GMO in agriculture and food production - pros and cons

Dr. Renata Kazimierczak
Prof. Ewa Rembiałkowska, SGGW

Warsaw University of Life Sciences
Faculty of Human Nutrition and Consumer Sciences
Organic Foodstuffs Division
e-mail: renata_kazimierczak@sggw.pl
phone: +48 22 593 70 35

Prague, 21 VII 2015

What is GMO?

Genetically Modified Organism (GMO)

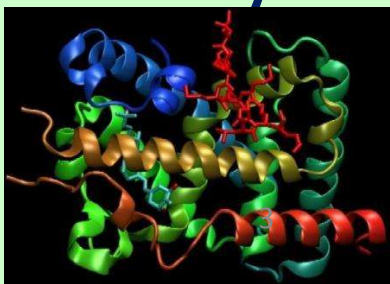
is an organism, with the exception of the human being, in which the genetic material has been altered in a way that does not occur naturally by mating and/or by natural recombination (*definition from EU Regulation (EC) No **1829/2003** on genetically modified food and feed*).

Source: http://ec.europa.eu/agriculture/glossary/

GM has hundreds of applications. The majority of is not controversial:

- **Biopharmaceuticals** - It is possible to obtain on a large scale valuable medicines using modified organisms (insulin, growth hormone, interferon, vaccines against viruses, blood coagulability factors).
- **GM laboratory animals and cell lines** - as a model to testing the innovative methods of diseases treatment, among the others: bone marrow diseases and cancer.
- **"Vaccines" GMOs** - as experimental treatments for cancer

Latest achievements in biotechnology, especially concerning the modified microorganisms are evident, uncontested and worthy of development



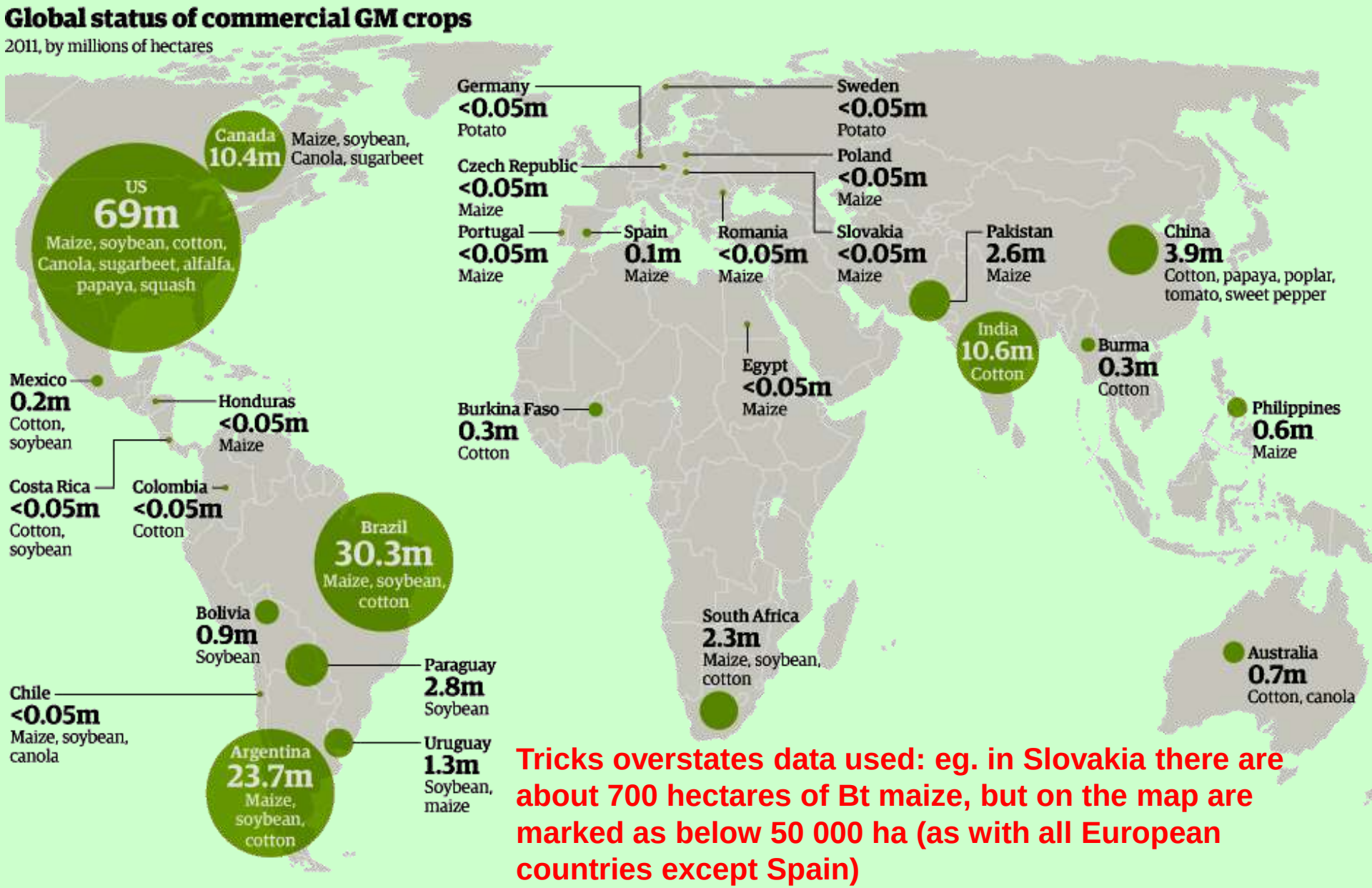
Doubts and fears

concern the use of GMOs
in agriculture
and food production

GMO in numbers

- **The country with the largest area of transgenic crops are the United States of America (USA)**
- **Most often cultivated transgenic plants are: soybean (mainly for feed), corn (mainly for animal feed and biofuels), canola (mainly for cooking oil and biofuel) and cotton**
- **Currently around the world more than 90% of cultivated varieties of GM contains 2 kinds of modifications: resistance to herbicides - 59% (the most common varieties are the brand name "Roudup Ready" (RR) - produced by Monsanto, resistant to the herbicide Roundup, a product of the same company) and the ability of synthesis the protein Bt (= Cry proteins) - insecticide from the soil bacterium Bacillus thuringiensis - 35%**
- **Transgenic plants are grown on all continents** (according to The International Service for the Acquisition of Agri-biotech Applications - ISAAA) – organisation sources of information derives from biotech, and therefore may not be fully true….

