in food necessarily, because the laws of comparative advantage state that this would be highly inefficient - but there is a balance to be struck between resilience and exposure to external price shocks.

#### Slide 18:

Looking towards the future, it is almost certain that these pressures will continue to intensify. Population growth will continue, with another 2 billion people added in the next 35 years. Economic growth and poverty reduction should also continue, and will also add to increasing demand from more affluent populations consuming more calories, and demanding more meat and dairy intensive diets which overall require more food. This means our great challenge is to increase food production by 100% or more, and to do so without further destroying the planet's ecological capital. We have to respect limitations on carbon emissions, freshwater use, land use, chemical use and fertiliser use.

All of these pressures combine into a kind of 'perfect storm' where we have to make some dramatic innovations in order to succeed. We cannot simply continue with business as usual. Already you can see that the growth in cereals production on this graph is beginning to lag behind the growth in human population - this is because the world is not putting enough effort into agricultural innovation, and because genetic improvements are being prevented by popular superstition and over-regulation applied to biotechnology.

#### Slide 19:

Currently the world population is growing by 75 million people every years - that's a new Germany added every year to global total. Many people have the wrong idea about why this is happening, and blame people in developing countries for having too many children. Actually this idea of high fertility in poorer countries is mostly a myth: today the global average fertility rate is 2.4, which is not far above the natural replacement level of 2.1. According to Hans Rosling, the Swedish professor, we are already at 'peak child' - with 2 billion children alive today there will never be more in absolute numbers.

So where does population growth come from? Although fertility is still high in some of the poorest countries, the increasing population pressure overwhelmingly comes from higher life expectancy. Because of dramatic reductions in infant mortality more children are surviving childhood to have children of their own. So basically the parents of the children of 2050 have already been born today, and therefore population then of over 9 billion is mathematically inevitable unless you somehow get more children to die in the intervening period. Although I entirely support women in all countries having access to family planning, there is not much that

we can do to constrain population growth, so we need to plan to feed all these new people.

Slide 20:

There are some other periods in history when people were worried about food resources not being able to keep up with population growth. In about 1900, the British scientist William Crookes and many other eminent people were extremely concerned about the shortage of fertiliser because guano supplied from Pacific islands were running out. But instead of trying to stop people having more children, this looming crisis was tackled in the laboratory by technical innovation.

Slide 21:

As is well known, in 1912 Fritz Haber first solved the problem of how to synthesise ammonia from unreactive atmospheric nitrogen by combining it with hydrogen at high pressure. He could only manage to convert a few drops to ammonia, but Carl Bosch managed to scale this up to an industrial scale. Like many technologies, this had a distinct dual purpose - synthetic nitrate was initially employed for bomb and ammunition making by the Germans in the First World War, and no doubt many millions of people died as a result. But it also allowed the production of synthetic nitrogen fertiliser for crops, which has enabled billions more to be fed in the decades afterwards. Today half the entire world's population is dependent on synthetic nitrogen - we are all partly created in a factory in other words, because the protein in our bodies contains nitrogen which was manufactured synthetically.

Slide 22:

More recently in 1968 Paul Ehrlich wrote the very famous introductory sentence to his book *The Population Bomb*:

“The battle to feed all of humanity is over. In the 1970s hundreds of millions of people will starve to death in spite of any crash programs embarked upon now.”

At that time global fertility was about 5 children per woman, so perhaps he was right to be concerned. But he didn't anticipate the demographic transition, where fertility dropped rapidly when countries reached a certain level of development, urbanisation, education and female empowerment. The solution proposed for population growth then, of forced sterilisations and stopping food aid, was entirely wrong and inappropriate. Instead, the correct thing to do was to accelerate poverty reduction and focus on producing much more food.

Slide 23:

That the world was able to achieve enormous increases in food production owed most to this

man, the American agronomist Norman Borlaug. In my opinion he should be one of the 20th century's most famous people, like Winston Churchill and John Lennon. Instead, he is very little known today, even though he received the Nobel Peace Prize in 1970 for saving 1 billion lives through increased food production. His 'Green Revolution' crops doubled and tripled production in many developing countries, which in the late 1960s stood on the brink of famine.

Borlaug was always very clear about the important contribution genetics made to his Green Revolution crops. Genetic traits for dwarfing in wheat and rice were very important contributors. They were brought in by conventional selective breeding, but Borlaug was also very enthusiastic about the potential for biotechnology to continue improving productivity.

Before Borlaug died in 2009 he spent many years campaigning against those who for political and ideological reasons oppose modern innovation in agriculture. To quote: "If the naysayers do manage to stop agricultural biotechnology, they might actually precipitate the famines and the crisis of global biodiversity they have been predicting for nearly 40 years."

This is his warning that we need to listen to today when we discuss the issue of GMOs. If the anti-GMO activists are allowed to win, we are risking the food security of the entire planet in decades to come.

Slide 24:

So today the challenge is just as clear as it was in 1900 or in 1968. We face clear ecological constraints in terms of land use, water use, climate, fertiliser, toxics and climate change. But we also have a more affluent and more healthy human population, who are more capable than ever of solving these problems. Perhaps this young girl in Bangladesh will be the next agricultural scientist who finds a breakthrough in crop productivity - for the first time ever (unlike her mother and grandmother) she can expect a proper education despite being female, and can put her brainpower together with that of billions more well educated and instantly interconnected people the world over in whatever way she chooses.

And that's why despite the ecological context and population growth, I am optimistic about the future - for these children, my children and your children, this should still be a Great Century, where they help bring about a world which is more democratic, more peaceful and more wealthy than ever before. But innovation is the key to this better future - our constant inventing and using new tools is what best defines us as civilised human beings.

Slide 25:

Thank you.

## 영국 출신의 저명한 환경운동가이자 GM 반대운동가인 Mark Lynas의 Oxford Farming Conference 강연 내용 전문

2013년 1월 3일

먼저 사과 말씀부터 드리겠습니다. 수년 동안 GM 작물을 강렬히 비난한 점에 대해 공식적으로 이 자리에서 솔직하게 사과 드립니다. 지난 1990년대 중반에 반 GM 운동이 시작되는 것을 도왔으며, 환경에 이로울 수 있는 중요한 기술적 선택 사항을 악으로 매도하는데 협조했던 점도 죄송하게 생각합니다.

환경론자로서, 그리고 전세계 모든 사람들이 건강하고 영양소가 풍부한 음식을 선택할 권리가 있다고 믿는 사람으로서, 더 큰 역효과를 낳는 길을 선택하면 안 되는 것이었습니다. 정말 진심으로 후회합니다.

1995년부터 지금까지 무슨 일이 있었기에 제 생각이 바뀌고 이 자리에 나와서 잘못을 인정하게 되었는지 궁금하실 것입니다. 대답은 간단합니다. 과학을 발견했으며, 그 과정에서 더 나은 환경론자가 되어야겠다고 생각했습니다.

제가 처음 몬산토의 GM 콩에 대해 들었을 때, 저는 제가 생각했던 것을 정확히 알고 있었습니다. 여기 뭔가 새롭고 실험적인 것을 말도 없이 우리가 먹는 음식에 넣으면서 끔찍한 길을 가고 있는 한 대형 미국 기업이 있었습니다. 종들 간에 유전자를 혼합하는 것은 너무도 부자연스러운 것 같았습니다. 너무 큰 기술력을 지닌 인간이 있었습니다. 무언가 끔찍이 잘못될 것 같았습니다. 이 유전자들은 살아있는 오염물질처럼 퍼져나갔습니다. 무서운 악몽이었습니다.

이 두려움은 산불처럼 퍼져나갔으며, 몇 년 이내에 GM은 유럽에서 본질적으로 금지되었습니다. 우리가 우려하던 점들을 그린피스(Greenpeace), 지구의 벗(Friends of the Earth)과 같은 NGO가 아프리카, 인도, 다른 아시아 국가에 전했으며, 이들 국가들은 오늘날까지도 여전히 GM을 금하고 있습니다. 이는 제가 관여했던 일들 중 가장 성공한 것이었습니다.