ISAAA: GM crops around the world



Tricks overstates data used: eg. in Slovakia there are about 700 hectares of Bt maize, but on the map are marked as below 50 000 ha (as with all European countries except Spain)

GMO cultivation in Europe - 2011

- The European Union has **110 849 000 hectares of arable land**, and only **114 525 hectares of GMO crops**
- In 2011 in Europe, GMOs was cultivated only at **0.1% of the arable land**
- **Organic land accounts for 4% of the crops in the EU**
- 19 EU countries did not cultivated GMOs
- According to the published report of non-governmental environmental organization ‚Friends of the Earth' in 2010, genetically modified crops were grown only in 8 from the 27 European Union countries (most of these crops are located in Spain).

Genetic modification – advanced biotech methods and tools

- **Vectors are the carriers of genetic information**
- **It can be viruses, plasmids or DNA fragments of another organism**
- **These carriers are implanted into a host organism (the recipient) in order to change its genetic material and its properties – using complicated technics**
- **The described process does not never occur spontaneously under natural conditions, it is necessary to human intervention**
- **As a result of the procedure used, a new organism originate, capable of transferring their genetic material (as different to the starting material) to filial organisms .**

Genetic engineering vs breeding
FACTS:

- From centauries in plant and animal breeding human has used techniques of mating genetically close organisms, creating varieties that had favourable traits from the breeder point of view, as a result of selection.
- Genetic engineering start to radically experiment through combining genetic information of very different organisms:

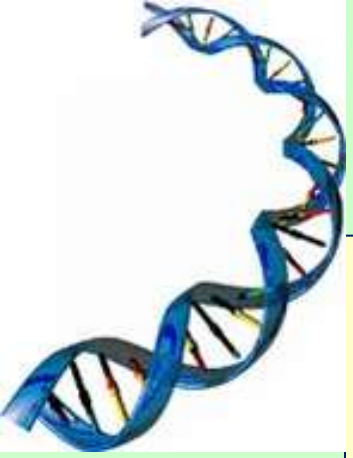
Source: Sznelewski 2009

Plants ⟺ Animals
Plants ⟺ Bacteria

Genetic engineering vs breeding
FACTS:

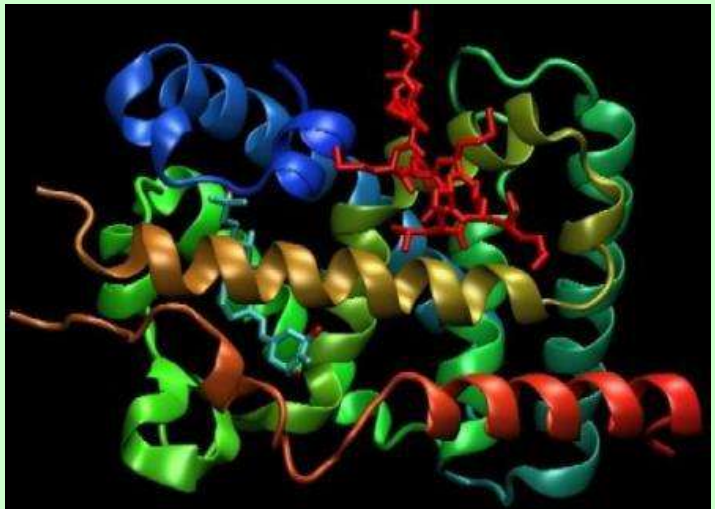
It is wrong to claim that the cultivation of GM crops is a natural extension of breeding and they do not pose any threats to traditional crop varieties

- **GM is something totally different than natural breeding and entails risks**
- **GM often leads to the formation of difficult to predict variability in populations of genetically modified plants**
- **Natural methods of breeding may take place only within the same species or two very closely related species**



Genetic engineering vs breeding
FACTS:

The current knowledge on genetic engineering allows scientists to manipulate on genetic material and alter plants, animals and micro-organisms to create varieties that would never occur in the natural environment.



Technology of obtaining genetically modified plants is imprecise method

Because it is based on incorrect assumptions, like:

- Gene (that is DNA fragment coding protein) produce always one specific protein that has precisely determined properties and is responsible for one defined trait
- Gene is not influenced by the environment
- Gene always remains the same and is stable
- In GMO gene always remains in the place of inserting (that is in DNA in chromosome)
- Product of inserted gene do not interact with molecules in the cell
- It is unimportant in which place of chromosome (DNA) the transgene is inserted
- Transgene always have an effect only on the target organism.

Source: Chorąży 2007

Technology of obtaining genetically modified plants is imprecise method

Scientific facts are different:

- **Theory showing relation: one gene –> one protein (enzyme) –> one function, was definitively invalidated.**

  At the same time the idea of simple, casual relation between gene and final trait was rejected.
- **Currently it is known that information contained in one gene is responsible for production many different proteins.**
- **Molecules of many proteins show the ability to fulfil many functions depending on environment in which they occur, interacting with other molecules of living cells and ions.**

Source: Chorąży 2005

Risks of the genetic manipulations

- During genetic manipulation process there is the possibility of **removing some parts of DNA and shifted it**.
- The characteristic feature of the DNA in GM organisms is its variability.
- **Occurrence of this kind of variability may result in unpredictable and unexpected effects**, because:

  most genes do not encode only one protein

  → *(for example one of the genes of fruit fly may even produce 38,000 of the different proteins)*

Source: Sznelewski 2009

Who's afraid of GMOs?

- **Consumers**
- **Natural scientists**
- **Sectors of organic, traditional and regional production**
- **Politicians and economists**

Why do some countries prohibit / introduce moratorium on the cultivation of GMOs

- Consumers do not want GMO food
- Problems with sales of GM food
- The high cost of pollution control of GMOs in agriculture and food production
- Protection of family farms
- Preventing unemployment in rural areas

We need to remember:

Knowledge about the state of environment and changes that take place in it, allow to protect it in the effective way.

There is a lot of ways that allow to eliminate and reduce environmental toxins.

Elements and chemical compounds inserted to the environment stay in it in the same quantities and due to natural detoxification and human activity they are inactivate and removed.

Source: Żarski 2009

We need to remember:

GMO is a living organism that may mutate, reproduce and cross with other living organism and may migrate in the environment.

Introducing transgenic organisms to the environment or the part of their genetic material may cause irreversible effects and unpredictable changes in the natural environment.