이는 명백히 반 과학운동이었습니다. 우리는 과학자들이 생명의 제일 기본 요소에 변화를 가했을 때 그들이 연구실에서 악마처럼 낄낄거리고 웃는 모습을 이용했습니다. 그에 따라 프랑켄슈타인 식품이라는 꼬리표가 붙었습니다. 이는 몰래 부자연스러운 결과를 만들어내기 위해 사용하는 과학적 힘에 대해 깊이 자리잡고 있는

두려움에 대한 것이었습니다. 우리가 그 당시 깨닫지 못했던 것은, 실제 프랑켄슈타인의 괴물은 GM 기술이 아니라 그에 대한 우리의 반응이었습니다.

반 과학 환경보호론은 기후변화와 관련하여 제가 지지하는 과학 환경보호론과는 점차 모순적이게 되었습니다. 저는 2004년에 지구온난화에 대한 첫 번째 책을 출간했으며, 개인적인 진술을 기반으로 한 것이 아니라 과학적으로 믿을 수 있도록 만들었습니다.

따라서 저는 알래스카로의 여행에 대한 내용을 위성 데이터 및 빙하로 뒷받침해야 했으며, 안데스 산맥에서 빙하가 사라지는 사진을 산 빙하의 질량 수지에 대한 장기간의 기록으로 해명해야 했습니다. 이는 즉, 과학 논문을 읽고 기본적 통계를 이해하는 법, 해양학에서 고기후(지질시대 기후)에 이르기까지 매우 다른 분야에 학식을 쌓는 법을 배워야 했다는 뜻이며, 정치와 현대 역사 부문 학위로는 아무런 도움이 되지 못했습니다.

저는 구제 불능 반 과학이라고 여겼던 사람들과 지속적으로 싸우고 있는 자신을 발견했습니다. 그들은 기후학자들의 말을 들으려 하지 않았고, 기후 변화의 과학적 현실을 부인했습니다. 그래서 저는 그들에게 상호 검토의 가치에 대해, 과학적 합의의 중요성에 대해 강의했으며, 문제가 되는 그 사실이 어떻게 가장 유명한 학술 저널에 출간되었는지에 대해서도 강연했습니다.

두 번째 기후 관련 책인 *Six Degrees* 는 매우 과학적이어서 왕립학회 과학서적상을 수여하기도 했습니다. 친분이 생긴 기후과학자들은 제가 그들보다 기후에 대해 더 많이 안다고 농담하기도 합니다. 그리고, GM 과학에 대한 학술적 연구를 하지도 않았으며 개인적인 이해의 폭도 꽤 제한적이었음에도 불구하고, 놀랍게도 2008년 이맘때 *Guardian* 에 GM 과학을 비난하는 글을 썼습니다. 저는 이때에도 생명공학 또는 식물과학에 대한 상호 검토된 논문을 읽지 않았던 것 같습니다.

분명 이러한 모순은 지지 받을 수 없었습니다. 제가 혼란에 빠졌던 것은 반 GM에 대한 내용으로 *Guardian*에 적었던 제 마지막 글의 일부 견해를 본 뒤였습니다. 특히, 한 명의 비평가가 제게 이렇게 말했습니다. “그러니까 대기업이 마케팅하는 것을 기반으로 GM에 반대하시네요. 자동차 바퀴도 대기업이 마케팅하는데, 이 또한 반대하시나요?”

이후 일부 자료를 읽어봤으며, 차례 차례 제가 소중히 갖고 있던 GM에 대한 믿음이 녹색 도시 신화에 지나지 않는다는 것을 알게 되었습니다.

저는 GM이 농약 사용을 증가시킨다고 생각했습니다만, 해충 저항성 면화 및 옥수수는 살충제가 거의 필요 없었습니다.

GM은 단지 대기업에만 이득이 되는 줄 알았습니다만, 투자를 거의 하지 못하는 농업인들에게 수십억 달러가 돌아갔습니다.

터미네이터(Terminator) 기술로 인해 농업인들이 종자를 재사용 하는 권리를 빼앗길 줄 알았으나, 1대 잡종기술이 개발되어서 종자를 재사용하는 대신 성능이 훨씬 우수한 1대잡종 종자의 이용이 늘어나서 굳이 터미네이터 기술을 이용할 필요가 없게 되었습니다.

저는 어느 누구도 GM을 원치 않는다고 생각했습니다. 하지만 실제로는 Bt 면화가 인도로 불법 복제되었으며, 집합적으로 준비된 콩은 브라질로 복제되었습니다. 농업인들이 간절히 사용하길 원했기 때문입니다.

저는 GM이 위험한 것이라고 여겼으나, 예를 들어 돌연변이 유발 등을 사용하는 전통 육종보다 GM이 더 안전하고 정밀했습니다. GM은 단지 일부 유전자만을 움직이지만 전통 육종은 시험적이고 잘못된 방법으로 전체 게놈을 조작합니다.

그러면 서로 관련 없는 종 간의 유전자 혼합은 어떤가요? 가령 물고기와 토마토의 혼합 말입니다. 바이러스는 항상 그렇습니다. 식물들, 벌레들, 심지어는 우리도 그렇지요. 이는 유전자 흐름(유동)이라고 부릅니다.

하지만 이는 여전히 시작일 뿐입니다. 그래서 저는 제 세 번째 책인 *The God Species* 에서 모든 환경론자의 통설을 처음부터 버리고 더 큰 그림을 보려고 노력했습니다.

오늘날 우리가 직면한 문제는 늘 한정된 비료, 물 부족, 살충제 사용과 급속히 변하는 기후 속에서 우리가 살고 있는 곳과 같은 지역에 있는 (바라건대 훨씬 덜 가난한) 사람들 95억명을 먹여 살려야 한다는 것입니다.

이를 조금만 분석해 봅시다. 작년에 이 컨퍼런스에서 인구 증가에 대한 주제로 강연이 있었던 것을 알고 있습니다. 이 지역 역시 근거 없는 믿음으로 인해 어려움에 처해 있습니다. 사람들은 개발도상국의 고출산율이 큰 문제라고 생각합니다. 다시 말해, 가난한 사람들이 자녀들을 많이 낳고 있습니다. 따라서 가족 계획을 세우거나 대대적으로 한 아이 정책과 같은 과감한 무엇인가가 필요합니다.

현실상 전세계 평균 출산은 약 2.5명으로 줄고 있습니다. 자연적 출산이 2.2명이라는 것을 고려해보면, 2.5명이 그렇게 큰 수치는 아닙니다. 그렇다면 그 엄청난 인구 성장은 어디에서 오는 것일까요? 유아 사망률이 줄고 있기 때문입니다. 오늘날 아이들은 어린 시절에 예방 가능한 질병으로 죽기 보다는 성장합니다. 그리고 그들의 또 다른 2세를 가집니다.

유아 사망률이 빠르게 감소하는 것은 오늘날 최고의 소식 중 하나이며, 이 성공 스토리의 중심부는 아프리카 사하라 사막 이남지역입니다. 그 곳에 더 많은 아이들이 태어나기 때문은 아닙니다. 한스 로슬링(Hans Rosling)의 말에 따르면, 이미 아이들 수는 ‘최절정’에 달해 있습니다. 약 20억명의 아이들이 오늘날 살고 있으며, 출산율이 감소하고 있기 때문에 그보다 더 많은 수치는 앞으로 없을 것입니다.

하지만 이 20억명의 아이들 중 상당히 많은 수가 성인으로 성장하여 자녀를 가질 것입니다. 이들은 2050년에 어린 성인을 둔 부모가 될 것입니다. 이는 2050년에 인구가 95억명이 될 것이라고 예상한 근원이기도 합니다. 유아 사망률 감소는 바람직한 현상이니, 결코 그런 일이 있어서는 안되겠지만 자녀를 잃을 필요는 없습니다.