Source: Żarski 2009

We need to remember:

GENES THAT ARE ONES INTRODUCED TO THE ENVIRONMENT CAN'T BE REMOVED

- **in case of chemical contamination there is possibility of removing them from the environment**
- **in case of GMO - there are organisms that are able to reproduce, evolve, compete and adapt**

Source: Tomiałojć 2007

Time-lag of GMO effects

- The effects of the introduction of new substances into the environment often become apparent with many years of delay

- The negative effects of asbestos, DDT (dichloro-diphenyl trichloroethane), PCBs (Polychlorinated Biphenyls), CFCs (Chlorofluorocarbons), pesticides, or greenhouse gases revealed after several years / decades

- Some scientists believe that the side effects of GMOs will be known at least **in 1-3 generations**

Źródło: Tomiałojć 2007

The arguments of GMO supporters

- GM cultivations will solve the problem of world hunger
- GM plants give higher and better crops
- Food producer profit will increase, while food prices fall
- Resistance to pests and weeds => reduction of pesticide use => health benefits for people and natural environment
- GM cultivations will reduce degradation of ecosystems
- Food coming from genetically modified crops is safe for health

Problem of World Hunger?

- Contrary to the opinion of most companies that produce and sell GM food, this technology is not the remedy for farming difficulties and world hunger.
- According to Jacques Diouf, director of the FAO (Food and Agriculture Organization of the United Nations) **world hunger is not the result of lack of food, but its inequitable distribution.**
- **The same claimed Amartya Cumar Sen - an Indian economist and philosopher, who was awarded the Nobel Memorial Prize in Economic Sciences in 1998 for diagnosis of world hunger reasons.**

Problem of World Hunger?

- The main cause of hunger and undernourishment in Third Countries are industrial monocultures, which were created during ‘Green Revolution’. They contributed to the biodiversity and soil fertility loss, resulting in permanent decrease in mineral and microelement content in food.

- **GM crops are industrial monocultures**, even more dangerous, that increase this trend, **causing arable land degradation and impoverishing local farmers**.

Source: Science in Society 37, Ho MW. 2008

Problem of World Hunger?

- Hunger appear in the places, where there is lack of means to buy food or land and resources to cultivate it.
- Genetically modified cultivation additionally worsen this situation, because technically advanced solution are expensive, and increase social inequality and deepen problem with access to the land.
- The aim of the food policy should be providing that the control on food production will stay in farmers and local community hands, not in large and powerful corporation, which aspire to take over successive parts of food production chain.

Statement made to the United Nations by delegates from 24 African states backed by 30 development, farmer and environmental organizations

"(We object) strongly that the image of the poor and hungry from our countries is being used by giant multinational corporations to push a technology that is neither safe, environmentally friendly, nor economically beneficial to us. We do not believe that such companies or gene technologies will help our farmers to produce the food that is needed in the 21st century. On the contrary, ***we think it will destroy the diversity, the local knowledge and the sustainable agricultural systems that our farmers have developed for millennia and that it will thus undermine our capacity to feed ourselves****."*

Source: http://archive.greenpeace.org

Patent Policy

- Patent law in USA allows to patent genomes, genes, DNA sequences that have regulating functions, but also DNA segments which function and significance is unknown.

- Also isolation and amplification methods and application of those preparations in biotechnological business are patented.

- **GM plants are patented and belong to large companies producing seeds and pest control agents. It places farmers as potential planters of GM plants and food producers as subjects depended from patent owners.**

Source: Chorąży 2007

GM plants do not give better and higher crops

- Traditionally cultivated plants was adapting to the local climate for thousands years . **GM plant varieties are the same everywhere.**
- Very often GM plants are less resistant to the local climate, require more water supplies and more chemicals than the locally grown cultivars.
- Often is observed the occurrence of plant diseases that attack only GM plants.

Genetic modifications do not protect from pests and weeds

- With time pests and weeds become resistant to toxic proteins in the GM plants.
- Creation of genetically modified plant varieties resistant to chemical pesticides caused appearance of superweeds resistant to spraying.

→ *Some superweeds are more than 3 meters high, grow fast, and one plant is able to create 200,000 wind-pollinated seeds. Even two times higher dose of pesticides in the 3-fold higher concentration is not able to eliminate them.*

- Some plants are capable to intraspecies pollination, for example canola may pollinate other wild brassicas.

The problem of "superweeds" resistant to herbicides

in the US superweeds the problem occurs on 5 million hectares and continues to grow (overall acreage of cultivated area in USA is 180 million hectares)

The stalk of a mature Palmer amaranth weed can reach six inches in diameter, and can damage mechanical cotton pickers.

- In 2008 in the county of Macon, Georgia (USA), 70-80% of the crop was infested by Palmer amaranth (*Amaranthus Palmerii*) resistant to Roundup

by Charles Benbrook, 2009

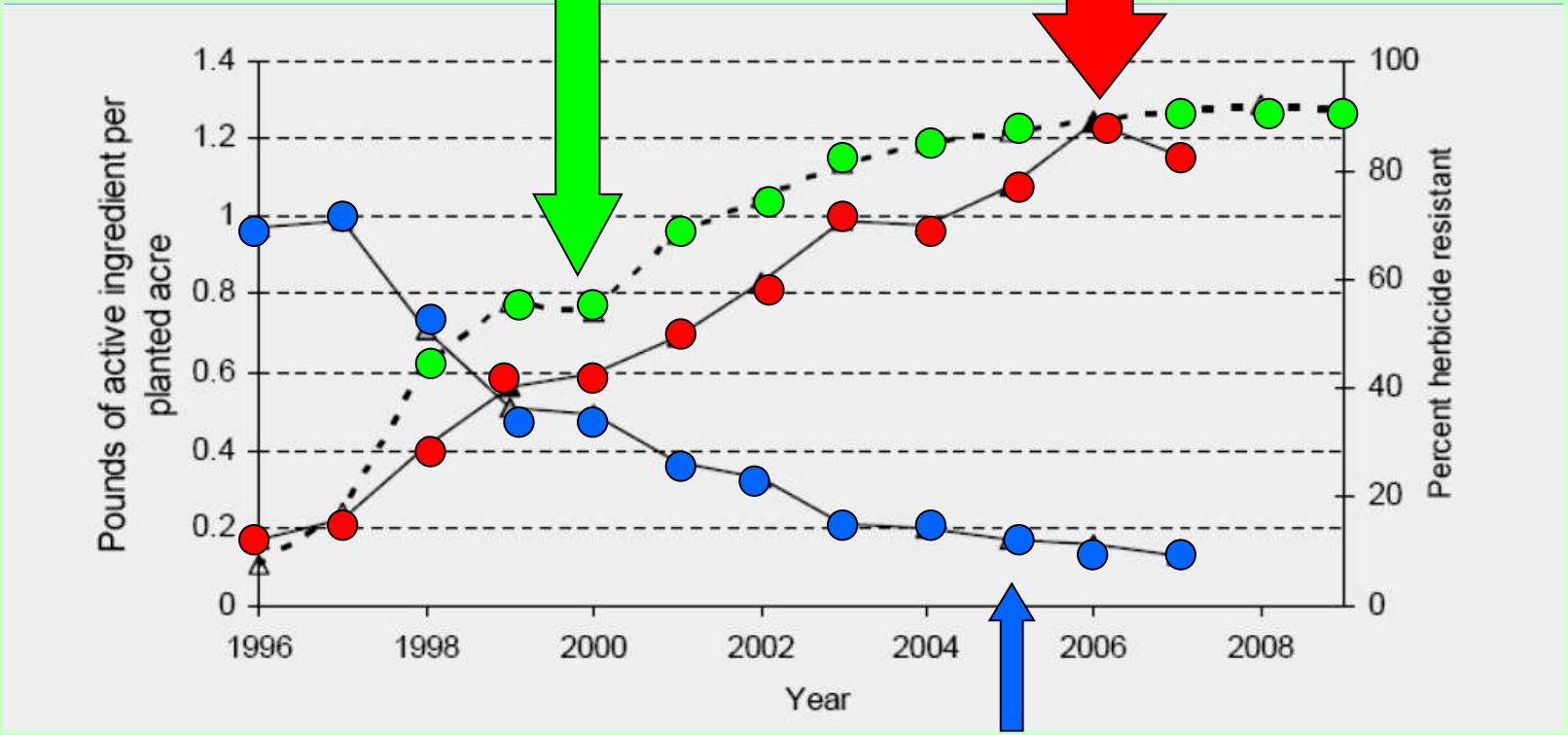
- 4 thousand hectares of crops have been for this reason abandoned by their owners
- Farmers are returning there to the old, highly toxic herbicides or remove weeds by hand.