그러면, 이 많은 사람들이 필요로 하는 식량은 얼마나 될까요? 국립 과학 아카데미 회보에 작년에 실린 예측자료를 보면, 21세기 중반까지 100% 이상 국제 수요가 증가할 것입니다. 이는 특히 개발도상국에서 거의 전적으로 GDP가 성장하기 때문입니다.

다시 말해, 우리는 더 많은 식량을 생산해야 하며, 단순히 인구 수에 맞춰 생산할 것이 아니라 가난이 점차 근절되어야 하기 때문에 널리 확산되는 영양실조에 맞춰 식량을 생산해야 할 것입니다. 여전히 오늘날에도 거의 8억 명이 가까운 사람들이 배고픔 속에서 잠에 들고 있습니다. 그리고, 저는 부유국 사람들이 빈국의 GDP 성장은 좋지 못한 일이라고 말하는 것에 대해 이의를 제기합니다.

하지만 이 성장에 따른 결과로 우리는 매우 심각한 환경적 문제를 지니게 되었습니다. 토양을 전환하면서 온실가스가 많아졌고, 이는 아마도 생물 다양성을 손실하는 가장 큰 근원이기도 합니다. 식량 생산 강화가 필요한 이유가 바로 이 때문입니다. 우리는 우림 지역을 구하고 천연 서식지를 농업화로부터 지켜내기 위해 제한된 땅에서 더 많은 것을 재배해야 합니다.

물 부족 문제도 처리해야 합니다. 기후 변화로 인한 대수층 감소 및 가뭄이 대륙 농업 중심지에 엄청난 영향을 미칠 것으로 예상됩니다. 강에서 더 많은 물을 끌어오면 이 위태로운 서식지에 생물 다양성 감소는 가속화될 것입니다.

우리는 질소 사용을 관리하는데 더 신경 써야 합니다. 인공 비료는 인류에 식량을 공급하는데 필수적인 요소입니다. 하지만 비효율적인 사용으로 인해 담수 생태계에 부영양화뿐만 아니라 멕시코만 및 전세계 많은 해양 지역에 데드 존(dead zone)이 생길 수 있습니다.

뒷집지고 서서 기술 혁신이 이 문제들을 해결해줄 것이라고 생각해서는 안됩니다. 훨씬 더 전략적이 되어야 하며 행동가가 되어야 합니다. 기술 혁신이 더 빠르게,

올바른 방향으로 일어나 이를 필요로 하는 사람들에게 도움을 줄 수 있어야 합니다.

어떤 의미로는 과거에도 이 위치에 있었습니다. 파울 에를리히(Paul Ehrlich)가 1968년에 인구폭탄(Population Bomb)이라는 책을 출간했을 때 그는 책에 “모든 인류를 먹여 살리기 위한 전쟁은 끝났습니다. 단기 집중 프로그램을 실시함에도 불구하고 1970년대에는 수천억 명의 사람들이 굶어 죽을 것입니다.”라고 적었습니다. 그 조언은 인도와 같은 무력한 국가에서 노골적으로 드러났습니다. 사람들이 머지않아 굶주리게 될 것이고, 따라서 인구 증가를 줄이기 위해 그들에게 식량 원조를 하지 않아야 한다고 말입니다.

이는 이미 예정된 바는 아니었으며, 에를리히가 틀렸습니다. 모든 사람들이 그의 조언에 주의를 기울였다면 수억 명의 사람들이 불필요하게 죽었을 것입니다. 하지만 노먼 볼락(Norman Borlaug)과 그의 녹색혁명 덕분에 영양실조는 놀라울 정도로 감소했으며 인도는 식량을 자급자족하게 되었습니다.

볼락도 에를리히만큼 인구 성장에 대해 걱정했다는 것을 상기하는 것이 중요합니다. 그는 단지 인구 성장에 대해 무엇인가를 해야겠다고 생각했습니다. 그는 가능한 일을 행하겠다고 믿는 실용주의자였으나 한편으로는 모든 사람들이 충분히 먹을 권리가 있다고 믿는 이상주의자이기도 했습니다.

노먼 볼락은 무슨 일을 했을까요? 그는 과학과 기술에 눈을 돌렸습니다. 인간은 옷에서부터 쟁기에 이르기까지 도구를 만들 줄 알며, 기술은 특히 다른 유인원들과 인간을 구별 지어 줍니다. 기술의 대부분은 주요 재배 작물의 계놈에 중점을 두었습니다. 예를 들어, 밀의 줄기 높이를 줄여주면 종자를 만드는데 더 많은 노력을 기울임으로써 생산량을 늘리고 비, 바람으로 인한 곡물 손실도 최소화 할 수 있습니다.

2009년 볼락이 사망하기 전, 그는 수년 동안 정치적이고 이데올로기적인 이유로 농업에서의 현대적 혁신을 반대하던 사람들에게 반하는 운동을 했습니다. 그의 말을 인용하면 다음과 같습니다. “회의론자들이 농업 생명공학을 중단시킨다면 거의 40년동안 예견해온 기근 및 세계적 생물 다양성의 위기를 촉발하게 될 것입니다.”

아마도 환경운동이 부유국에서부터 확산된 덕분에 우리는 지금 이 위치에 위태롭게 근접해 있습니다. 생명공학은 중단되었으며, 거의 모든 대기업은 엄청나게 비싼 비용을 들여야 합니다.

현재 여러 국가에서 규제 시스템을 통해 작물을 얻으려면 수천만 달러가 듭니다. 크롭라이프에서 본 최근 수치에 따르면, 신 작물 형질을 발견하여 최종적으로 상업화하기까지 1억 3900만 달러의 비용이 들어갑니다. 따라서 오픈소스 또는 공공부문

생명공학은 실제로 설 자리가 없습니다.

우울해지는 아이러니한 점이 있습니다. 생명공학 반대 운동가들은 자신들이 더 많은 마케팅을 해온 상황에서 단지 대기업들이 마케팅하는 GM 작물에 대해 불평을 합니다.

EU에서는 GM 규제 시스템에 진척이 없습니다. 많은 GM 작물이 십 년 이상 승인을 받기 위해 대기 중에 있습니다만 프랑스와 오스트리아 같은 반 생명공학 국가들의 꼬인 국내 정책 때문에 영구적으로 정체되어 있습니다. 전세계적으로 규제로 인한 지연 기간이 2002년에는 3.7년이었으나 지금은 5.5년 이상으로 늘어났습니다. 관료주의적 부담이 점차 심해지고 있습니다.

기억하시겠지만, 프랑스는 감자가 미국 수입품이었기 때문에 오랫동안 감자를 들여오지 않았습니다. 최근 한 해설가가 말하는 것처럼, 유럽은 음식 박물관에 가깝습니다. 잘 먹고 사는 소비자들은 과거 전통적인 농업에 대한 로맨틱한 향수에 눈 멀었습니다. 먹을 것이 충분하고 미적인 환상에 빠져들 만큼 여유가 있기 때문입니다.

하지만 이와 동시에, 저널 *Nature Communications* 에서 지난달 Jonathan Foley와 다른 사람들이 보고한 연구자료에서 보여주듯이, 전세계 주요 식량 작물의 생산량이 부진해졌습니다. 예전처럼 생산량을 늘릴 수 없다면 인구 증가에 맞춰 식량을 보유하는데 어려움이 생기며, 가격 상승은 물론 자연 상태에서 농업환경으로 전환되는 토양도 늘어날 것입니다.

노먼 볼락의 말을 다시 한번 인용해보면, “세계는 사용 가능하거나 연구 단계로써 발전한 기술력을 보유하고 있어 지속적으로 백억 명의 사람들을 먹여 살릴 수 있습니다. 오늘날 이와 관련있는 의문은 농업인들과 목장주(농장주)들이 이 신기술을 사용할 수 있도록 허가받을 수 있느냐 하는 것입니다. 부유국은 분명 위험이 극도로 낮은 입장을 선택할 여력이 있고, 소위 말하는 ‘유기농’ 방법으로 재배한 식품을 구입할 수 있겠지만, 식량 부족국에서 소득이 낮으며 고질적으로 영양 결핍에 시달리고 있는 10억명의 사람들에게는 불가능한 일입니다.” 라고 했습니다.

볼락이 말했듯이, 아마도 가장 위험한 생각은 유기농 생산품이 사람 또는 환경에 더 이롭다는 것입니다. 유기농이 더 건강하다라는 생각은 과학 서적에서 반복적으로 틀린 것임이 입증되었습니다. 우리는 여러 연구자료를 통해 유기농 식품이 최대 40-50%까지 생산량이 낮다는 것을 알고 있습니다. 영국 토양협회는 최근 보고서에서 이 생산성의 차이는 언급하지 않고 유기농으로 세계를 먹여살린다는 것에 관해 장황하게 설명했습니다.

전반적으로 토양 변경에 따른 영향을 고려해보는다면, 유기농 또한 생물 다양성을 악화시킬 것이라는 점 또한 언급하지 않았습니다. 대신, 서구 사람들이 전체적으로 육식을 줄이고 칼로리를 낮추면 개발도상국의 사람들이 더 많이 먹을 수 있다는 이상적인 세계에 대해서만 설명합니다. 이는 지나치게 단순화된 말도 안 되는 소리입니다.

이에 대해 생각해보면, 유기농 운동은 본질적으로 반대파의 것입니다. 원칙상 많은 현대 기술을 받아들이지 않습니다. 1850년 기술 발전을 말과 수레로 정체시켰던 펜실베이니아의 아미시파처럼 유기농 운동은 1950년경 어딘가에서 무턱대고 기술을 동결시켰습니다.

하지만 이런 사상이 일관적으로 적용되지는 않습니다. 최근 영국 토양협회 잡지에서 읽은 글을 보면, 화염방사기로 잡초를 죽이거나 전류로 잡초를 태워버리는 것은 괜찮지만 글리포세이트와 같은 순한 제초제는 ‘인공 화학제품’이기 때문에 여전히 쓰면 안 된다고 합니다.

현실적으로, 화학제품을 피하는 것이 환경에 이롭다고 하는 근거는 전혀 없습니다. 사실 그와 반대입니다. 록펠러 대학(Rockefeller University)의 Jesse Ausubel와 그 동료들은 인도 농업인들이 1961년 기술로 오늘날 전체적인 생산량을 얻는데 사용하는 농지가 얼마나 되는지 살펴봤습니다. 그 규모는 프랑스의 규모인 6500만 헥타르에 달합니다.

중국의 경우 옥수수 농업인들은 수확량을 더 높여주는 현대 기술을 사용하여 프랑스의 두 배에 해당하는 1억 2000만 헥타르에서 옥수수를 재배합니다. 전세계적으로 봤을 때 1961년과 2010년 사이에 농경지는 고작 12% 증가했으며 사람 당 섭취 칼로리는 2200 kcal에서 2800 kcal로 늘어났습니다. 따라서 30억 명이라고 하더라도 동기간에 생산량 300% 증가 덕분에 이 모든 사람들은 여전히 먹을거리가 충분했습니다.

화학제품 투입이 수확량 향상에 지대한 역할을 하면서 전세계 얼마나 많은 토양이 농경지로 사용되었습니까? 30억 헥타르 즉, 남아메리카 두 개를 합친 것과 같은 크기의 토양이 쓰였습니다. 이 정도의 수확량 향상이 없었다면 오늘날 아마존의 유럽지역은 없었을 것입니다. 인도에는 호랑이도 멸종했을 것이고, 인도네시아에는 오랑우탄도 남아있지 않았을 것입니다. 따라서 저는 농업에서 기술 사용을 반대하는 사람들이 왜 스스로를 환경론자라고 부르는지 이해할 수 없습니다.

그럼, 이러한 반대주장은 어디서 온 것일까요? 널리 확산된 일부 추정에 따르면 현대 기술이 더 많은 위험을 초래한다고 합니다. 2011년에 입증된 독일 유기농 콩

나물에서의 대참패처럼 실제로 질병이나 조기 죽음을 초래하는 자연적인 일들이 많습니다. 독일의 유기농 콩나물 사건은 공식적인 건강상의 대재앙이었습니다. 체르노빌 사건이 야기했던 사망자 및 부상자 수와 동일한 피해를 일으켰습니다. 아마도 동물 분뇨에서 나온 E-coli 가 이집트에서 수입된 유기농 콩나물 종자를 감염시켰던 것이 그 원인이었습니다.

총 53명이 사망했으며, 3,500명이 심각한 신장 질환을 겪었습니다. 그러면 왜 소비자들은 유기농을 선택했던 것일까요? 유기농이 더 안전하고 건강하다고 생각했으며, 엄격하게 규제된 화학 살충제 및 비료에서 발생하는 정말 미미한 위험에 대해서는 크게 우려했기 때문입니다.

편견 없이 이 상황을 살펴보면, 반 생명공학과 유기농에 있어서 대부분의 논쟁은 단순히 자연주의적인 오류를 기반으로 하고 있습니다. 자연적인 것은 좋은 것이며, 인공적인 것은 나쁘다는 믿음 말입니다. E-coli 중독으로 사망한 사람들의 친척들이 하는 말처럼, 세상에는 죽음에 이르도록 하는 천연 독성분과 방법들이 많습니다. 따라서 그런 믿음은 분명 오류입니다.

유기농의 경우, 자연주의적인 오류는 중심적인 지도 원리로 올라갑니다. 이는 비논리적이며, 우리는 지구와 아이들에게 빛을 지고 있습니다.

그렇다고 해서 유기농법이 쓸모 없다고 말하는 것은 아닙니다. 간작 및 혼식과 같이 개발된 좋은 기술이 많으며, 이는 노동집약적임에도 불구하고 환경적으로 매우 효과적일 수 있습니다. 영양분 재활용 및 농장 다양화 촉구와 같은 농업생태학 원칙도 어디에서나 심각하게 고려되어야 합니다.

하지만 유기농은 혁신을 거부하는 과정 속에서 진행되고 있습니다. 가장 분명한 예로, 다시 한번 GM을 들면, 많은 3세대 GM 작물은 환경적으로 피해를 입히는 화학제를 사용할 필요가 없습니다. 해당 작물의 게놈이 변형되어 해충으로부터 스스로를 보호하기 때문입니다. 이것이 왜 유기농이 아닙니까?

유기농 또한 다른 것로부터 선택을 박탈하기 위해 사용될 때 이런 과정을 거칩니다. GM에 대해 가장 흔한 주장 중 하나는 유기농을 하는 농업인들은 GM 꽃가루로 ‘오염’될 것이므로, 이를 사용해서는 안 된다는 것입니다. 따라서 궁극적으로 미학적인 것에 기반하여 소비자 선호로 이어지는 부유한 소수들의 권리는 환경에 이득을 주는 개선된 작물을 사용하려는 그 밖의 모든 사람들 권리를 능가합니다.

저는 다양성의 세계에 찬성합니다. 그 의미는 한가지 농업 시스템이 장점을 독점하고 있다고 주장할 수 없으며, 모든 다른 선택사항을 배제할 것을 목표로 한다고

할 수도 없습니다. 왜 평화로운 공존 상태를 유지할 수 없는 걸까요? 특히 현 기술보다 더 심각한 위험을 갖고 있는 오래된 기술에 구속되어 있어서 그렇습니다.

거의 모든 사람은 ‘유기농’에 경의를 표해야 하며 이 통설은 말도 안 된다고 의심하는 것 같습니다. 자, 저는 오늘 그것에 대해 이의를 제기하겠습니다.

가장 큰 위험은 혁신에 대한 모든 기회(가능성)를 이용하지 못한다는 점입니다. 실제로 맹목적 편견에 지나지 않기 때문입니다. 두 가지 예를 들어보겠습니다. 유감스럽게도 그린피스에 관련된 것입니다.