Manual removal of weeds resistant to Roundup

More GM crops = more Roundup = more glyphosate resistant weeds

GMO SOJA

ROUNDUP



OTHER HERBICIDES


VERY DENGEROUS ARE
THREATS TO NATURAL AND
AGRICULTURAL ENVIRONMENT
AND WILDLIFE

Negative effects of GMO

- Biodiversity loss , that will result in inferior state of ecosystems, lower resistance to epidemics and climate change.

- Cross-pollination of crops and plants growing in the wild causing genetic contamination of environment.

- At first lower and than in most cases higher use of pesticides and herbicides to control plants and insects that become resistant to them.

- Instability of the GMO genome results in assimilation resistance for antibiotics by the intestinal and soil bacteria, which may be transfer to those organisms. It may have very negative influence on bees and the whole ecosystem, causing massive disappearing of insects.

Source: Świecicki 2008

Threats to biodiversity means:

- **Threats to high structural diversity of agricultural landscape**, as the refugium for disappearing in Western Europe animal and plant species
- **Threats to genetic purity of wild species**, especially related with GMO forms
- **Threats to existing of old farm cultivars**, as the genetic resources

Source: Tomiałojć 2007

GMO and organic farming

- **In organic farming GMOs are not allowed.**
- According to recent Council regulation (EC) No 834/2007 on organic production and labelling of organic products **only products containing traces of GMO below threshold of 0.9% can be considered as GMO free.**
- Close neighbourhood with GM crops means direct threat for organic farmers.
- In the USA and Canada many organic farmers bankrupted due to contamination by transgenic crops (e.g. Percy Schmeiser - he is the winner of a Nobel Prize for informing farmers on GMO threats).
- **And what about Europe?????**

Coexistence of GM crops and traditional and organic crops is not possible

- According to European scientist panel (*Independent Science Panel, 2002*), **'separable coexistence of GM and non-GM crops would be very difficult or impossible'.**

- Ecologists know that even oceans do not fully isolate the continents. Sand from Sahara Desert reach Europe and Indian coast.

- Pollen, spores or seeds are spread by wind, rain, water, bees and other pollinating insects. Insects may cover the distance of few thousands kilometres, while birds even a dozen thousands kilometres.

Source: Tomiałojć 2007, Więcławski 2007

Coexistence of GM crops and traditional and organic crops is not possible

- **Research on GM plants conducted to the order of biotechnological concerns are performed in short time and in stable weather conditions - therefore not show the negative effects….**
- **They do not take into account crucial for long-distance dispersion of organisms occurrences like gales, whirlwinds or floods, that may move seeds or even whole organisms (frogs, fish) on hundreds kilometres.**
- **They do not take into consideration fluctuations and climate change creating new conditions to reproduction (by climate warming, disappearance of frosts, different soil chemistry, changes in rainfalls, floods).**

Source: Tomiałojć 2007

GM plants that tolerate herbicides – how it happens (e.g. canola resistant to Roundup)

- **Transferring traits of GM plants on non-GM plants of the same species or related species - causes hybridization.**
- **Hybridization occurs when non-GM plants become cross-pollinated by pollen spread by wind or insects.**

- **This process eliminate natural varieties of plants adopted to their natural land, soil and climate conditions…**

  and violate farmers' right to cultivate conventional and organic crops.

Source: Chorąży 2007

GM plants that tolerate herbicides – how it happens (e.g. canola resistant to Roundup)

- **There were several cases of the pollination of herbicide-resistance trait on related weeds.**
- It creates new problems for agriculture **– new varieties of weeds (superweeds) are created, which are resistant to the herbicides that GM crops were engineered to tolerate**

Examples:

- GM soybean resistant to Roundup contaminate other cereal crops acting like aggressive weed.
- It was observed that oat-grass created tolerance on Roundup herbicide.
- GM grasses used on golf courses may pollen and modify other grasses, even on distance areas.

Source: Chorąży 2007

GM insect-resistant maize varieties

- **There is a threat that GM insect-resistant (Bt) maize could be grown in Europe on a large scale as companies are submitting new GM Bt maize varieties to the EU approval process.**
- Cultivation of GM Bt maize will **harm European wildlife and threatens conventional and organic farming**.
- **Contamination of non-GM crops is already happening from the small acreage of GM Bt maize that is grown in Europe: coexistence with non-GM crops is impossible**.

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.

GM insect-resistant maize varieties

- **MON810, Bt11 and 1507 maize varieties** have been genetically modified through the insertion of a gene from the Bacillus thuringiensis (Bt) soil bacterium, **to produce a pesticide, the Bt protein or toxin – tocsic to insects**.