작년에 그린피스는 호주에서 전통적인 이유로 GM 밀 작물을 훼손했습니다. 영연방 과학연구기관(Commonwealth Scientific Research institute)이 시행했던 공식적으로 자금 지원을 받은 연구였습니다만 그런 건 상관 없습니다. 그 작물은 GM 이고 자연적인 것이 아니라는 이유로 그린피스는 그 밀 작물을 반대했습니다.

그 이후로 소수의 사람들은 다른 시험 중 하나가 실시되었다는 말을 들었습니다. 자동 잔디 깎기를 갖춘 그린피스 운동가들이 다행히도 파괴하지 못한 것이었으며, 우연히 밀 수확량이 이례적으로 30% 증가한 것을 발견했습니다. 생각해 보십시오. 그린피스가 이 혁신을 파괴했다라면 이 GM 밀 작물의 수확량 증가는 알 수 없었을 것입니다. NFU의 피터 켄달(Peter Kendall) 회장은 최근에 이번 일은 도서관의 책을 누군가가 읽기 전에 모두 불태우는 것과 유사하다고 말했습니다.

두 번째 사례는 중국에서 일어난 일입니다. 그린피스는 20명 이상의 아이들이 GM 황금 쌀 시험에서 인간 실험 대상이 되었다고 주장하면서 전국을 혼란에 빠뜨렸습니다. 그린피스는 이 쌀이 더 건강하며 매년 비타민 A 결핍과 관련하여 실명 및 죽음을 맞이하는 수천 명의 아이들을 구할 수 있다는 사실은 언급하지 않았습니다.

그린피스 보도자료에 지명되어 있던 세 명의 중국 과학자들은 공적으로 시달림을 당했으며, 그 이후 직업을 잃었습니다. 중국과 같은 독재 국가에서 그들은 심각한 개인적 위험에 처해 있습니다. 국제적으로 엄격히 규제된 황금 쌀이 이미 십 년 이상 시장에 출시되어 있으며, 그린피스와 같은 단체의 활동 때문에 이 쌀은 비타민 결핍을 호소하는 가난한 사람들에게 결코 사용될 수 없을 것입니다.

비타민 A 결핍의 위험이 없는, 멀리 있는 부유한 사람들의 미학적인 선호도 때문에 가난한 사람들과 그 아이들에게 도움을 줄 수 있는 것을 뺏는다는 비도덕적이고 비인간적이라고 생각합니다. 그린피스는 연 1억 달러를 벌어들이는 다국적기업입니다. 따라서 다른 대기업들처럼 도덕적 책임이 있습니다.

황금 쌀이 공공 부문에서 공익을 위해 개발되었다는 사실은 반대론자에게 아무

런 효과가 없습니다. 로담스테드 연구소(Rothamsted Research)를 보십시오. 연구소 소장인 Maurice Moloney 가 내일 연설을 할 것입니다만, 작년에 로담스테드 연구소는 진딧물에 내성을 가진 GM 밀을 시험하기 시작했습니다. 이 작물은 이 심각한 해충에 대항하기 위해 별도의 살충제를 사용할 필요가 없습니다.

단순히 그 작물이 GM이기 때문에 반대론자들은 그것을 파괴하기로 결정했습니다. 하지만 John Pickett 교수 및 그 연구팀이 유튜브와 미디어에 자신들의 연구가 왜 중요하며 왜 버려져서는 안 되는지에 대한 중요한 이야기를 하면서 반대론자들의 파괴 계획은 실패했습니다. 교수 및 연구팀은 반대론자들이 고작 200개의 탄원서를 준비했을 때 탄원서에 수천 개의 서명을 받았으며, 파괴하려던 일이 수포로 돌아갔습니다.

하지만 한 반대자가 펜스를 거두려고 했습니다. 알고 보니 아주 진부한 GM반대 시위자였으며, 이튼학교 출신이었습니다. 그의 화려한 과거는 옥스포드의 블랜드포드 후작(Marquess of Blandford)을 마치 책임이 막중한 시민들의 표본처럼 보이게 했습니다.

이 상류층 출신 운동가는 시험 현장에 유기농 밀 종자를 상징성 있게 흩뿌려 놓았습니다. 덕분에Pickett 교수의 연구팀은 휴대용 무선 진공청소기로 주변을 돌아다니며 하나 하나 제거 해야만 했습니다.

올해 로담스테드에서는 밀 시험을 반복하면서 오메가 3 지방종자에 대한 연구를 할 것입니다. 이 지방종자는 자연산 연어를 대체할 수 있으며, 이렇게 되면 육지 기반 원료가 수산 양식에서 사용되어 남획을 줄이는데 도움이 됩니다. 이 또한 GM이기 때문에 반대론자들은 해양 생물 다양성에 대해서 잠재적인 환경적 이득이 분명함에도 불구하고 또 반대할지 모릅니다.

여러분은 어떻게 생각하실지 모르겠지만, 저는 충분히 생각했습니다. 그래서 오늘 제가 내린 결론은 매우 명확합니다. GM에 대한 논쟁은 끝났습니다. 우리는 더 이상 GM이 안전한지 아닌지 논의할 필요가 없습니다. 15년 이상 3조나 되는 GM 음식을 먹었으나 단 한 건도 위해성에 대해 입증된 것이 없었습니다. GM 음식으로 다치기보다 소행성에 맞을 가능성이 더 많습니다. 요점은, 유기농 음식을 선택하여 사망한 사람들은 있지만, GM 음식을 먹어서 사망한 사람은 한 명도 없다는 것입니다.

제가 10년 전에 그랬던 것처럼 그린피스와 영국 토양협회는 기후변화의 경우처럼 합의 과학으로 인해 인도되어야 한다고 주장합니다. 하지만 GM의 경우 미국과학진흥회, 왕립 학회, 전세계에 있는 건강 연구소 및 국립 과학 아카데미의 지원을

받은 확고한 과학적 합의가 있습니다. 하지만 이 불편한 진실은 이데올로기와의 갈등 때문에 무시되었습니다.

마지막 예는 병충해 저항성을 지닌 GM 감자에 대한 안타까운 이야기입니다. 이 감자는 아일랜드에서 공공 자금을 받은 기관인 Sainsbury Lab와 Teagasc가 개발하였습니다. 하지만 아일랜드의 녹색당(당 리더는 이 컨퍼런스에 자주 참석함)은 이에 너무 반대하여 법정 소송까지 제기했습니다.

병충해 저항성 감자는 농부들이 시즌 별로 15회의 살균제 스프레이를 뿌리던 것을 막아줬지만, 감자가 복제되어 번식되었으며 문제가 되는 유전자는 야생 감자에서 왔기 때문에 꽃가루 이동은 중요한 것이 아니라는 것입니다.

19세기 중반에 감자 기근으로 수백 명이 사망한 것을 고려해보면, 아일랜드에서 개발된 병충해 저항성 감자를 받아들이는 것은 역사적으로 좋은 울림이었을 것입니다. 아일랜드가 병충해를 물리친 국가가 되는 획기적인 사건이 되었을 것입니다. 하지만 아일랜드 녹색당 덕분에 그럴 일이 없습니다.

안타깝게도 오늘날 반대론자들은 관료주의자들을 자신들의 편에 두고 있습니다. 웨일스 및 스코틀랜드는 아마도 과학의 이끌림을 받는 위임된 정부에 대해 전략적 임무로써 중세 미신을 받들면서 공식적으로 GM 을 받아들이지 않습니다.

이는 아프리카와 아시아 대부분의 국가에서도 거의 비슷합니다. 인도는 Bt 가자 토양에 살충제를 뿌리는 것을 줄여주며 열매에 살충제 잔류물이 남는 것도 줄여주지만 이를 거부합니다. 인도 정부는 점차 Vandana Shiva와 같은 회고적인 이론가에 사로잡혀 있습니다. Vandana Shiva는 반복적인 기근 및 구조적인 불안정의 시대였음에도 불구하고 이 산업화 이전의 마을 농업을 이상화합니다.