➢ **MON810** has already been approved for cultivation in the EU but is subject to national bans and, in 2008, only grown on less than 0.2% of EU land used for cereal production, mainly in **Spain** and, to a lesser extent, the **Czech Republic**, **Germany**, **Slovakia**, **Portugal**, **Romania** and **Poland.**

➢ **Bt11** and **1507** are currently in the final stages of the EU authorization process.

The environmental effects of growing Bt maize in Europe include:

- Toxic effects on non-target organisms such as butterflies
- Toxic effects on beneficial insects (e.g. ladybirds)
- Possible long term harm to soil ecosystems
- Persistence in aquatic ecosystems
- Increased pest resistance to Bt
- Bt maize: swapping one pest for another

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.

Toxic effects on non-target organisms such as butterflies – research examples:

- Current Bt maize crops have been genetically modified to be toxic to certain species of moths and butterflies (*Lepidoptera*), e.g. the European corn borer (*Ostrinia nubilalis*), which are pests of maize. However, larvae of non-target moths and butterflies, e.g. the European peacock butterfly (*Inachis io*) may inadvertently ingest the Bt toxin whilst feeding on plants growing near Bt maize field.

- Long-term exposure to Bt pollen from two Bt (*containing protein Cry1Ab*) maize types (MON810 and Bt11) caused reduced survival of monarch butterfly larvae to adulthood *(Dively et al. 2004).*

- Many species of butterflies in Europe are already facing multiple threats, such as climate change and loss of habitat *(Thomas et al. 2004)*. Additional stress from exposure to Bt pollen could further threaten certain species of butterflies and moths.

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.

Toxic effects on beneficial insects – research examples:

- GM Bt maize **could adversely affect beneficial insects that are important in the natural control of maize pests**, for example those that eat the maize pests (*Harwood et al 2005*).
- **Many experiments indicated that the use of GM crops may result in negative effects on the natural enemies of crop pests** (*Lovei and Arpaia 2005*).
- There are also concerns that Bt (Cry1Ab) maize **may affect the learning performance of honey bees** (*Ramirez-Romero et al 2008*).
- **Average abundance of non-target invertebrates were lower in fields of Bt (Cry1Ab) maize**, compared to fields were no pesticides were sprayed (*Marvier et al 2008*).

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.

Possible long term harm to soil ecosystems – research examples:

- The Bt toxin exuded by GM Bt (Cry1Ab) maize has been shown to persist in the soil whilst remaining biologically active *(Baumgarte and Tebbe 2005)*.
- GM Bt maize decomposes less in soil than non-Bt maize and this may be related to their higher lignin content *(Flores et al. 2005).*
- Growing Bt crops **may be problematic for long-term soil health**, as Bt crops contain proteins that are known to be toxic to certain insects, and are suspected of being toxic to a range of non-target organisms such as earthworms and nematodes *(Zwahlen et al 2003).*

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.

Persistence in aquatic ecosystems – research examples:

- The Bt toxin from maize can enter streams **where it might be toxic to aquatic (insect) life**, possibly resulting in ecosystem level effects. In the United States, agricultural waste from Bt maize has been shown to enter streams.
- Initial ecotoxicity tests on the standard test organisms for water quality, the water flea (*Daphnia magna*), showed a **significantly reduced fitness performance when fed with MON810, indicating a toxic effect**.
- The Cry1Ab gene is persistent in aquatic environments and has been found in the tissues of fresh water mussels in areas where Bt (Cry1Ab) maize is cultivated, accumulated via microorganisms ingested by the mussels.

Source: Rosi-Marshall et al. 2007, Bohn et al. 2008, Douville et al. 2007, 2009

Increased pest resistance to Bt – research examples:

- There are overwhelming scientific data to support concerns of **insect pest resistance** *(Andow 2001).*
- **If widespread resistance were to occur, the insect-resistant properties of GM crops would become ineffective. The application of new and even more toxic chemical pesticides would be inevitable.**
- There is evidence that insect resistance is now appearing for cotton pests in the US. However, this resistance is reported not to have caused crop failures because farmers are still using insecticides to control the target pest *(Tabashnik 2008).*

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.

Bt maize: swapping one pest for another?

- **Several studies have shown that other pest insects are taking the place left by the absence of the insect pests that Bt crops target.**

Examples:

- For Bt (Cry1Ac) cotton, after a few years of cultivation, farmers in China and elsewhere have to spray more pesticides for **secondary pests** – those not controlled by the Bt toxin.

- Bt cotton was first introduced and promoted to farmers as a crop that would reduce the use of pesticides. However, it was soon evident that some insects, which were not an important pest before the introduction of Bt cotton, were becoming a problem. **As a consequence, the level of pesticide spraying for these pests has increased several fold** *(Men et al. 2005, Deguine et al. 2008, Wang et al. 2008).*

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.

Coexistence is impossible – examples:

- There are many studies confirming long distance pollination from GM maize up to 1 000 m away. “
- In all of the EU reports published on gene flow and coexistence *(e.g. EEA, 2002; IPTS/JRC, 2002, IPTS/JRC/ESTO, 2006)* maize has been shown to be amongst the most difficult GM crops to contain (alongside oilseed rape), due to the **high cross pollination rate and the large distances that viable maize pollen can travel**.
- GM maize is described as presenting a “medium to high risk” for cross-pollination with other crops.

Source: Jarosz et al. 2005, Halsey et al. 2005

Coexistence is impossible

- **Releases of GM organisms are irreversible**.
  In particular, **GM maize is uncontrollable because of the high cross-pollination rate and the large distances that maize pollen travels**.
- Therefore, in Europe and elsewhere, **co-existence of conventional and organic maize with GM maize is impossible**.
- Hence, **the cultivation of GM maize will erode farmer's choice to say no to GM crops and consumer choice to avoid GM food**.

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.

Coexistence is impossible

- **In the EU there is still lack of binding regulations as regards to genetically modified crops and coexistence between three forms of farming – traditional and organic and farming that use transgenic plants.**
- **There are only partial regulations in the form of European Commission's recommendations (**Regulation (EC) No 1829/2003 on genetically modified food and feed)**.**
- **There is no liability legislation that would award compensation for farmers whose crops are contaminated and therefore devalued by GM maize in Europe.**

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.

Contamination by GMOs

- **There is still no global monitoring system for GM contamination.**

- **Contamination incidents from field trials occur on a regular basis, yet there is neither systematic official testing nor publicly available information to enable the presence of such crops to be detected in the food chain.**

Contamination by GMOs

The GM Contamination Register was started by **GeneWatch UK** and **Greenpeace International** in **2005**, in an attempt to address the failure of international agencies to monitor contamination.