아프리카는 ‘GM 반대’가 여전히 여러 정부의 모토입니다. 예를 들어, 여전히 영양실조가 만연한 국가인 케냐는 GM 음식이 영양실조를 줄여줄 수 있음에도 불구하고 이를 “건강 위해음식”으로 여겨 GM 음식을 금했습니다. 영양실조가 추가적인 증거가 필요 없는 입증된 건강 위해 요소임에도 말입니다. 케냐에서 영양이 풍부하거나 높은 수확량으로 가난한 농부들을 도와줄 수 있는 GM 작물을 개발하게 되면 10년간 감옥에 구속됩니다.

따라서 절실히 필요한 농업 혁신은 합리적인 과학적 위해성 평가를 기반으로 하지 않은 대대적인 규제에 숨막혀 질식사하고 있습니다. 오늘날 위험한 것은 GM 음식이 아니라 충분한 음식이 없어 수백만 명이 해를 입는 것입니다. 부유국에서 목소리를 내는 소수자들은 자연스럽다고 생각하는 것을 먹고 싶어하기 때문입니다.

저는 이제 상황이 바뀌기를 희망합니다. 빌과 멜린다 게이츠 재단은 최근 John

Innes Centre에 1000만 달러를 주며 옥수수를 시작으로 주요 작물에 질소를 고정하는 능력을 통합시키고자 합니다. 그렇습니다 그린피스 여러분 이는 GM 옥수수입니다. 무시하십시오. 전세계적 문제인 질소 오염을 줄인다면, 질소를 고정하는 주요 작물을 개발해내는 것은 훌륭한 성과가 될 것입니다.

이 모든 것은 정치적으로는 합당하지 않다는 것을 잘 압니다. 하지만 국제적으로 근거 없는 믿음을 불식시키고 규제를 완화하는 주요 정책이 필요합니다. 제가 아는 식물과학자들은 이에 대해 제가 얘기를 하면 손으로 머리를 감싸 집니다. 왜냐하면 정부와 많은 사람들이 완전 잘못된 위험하다는 생각을 가지고 꼭 필요한 기술을 배제하기 때문입니다.

노먼 볼락은 이 세상에 없습니다. 하지만 우리는 정치적으로 옳다고 믿는 통설이 틀렸다는 것을 깨닫고 그 통설을 받아들이기를 거부하면서 그의 생각과 비전을 존중해야 합니다. 왜냐하면 그만큼 중요한 문제이기 때문입니다. 하지만 우리가 계속해서 잘못 이해하고 있으면 수십억 명의 생명이 위험에 처할 것입니다.

따라서 저는 오늘 여러분에게 이 분야에 대한 여러분의 믿음에 이의를 제기하며 여러분의 믿음이 합리적인 설명으로 뒷받침되는지를 보고자 합니다. 운동 단체인 Sense About Science가 조언하듯이 항상 증거를 구하십시오. 그리고 캠페인을 벌이는 NGO의 자기 언급적인(우물안 개구리식) 보고서를 뛰어넘으십시오.

하지만 무엇보다도 가장 중요한 것은, 농업인들이 스스로 채택하고자 하는 기술을 자유롭게 선택하도록 해야 합니다. 여러분이 만약 오래된 방법이 최선이라고 생각한다면 그게 맞습니다. 여러분은 그럴 권리가 있습니다.

여러분이 가지지 못한 권리가 있다면 다르게, 더 나아지길 희망하며 노력하는 다른 사람들을 방해하는 것입니다. 농업인들은 인구 증가와 지구 온난화의 압박에 대해 이해하고 있습니다. 헥타르 당 수확량이 가장 중요한 환경적 미터법임을 알고 있습니다. 그리고 기술은 결코 발전을 멈추지 않으며 심지어 냉장고와 보잘 것 없는 감자도 한때는 새롭고 두려운 것이었다는 점을 잘 알고 있습니다.

영국 귀족 계층, 유명인 주방장에서부터 미국 식도락가, 인도의 소작농에 이르기까지 반 GM 로비단체에게 전하고자 하는 제 메시지는 이것입니다. 여러분은 여러분의 시각을 고수할 자격이 있습니다. 하지만 지금부터 여러분은 그 시각이 과학에 기반한 것이 아니라는 점을 알아야 합니다. 우리는 곧 식량 부족 사태에 직면합니다. 사람들과 지구를 위해 바로 지금이 때입니다. 여러분이 물러나고 다른 사람들이 나서서 세계를 지속적으로 먹여 살리도록 해야 합니다.

감사합니다.

## Time to call out the anti-GMO conspiracy theory

29 April 2013

**Mark Lynas speech hosted by the International Programs – College of Agriculture and Life Sciences (50th Anniversary Celebration), and the Atkinson Center for a Sustainable Future, Cornell University**

**29 April 2013, 2.15pm ET**

I think the controversy over GMOs represents one of the greatest science communications failures of the past half-century. Millions, possibly billions, of people have come to believe what is essentially a conspiracy theory, generating fear and misunderstanding about a whole class of technologies on an unprecedentedly global scale.

This matters enormously because these technologies – in particular the various uses of molecular biology to enhance plant breeding potential – are clearly some of our most important tools for addressing food security and future environmental change.

I am a historian, and history surely offers us, from witch trials to eugenics, numerous examples of how when public misunderstanding and superstition becomes widespread on an issue, irrational policymaking is the inevitable consequence, and great damage is done to peoples' lives as a result.

This is what has happened with the GMOs food scare in Europe, Africa and many other parts of the world. Allowing anti-GMO activists to dictate policymaking on biotechnology is like putting homeopaths in charge of the health service, or asking anti-vaccine campaigners to take the lead in eradicating polio.

I believe the time has now come for everyone with a commitment to the primacy of the scientific method and evidence-based policy-making to decisively reject the anti-GMO conspiracy theory and to work together to begin to undo the damage that it has caused over the last decade and a half.

On a personal note, let me explain why I am standing here saying this. Believe me,

I would much prefer to live a quieter life. However, following my apology for my former anti-GMO activism at my Oxford speech in January, I have been subject to a co-ordinated campaign of intimidation and hate, mostly via the internet.

Even when I was at school I didn't give in to bullies, and at the ripe old age of 40 I am even less inclined to do so now. Moreover, I have been encouraged by emails and other support from globally-renowned scientists who are experts on this issue, and who all said basically the same thing to me: 'You think you've got hate-mail? Welcome to my world'.

I think these scientists are the unsung heroes of this saga. They carried on with their important work and tried year after year to fight against the rising tide of misinformation, while people like me were belittling and undermining them at every turn. I won't mention names, but they know who they are. Some of them are here today, and I would like to give them my deepest thanks.

So for me also there is also a moral dimension to this. The fact that I helped promote unfounded scare stories in the early stages of the anti-GMO movement in the mid 1990s is the reason why I now feel compelled to speak out against them. I have a personal responsibility to help put these myths to rest because I was so complicit in initially promoting them.

My activism, which I wrongly thought of at the time as being 'environmental', has done real damage in the world. For me, apologising was therefore only the beginning. I am now convinced that many people have died unnecessarily because of mistakes that we in the environmental movement collectively made in promoting anti-GMO fear. With that on your conscience, saying sorry and then moving on is not enough. Some restitution is in order.

Following a decade and a half of scientific and field research, I think we can now say with very high confidence that the key tenets of the anti-GMO case were not just wrong in points of fact but in large parts the precise opposite of the truth.

This is why I use the term conspiracy theory. Populist ideas about conspiracies do not arise spontaneously in a political and historic vacuum. They result when powerful ideological narratives collide with major world events, rare occasions where even a tiny number of dedicated activists can create a lasting change in public consciousness.

In the 1960s the conspiracy theories about Kennedy's assassination reflected the

profound feeling that there were shadowy people high up in the CIA and government who were subverting democracy, and fighting the Cold War by devious and deadly means. More recently, conspiracy theories about 9-11 reflected the hatred many on the political Left had for the Bush Administration.

Successful conspiracy theories can do real damage. In Nigeria an outbreak of Muslim conspiracy theorising against the polio vaccination campaign there led to a renewed polio outbreak which then spread to 20 other countries just when the disease was on the brink of being entirely eradicated.

In South Africa during the presidency of Thabo Mbeki the HIV/AIDS denialist myth became official government policy, just as the anti-GMO denialist myth is official European Union policy today. The result in South Africa was that hundreds of thousands of people were denied life-saving anti-retroviral treatments and died unnecessarily.

The anti-GMO campaign has also undoubtedly led to unnecessary deaths. The best documented example, which is laid out in detail by Robert Paarlberg in his book 'Starved for Science', is the refusal of the Zambian government to allow its starving population to eat imported GMO corn during a severe famine in 2002.

Thousands died because the President of Zambia believed the lies of western environmental groups that genetically modified corn provided by the World Food Programme was somehow poisonous. I have yet to hear an apology from any of the responsible Western groups for their role in this humanitarian atrocity.

Friends of the Earth was one of those responsible, and I note that not only has no apology been forthcoming, but Friends of the Earth Europe is still actively promoting GMO denialism in the EU in a new campaign called Stop the Crop. Check out their Youtube video to see how they have learned nothing in ten years.

Another well-known example is that of Golden Rice, genetically modified to contain high levels of beta carotene in order to compensate for the vitamin A deficiency which kills hundreds of thousands of children around the world and blinds many more every year. One study on the prospects for Golden Rice in India found that the burden of vitamin A deficiency could be reduced by 60%, saving 1.4 million healthy life years.

Here the actions of Greenpeace in forestalling the use of golden rice to address micronutrient deficiencies in children makes them the moral and indeed practical

equivalent of the Nigerian mullahs who preached against the polio vaccine – because they were stopping a lifesaving technology solely to flatter their own fanaticism.

I think this campaign is shameful and has brought the entire environmental movement into disrepute, with damaging consequences for the very beneficial work that many environmentalists do. Greenpeace's campaign against vitamin A-enhanced Golden Rice should therefore be cancelled, and I call on everyone concerned about children's health to lobby Greenpeace and demand that this happens immediately and without delay.

The anti-GMO campaign does not even have the benefit of intellectual coherence. If you truly think that herbicide-tolerant biotech crops are an evil plot by Monsanto to achieve a stranglehold on the entire world's food supply, why would you also oppose all other non-patented and open-source applications of biotechnology, which have nothing to do with Monsanto, apparently without exception? This is like being against all computer software because you object to the dominant position of Microsoft Office.

On a logical basis only a case by case assessment makes sense for deciding how any technology might best be applied. So if you think that Bt corn is bad for US farmers, despite all the evidence to the contrary, it shouldn't necessarily follow that you also have to ban virus-resistant papaya, or oppose a blight-resistant potato in Ireland.

This matters today more than ever because we are entering an age of increasingly threatening ecological scarcity. The planet is beginning to move outside the envelope of stable temperatures that we have enjoyed for 10,000 years, and into an age of instability and rapid change.

Within just a year from now, global CO<sub>2</sub> concentrations will break through the crucial 400 parts per million boundary, marking a change in atmospheric chemistry that is unprecedented for at least 3 million years.

Moreover, we are now on a global emissions path which puts us on track for 4-5 degrees Celsius of warming by 2100, a transformation which will leave this planet barely recognisable and considerably more hostile to human and other life.

But what about all those who say that global warming is a hoax, a product of thousands of scientists conspiring with governments and the UN to falsify temperature data and usher in a new age of global socialism?

Well, I've spent more than a decade arguing with climate sceptics, and in the end I fall back on a single killer argument: that if an overwhelming majority of experts say something is true, then any sensible non-expert should assume that they are probably right.

To make the point, here is the consensus position of the American Association for the Advancement of Sciences on climate change:

“The scientific evidence is clear: global climate change caused by human activities is occurring now, and it is a growing threat to society. Accumulating data from across the globe reveal a wide array of effects: rapidly melting glaciers, destabilization of major ice sheets, increases in extreme weather, rising sea level, shifts in species ranges, and more. The pace of change and the evidence of harm have increased markedly over the last five years. The time to control greenhouse gas emissions is now.”

Oh, but wait – the AAAS has also released another statement of consensus science on another area concerning us today:

“The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe... The World Health Organization, the American Medical Association, the U.S. National Academy of Sciences, the British Royal Society, and every other respected organization that has examined the evidence has come to the same conclusion: consuming foods containing ingredients derived from GM crops is no riskier than consuming the same foods containing ingredients from crop plants modified by conventional plant improvement techniques.”

So, my suggestion today is that a sensible baseline position for environmentalists and indeed everyone else is to accept the consensus science in both these areas. Instead, you have the unedifying spectacle of so-called green groups like the Union of Concerned Scientists stoutly defending consensus science in the area of climate change, while just as determinedly undermining it in the area of biotechnology.

Tellingly, the UCS utilises the exact same techniques as climate sceptics in its enduring and strikingly unscientific campaign against GMOs: it issues impressive reports based on strategic cherry-picking and only referencing its ideological allies in a kind of epistemological closed-loop, it pushes the perspective of a tiny minority of hand-picked pseudo-experts, and it tries to capture and control the public policy agenda to enforce its long-held prejudices.

Many of the most influential denialists like those at the Union of Concerned Scientists sound like experts; indeed they may even be experts. Richard Dawkins tells a story about a professor of geology, who lectured and published papers about stratigraphy in hundred-million year old rocks whilst at the same time being a ‘young-earth’ creationist who really believed the world was only 6,000 years old. His pre-existing religious conviction simply overpowered his scientific evidence-based training.

An even more striking example is Peter Duesberg, the leading light in the AIDS denialist movement, who is a professor of cell biology at the University of California in Berkeley.

Many anti-vaccine campaigners, like Andrew Wakefield, started out as qualified medical professionals. This is why scientific consensus matters – it is the last line of defence we have against the impressive credentials and sciency-sounding language of those who are really on the lunatic fringe.

Speaking of the lunatic fringe, someone else who claims scientific credentials is Vandana Shiva, probably the most prominent Indian anti-biotechnology activist, who incidentally draws much larger audiences than this one to her fiery speeches about the evils of Monsanto and all things new in agriculture. Shiva tweeted after my Oxford speech that me saying that farmers should be free to use GMO crops was like giving rapists the freedom to rape.

That is obscene and offensive, but actually is not the half of it. Let me give you my all-time favourite Vandana Shiva quote, regarding the so-called terminator technology, on which she launches constant blistering attacks without once acknowledging the salient fact that it was never actually developed.

“The danger that the terminator may spread to surrounding food crops or the natural environment is a serious one. The gradual spread of sterility in seeding plants would result in a global catastrophe that could eventually wipe out higher life forms, including humans, from the planet”.

Now, I’ve said and done some pretty stupid things in my time, but this one takes some beating. You don’t need the intelligence of a Richard Dawkins or indeed a Charles Darwin to understand that sterility is not a great selective advantage when it comes to reproduction, hence the regular observed failure of sterile couples to breed

large numbers of children.

As Shiva's case so clearly shows, if we reject data-driven empiricism and evidence as the basis for identifying and solving problems, we have nothing left but vacuous ideology and self-referential myth-making. Indeed in many related areas, like nuclear power, the environmental movement has already done great harm to the planet, even as it has rightly helped raise awareness in other areas such as deforestation, pollution and biodiversity loss.

Science tells us today that the coming age of ecological scarcity extends much further than just global warming. If we wish to preserve a semblance of current biodiversity on this planet, for example, we must urgently curtail agricultural land conversion in rainforest and other sensitive areas.

This is why organic agriculture is an ecological dead-end: it is dramatically less efficient in terms of land use, so likely leads to higher rates of biodiversity loss overall. Maybe organic producers should be legally mandated to specify on labels the overall land-use efficiency of their products. I'm all in favour of food labelling by the way when it comes to something important that the consumer should have the right to know.