It contains records of:

- **contamination incidents** – when food, feed or a related wild species have been found to contain unintended GM material from a GM crop or other organism
- **illegal plantings or releases of GM organisms (GMOs)** - when unauthorised planting or other release into the environment or food chain has taken place
- **negative agricultural side-effects** – when there has been a report in the scientific literature of agricultural problems arising from the GMO and how it is managed.

Source: www.gmcontaminationregister.org

GMO’s IMPACT ON HEALTH

GMO's influence on human life and health

There are serious evidences that GMO food may have negative influence on human health and contribute to the development of some diseases and disorders like:

- ✓ **obesity**
- ✓ **allergy**
- ✓ **weaker immune system functioning**
- ✓ **bacterial infections resistant to antibiotics**
- ✓ **development disorders in children and teenagers**
- ✓ **preneoplastic stage**

Source: Sznelewski 2009

GMO's influence on human life and health

- Many scientists working for **U.S. Food and Drug Administration** (**FDA**) are of the opinion that GM food might be dangerous.
- It may trigger allergy and dietary diseases.
- There is the possibility of unexpected and random changes in the GM plants, which may be the cause of very high concentrations of plant toxins.
- Such crops accumulate more toxic substances than natural crops, including pesticides and heavy metals.

Source: *http://nasionaklamstwa.info/rozne_o_GMO.htm*

GM food may cause toxic reactions in the digestive tract

- In female rats fed on FlavrSavr tomatoes, serious stomach lesions were found.

- In one of the tests mice were fed on the potatoes with the bacteria gene responsible for producing natural insecticide – Bt toxin from *Bacillus thuringensis bacterium*. After checking lower parts of the digestive tract of mice (ileum), damaged and unnaturally changed cells were found, as well as unusual growth of number of intestine cells were observed.

Source: *http://nasionaklamstwa.info/rozne_o_GMO.htm*

GM food may damage liver

- In rats fed on Mon 863 maize (producing Bt toxin) liver damages were found and other traces of toxin activity.
- In rabbits fed on GM soya, lesions in liver enzymes production were found and quickened metabolism was observed.
- Livers of rats fed on Roundup Ready canola were by 12% to 16% heavier than usually, probably as a result of inflammation or disorder.
- Examination of mice's livers that were fed on Roundup Ready soya showed changes in gene expression (encoding of proteins) and changes in activity and structure of the whole organ.
- Many of those lesions disappeared after turning to organic feed (genetically non-modified).

Source: *http://nasionaklamstwa.info/rozne_o_GMO.htm*

Higher mortality and percentage of organ lenses

- Pancreas cells of mice fed on Roundup Ready soya produced considerably less digestive enzymes.
- In rats fed on genetically engineered potatoes, pancreas were unnaturally bigger.
- In kidneys of animals fed on GM feed various lenses were found, as well as poisoning and inflammation symptoms and changes in enzyme production.
- GM potatoes caused slower development of cerebral tissue in rats.

Source: *http://nasionaklamstwa.info/rozne_o_GMO.htm*

Infertility and death in farm animals

- More than twenty farmers informed that thousands of their pigs had infertility problems after change of feed to some Bt maize varieties. Animals safer from infertility and false pregnancy.
- Infertility was also observed in bullocks and cows.
- According to farmers report Bt maize caused death in cows, horses, buffalos and chickens.

Source: *http://nasionaklamstwa.info/rozne_o_GMO.htm*

Research by Dr Arpad Pusztai

- Dr Arpad Pusztai with his team started his research in 1995 in the Rowett Institute in Aberdeen on testing model of GM foods to check its safety for consumers.

- Dr Pusztai's team created potatoes producing toxin repelling insects – **Lectin** (it was harmless to people and other mammals, what had been confirmed experimentally).

Source: Sznelewski 2009

Research by Dr Arpad Pusztai

- Nutritional value of GM potatoes was considerably lower than in natural potatoes cultivated in the same conditions **(GM potatoes contained 20% less protein than natural potatoes).**
- Nutritional composition of next generations of potatoes was variable.

Source: Sznelewski 2009

Research by Dr Arpad Pusztai

- In rats fed on GM potatoes producing **lectin**, damages of immune system were observed.
- The activity of leukocytes was reduced – rats were more prone to diseases and infections.
- Thymus and liver damages were noted.
- **Pathological changes appeared after 10 days from the first feeding.**

Source: Sznelewski 2009

Research by Dr Arpad Pusztai

- In some young rats symptoms of underdevelopment of central nervous system, liver and testicles were observed.
- In others hypertrophy of pancreas and intestine walls as well as liver atrophy appeared.
- Changes in intestine and stomach walls implied possibility of malignant tumour development in those organs.
- **Negative effects occurred only in rats fed on GM potatoes and did not appeared in rats fed on natural potatoes with natural lectin additive.**

Source: Sznelewski 2009

Research by Dr Arpad Pusztai

- Studies by Dr Pusztai were strongly attacked by GMO lobby on a large scale. Scientist and its study were discredit on many ways.

- At the turn of 1998/1999 23 scientists from 13 countries set up independent commission, which assessed Dr Pusztai's studies as solid.

- After many obstacles Dr Arpad Pusztai published and comment on results of his research in the article: *„Effect on diets containing modified potatoes expressing Galanthus nivalis lectin on rat small intestine"* The LANCET, Vol.354, October 16, 1999

Source: Sznelewski 2009

Research by I. Yermakowa

Research by Russian scientist **I. Yermakowa** showed **evidently negative influence of the diet consisting from GM soya meal on rat's growth, number of litters, vitality and lifespan of young rats:**

- In group fed on GM soya, **51.6%** of the offspring died during 3 weeks, whereas in group fed on natural soya only **10%**, while in control group that had not been fed on soya only **8.1%**

- Average size and body weight of offspring that was fed on GM soya were much above the standard

- In the preliminary studies it was found that the offspring fed on GM soya is infertile.

Source: Sznelewski 2009

Allergic reactions in people – examples:

- CryO protein in maize seeds as a result of inserting the cryO gene (coming from Arctic fish genome) cause allergic reactions in people.

- Gene from bean encoding alpha-amylase inhibitor is protein that is tolerated by animal organisms. However transferring it to pea genome (in order to stop alpha-amylase of pea pests and kill them) gives the protein that is strong allergen for mice.

Source: Sznelewski 2009

Allergic reactions in people – examples:

- Soon after putting GM soya on the market in Great Britain, number of cases of allergy to soya increased by 50%.
- According to the study published in ***Allergy and Asthma Proceeding no.3/2005*** scientist managed to identify GM soya protein that cause allergy and do not occur in the natural soya.
- By the end of 2005 in Australia 10-year long project with genetically engineered pea was stopped after finding that the pea cause immune reactions in mice.
- Hundreds of agricultural employees in India, who worked on Bt cotton plantations, had moderate and serious allergic reactions.

Source: Sznelewski 2009

Allergic reactions in people – examples:

- The only published studies on the impact of genetically modified food on people confirmed that the part of the gene inserted to GM soya may transfer to the DNA of bacteria in the human alimentary canal.

- It means that even years after stopping consumption of GM soya, people may be exposed to the potentially allergenic effect of this protein, because it will be produced in their intestine.

Source: *http://nasionaklamstwa.info/rozne_o_GMO.htm*

Seralini et al. 2014 research
Foods from RR plants - health risks

- Results of long term research of Seralini and colleagues on the toxicity of GMOs and Roundup published in 2012 in the **Food and Chemical Toxicology**, and (after the retracting from the FCT after discussions that went round the scientists and biotech institutions) republished in 2014 in **Environmental Sciences Europe**
- The study was the first and only investigation of the long-term effects of variety of GM maize (called NK603), grown with and without the pesticide Roundup, which the maize is engineered to tolerate during cultivation.
- Roundup was also tested alone in drinking water. Doses of Roundup started within the range of levels permitted by regulatory authorities in drinking water and as residues in GM feed.

Seralini et al. 2014 research
Foods from RR plants - health risks

- The effect of GM maize alone was tested on three groups of rats. Each group had a different proportion of GM in their feed, starting at 11%, then 22%, and finally 33% of the total diet.
- The effect of GM, which had been sprayed with Roundup in the field at the same proportions of 11%, 22% and 33% of their total diet, was tested on three groups.

- The main findings of the study were **severe multiple organ damage in rats fed the GM maize and low levels of Roundup, both separately and in combination**.

Seralini et al. 2014 research
Foods from RR plants - health risks

Séralini *et al. Environmental Sciences Europe* 2014, **26**:14
http://www.enveurope.com/content/26/1/14

Environmental Sciences Europe
a SpringerOpen Journal

RESEARCH Open Access

Republished study: long-term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize

Gilles-Eric Séralini[1*], Emilie Clair[1], Robin Mesnage[1], Steeve Gress[1], Nicolas Defarge[1], Manuela Malatesta[2], Didier Hennequin[3] and Joël Spiroux de Vendômois[1]

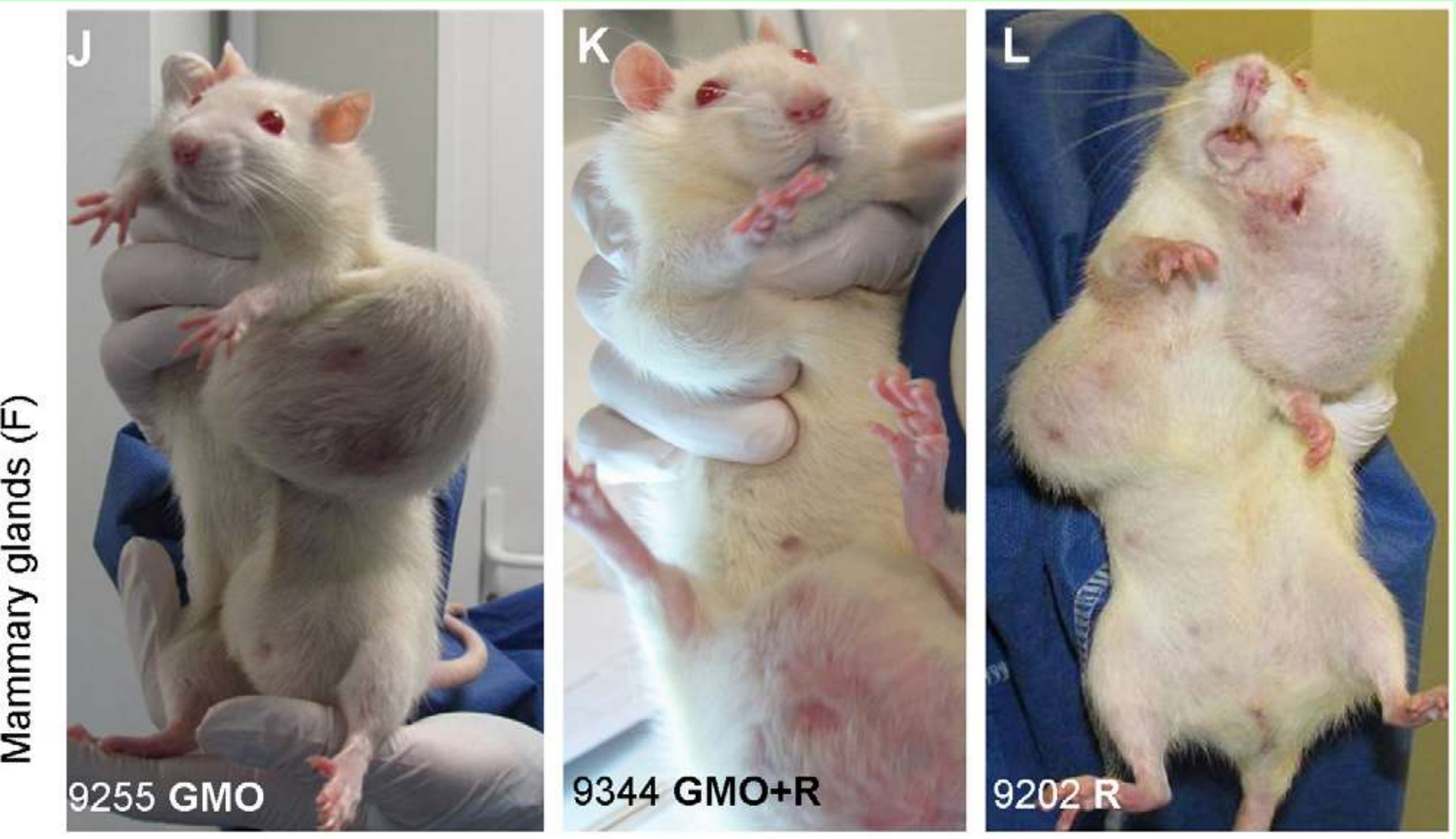
Abstract

Background: The health effects of a Roundup-tolerant NK603 genetically modified (GM) maize (from 11% in the diet), cultivated with or without Roundup application and Roundup alone (from 0.1 ppb of the full pesticide containing glyphosate and adjuvants) in drinking water, were evaluated for 2 years in rats. This study constitutes a

The observed effects of GM food were dependent on gender and hormonal status of the animals

- **In female rats fed GMO experienced more cases of tumors in the mammary gland and tumors have developed earlier than in the control group.**
- **The second organ where most frequently pathology were observed was the pituitary gland.**
- **In rats fed with GMO, and the rats being tested Roundup in drinking water, there abnormal secretion of hormones.**

Seralini 2014 – tumors in female rats



Does Seralini research successful?