Of course conventional agriculture has well-documented and major environmental failings, not least of which is the massive use of agricultural fertilisers which is destroying river and ocean biology around the world. But the flip side of this is that intensive agriculture's extremely efficient use of land is conversely of great ecological benefit.

For example, if we had tried to produce all of today's yield using the technologies of 1960 – largely organically in other words – we would have had to cultivate an additional 3 billion hectares, the area of two South Americas.

We cannot afford the luxury of romanticised but inefficient agricultural systems like organic because the planet is already maxxed out in terms of both land and water. Our only option therefore is to learn to do more with less. This is known as sustainable intensification – it's about improving the efficiency of our most ecologically scarce resources.

But remember, everything is changing. Food demand will inevitably skyrocket this half-century because of the twin pressures of population growth and economic

development. We need to sustainably increase food production by at least 100% by 2050 to feed a larger and increasingly affluent global population.

This is where the eco-Malthusians tend to pop up, illustrating another uncomfortable aspect of the anti-GMO philosophy. Let me share with you a rather revealing quote I read just a couple of weeks ago on Yale 360, from the US environmental writer Paul Greenberg, where he is lamenting the supposed wrongs of genetically engineered salmon. But forget the fish – when it comes to humans he says the following:

“If we continue to bend the rules of nature so that we can provide more and more food for an open-ended expansion of humans on the planet, something eventually will have to give. Would you like to live in a world of 15 billion people? 20 billion? I would not. And while it’s possible you will label my response as New Age-ish, I feel that GE food distracts us from the real question of the carrying capacity of the planet.”

Well, I think that calling these sentiments New Age-ish is to give them far too much credit. I would actually call them misanthropic. What Greenberg seems to be suggesting here, as Paul Ehrlich did before him, is the denial of food to hungry people in order to prevent them breeding more children and contributing to overpopulation.

Luckily this modern-day Malthusianism is wrong in point of fact as well as by moral implication. Firstly, the human population is never going to reach 20 billion. Instead, it is forecast to peak at 9-10 billion and then slowly decline.

Secondly, although we are certainly heading for 9 billion people by mid-century, but that is not because people in poor countries are still having too many babies. The main reason is that children who are born today are much more likely to survive, and become parents themselves.

It is a little-known fact that the global average fertility rate is now down to about 2.4, not far above natural replacement of 2.1. So pretty much all the increased population growth to 2050 will come from more children surviving into adulthood.

And that is surely a good thing. I want to see child death rates in developing countries continue to plummet thanks to better healthcare, access to clean water and sanitation, and all the other benefits the modern world can and should bring to everyone.

No doubt like all of you, I also want to see an end to the scourge of hunger which

today affects more people in an absolute sense than ever before in history. It is surely an abomination that in 2013 we can all go to bed each night knowing that 900 million other people are hungry.

This scourge affects children disproportionately – one third of child deaths are attributable to malnutrition. Among those who survive, nutrient deficiencies like iron, zinc and vitamin A can lead to cognitive impairment and other health problems, reducing a child's life chances for his or her entire future.

It is a truism to say that people are hungry not because there is a global shortage of food in an absolute sense, but because they are too poor to afford to eat. But it is a dangerous fallacy to suggest therefore that because the world on average has enough food, we should therefore oppose efforts to improve agricultural productivity in food insecure countries.

In fact probably the best way to address rural poverty is to ensure that subsistence farmers the world over enjoy more reliable and increasingly productive harvests. This will enable them both to feed their own families and to generate a surplus to sell at a profit so their children can go to school.

Is genetic modification a silver bullet way to achieve this? Of course not. It cannot build better roads or chase away corrupt officials. But surely seeds which deliver higher levels of nutrition, which protect the resulting plant against pests without the need for expensive chemical inputs, and which have greater yield resilience in drought years are least worth a try?

And real-world evidence so far gives grounds for optimism. The use of Bt cotton in China has been shown to dramatically improve biodiversity, unlike broad-spectrum insecticides which kill everything, pests and predators alike. The Bt protein only affects the insects which bore into the crop, is entirely safe for us, and has led to insecticide reductions of 60% in China and 40% in India on cotton.

The introduction of Bt brinjal in India, a project which I know people here in Cornell were closely involved in leading, would have dramatically reduced insecticide poisonings associated with that crop too, had the anti-GMO activists in India not succeeded in preventing its use.

India today seems to be perched on a scientific knife-edge, with a vociferous lobby pushing dark-age traditionalism on the brink of permanently capturing the entire political and legal agenda. If they succeed, hundreds of millions of food-insecure Indians will be the losers.

In Africa too there are a multitude of western-funded NGOs who all claim to be mysteriously protecting biodiversity by keeping cultivated plant genetic improvements permanently out of the continent. In many African countries GMOs are subject to the same kind of de-facto ban as is the case in Europe, leaving poorer farmers at the mercy of a changing climate and exhausted soils.

However, a showdown is looming, because some of the most exciting biotechnology initiatives are now based in African countries. The Bill and Melinda Gates Foundation is putting substantial funding into these efforts – such as improved maize for poorer African soils, a project which is looking to get yield increases of 50% even where fertiliser is not available or the farmer cannot afford to buy it.

There's also the public-private partnership called Water Efficient Maize for Africa, using biotech to produce drought tolerant corn specifically for African smallholders facing the challenges of a changing climate. There's C4 rice, aiming to improve the photosynthetic capacity of rice and thereby dramatically increase yields.

Another Gates-funded project is based at the John Innes Centre in the UK and aims by 2017 to have cereal crops which fix their own nitrogen available for farmers in sub-Saharan Africa. The list goes on: there's biofortified cooking bananas in East Africa, and cassava fortified with iron, protein and vitamin A in Nigeria and elsewhere.

I haven't finished! There's resistance to cassava brown streak disease, which is currently spreading rapidly and threatens the staple crop for two out of every five people in sub-Saharan Africa.

And of course transgenic technology focused on conferring wheat rust resistance at the molecular level to head off the threat of a global pandemic which could otherwise threaten one of humanity's most important staple foods.

But if the activists have their way, none of these improved seeds will ever leave the laboratory. And this brings me, by way of conclusion, to the essentially authoritarian nature of the anti-GMO project.

All these activists, strikingly few of whom are themselves smallholder farmers in

Africa or India, claim to know exactly which seeds developing country farmers should be allowed to plant. Those which are not ideologically approved by self-appointed campaigners should be banned forever.

The irony here is that predominantly left-wing activists, who are supposedly so concerned about corporate power, are determined to deny the right to choose to the most powerless people in the world – subsistence farmers in developing countries. In fact, this is more than an irony – it is a cruelty. And it is a cruelty which must stop, and stop now.

HG Wells is often quoted as saying that civilization is a race between education and catastrophe. The New Yorker writer Michael Specter, who wrote a great book about anti-science movements called ‘Denialism’, updates this, writing that civilisation is a race between innovation and catastrophe.

This is surely no more true than today, when civilisation is genuinely threatened by the twin catastrophes of climate change and ecological scarcity colliding with vastly greater food demand from a larger and wealthier population.

The solution is the same one that it always was – innovation – the uniquely human capacity to produce new tools which has saved our species so many times before from apparently inevitable Malthusian collapses. Therefore if we reject innovation now of all times we make catastrophe not just likely but probably inevitable.

This was indeed the warning the great Norman Borlaug left us with before he died. To quote:

“If the naysayers do manage to stop agricultural biotechnology, they might actually precipitate the famines and the crisis of global biodiversity they have been predicting for nearly 40 years.”

In the final assessment only way that conspiracy theories die is because more and more people begin to wake up to reality and reject them. Then perhaps there comes a tipping point where what was once received wisdom becomes increasingly understood for the foolish nonsense that it always was.

I think – I hope – that we are close to this tipping point today. And now, with just a little extra push, we can all join in consigning anti-GMO denialism to the dustbin of history where it belongs.

<http://www.marklynas.org/2013/04/time-to-call-out-the-anti-gmo-conspiracy-theory/>

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