- In 2013, EFSA (European Food Safety Authority) officially confirmed that there is a need for long-term research on food (food and feed)
- 90-day study in rats may not appear harmful effects arising in the the long time

http://www.efsa.europa.eu/en/efsajournal/pub/3347.htm

MAJOR GM CROPS

Soybean

- **79%** (79 million hectares) of total global soybean planted is GM
- Countries growing GM soybean: Argentina, Brazil, Canada, Chile, Mexico, Paraguay, and South Africa.

Maize

- **32%** (59,4 million hectares) of total global maize planted is GM
- Countries growing GM maize: Argentina, Canada, Chile, Czech Republic, France, Germany, Honduras, Philippines, Poland, Portugal, Romania, Slovakia, South Africa, Spain, Uruguay, and the USA.

Source: The annual report on the worldwide commercial use of genetically modified plants by the agro-biotechnology agency ISAAA ('International Service for the Acquisition of Agri-Biotech Applications')

MAJOR GM CROPS

Cotton

- **70%** (23.9 million hectares) of total global cotton planted is GM
- Countries growing GM cotton: Argentina, Australia, Brazil, China, Colombia, Mexico, South Africa, and the USA.

Canola

- **24%** (8.2 million hectares) of total global canola planted is GM
- Countries growing GM canola: Canada, Chile, and the USA.

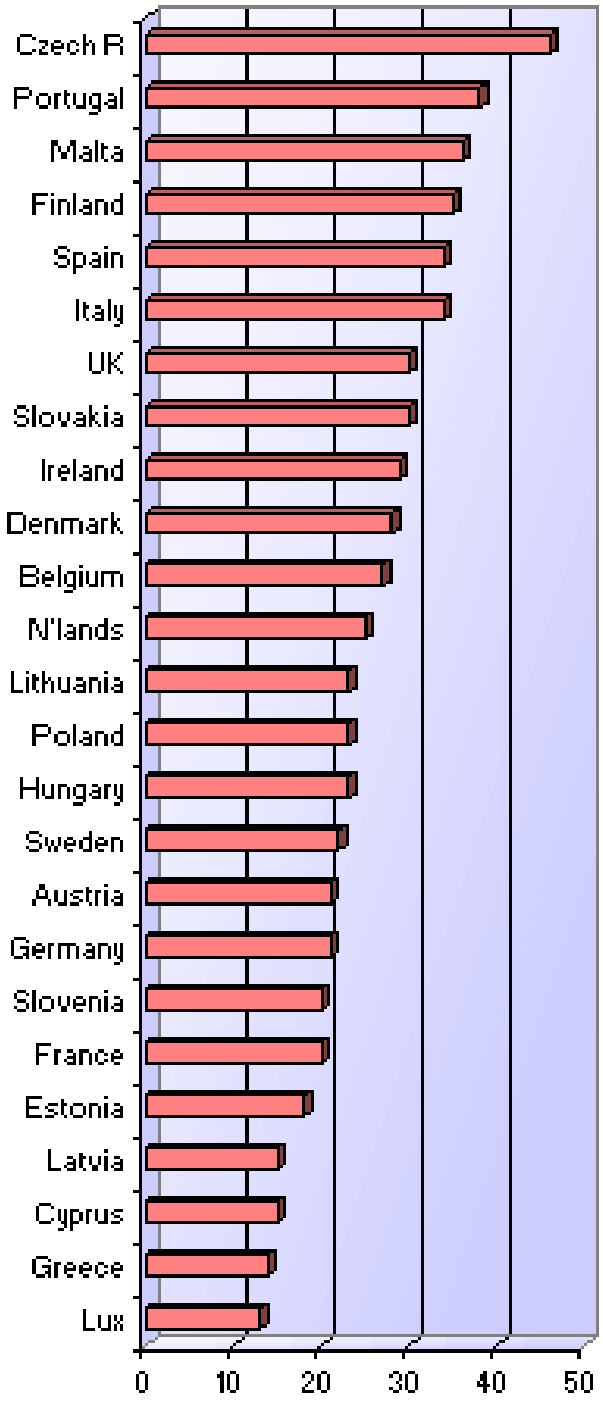
Source: The annual report on the worldwide commercial use of genetically modified plants by the agro-biotechnology agency ISAAA ('International Service for the Acquisition of Agri-Biotech Applications')

PUBLIC OPINION on GMO

PUBLIC OPINION on GMO

- Acceptance of biotechnology among Europeans is on the rise. According to the latest *Eurobarometer survey*, **slightly more than half of European citizens** are confident that applications of biotechnology will improve their quality of life – particularly when biotech is used for medicine and bio-based industrial applications.
- **Regarding GM foods most Europeans remain sceptical**. Unconvinced of the technology's benefits, most respondents expressed moral objections and concerns about potential risks.

Source: www.gmo-compass.org



SUPPORT FOR GM FOODS
(percent); EU Member States

The EU-wide average is **27%**.

Only **27%** of survey participants believe that the technology behind GM foods should be encouraged.

The public is clearly concerned about potential risks to human health and the environment.

based on the responses of 25,000 citizens – approximately 1,000 individuals from each of the 25 EU Member States

Source: *www.gmo-compass.org*

Do we always know what we eat?

European rules of food labelling have the gap…

meat, milk, eggs and other products from animals fed on GMO feed might not be marked.

How to recognize GMO product?

Inscription on the label of the GMO product contains phrase "genetically modified".

CONCLUSIONS

- Decision-makers at all levels in the EU and national governments need to put a halt the expansion of risky GM crops in the EU.
- **The future of agriculture lies in ecological farming that creates jobs, stimulates rural development, and promotes biodiversity by protecting soil, water and the climate.**
- **Ecological systems ensure healthy farming and healthy food today and in the future, and do not contaminate the environment with chemical inputs or genetic engineering**.

Source: Cotter J. 2009, GM insect-resistant (Bt) maize in Europe: a growing threat to wildlife and agriculture, Greenpeace Research Laboratories, Technical Note.


THANK YOU FOR YOUR ATTENTION!