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THE IMPACT OF GENETICALLY MODIFIED ORGANISMS SPREADING TO AGRICULTURAL ECONOMY

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Abstract

The paper represents a review of vegetal production obtained using GMOs technology targeted to animal feeding or human consumption. It consists of the definition of term, why are GMOs produced and which food contains GMOs. Harvesting, testing, authorizing and GMOs risk assessment are described in case of Romania and EU countries as well. The benefits and debates related to GMOs are shown in details using examples. The work also presents health concerns related to GMOs usage.

Key words: *GMOs, risk assessment, improved cultivation, human consumption, health concerns.*

INTRODUCTION

Genetically modified organisms (GMOs) are organisms in which the genetic material (DNA) has been modified, in a way that does not occur through the natural mechanisms ("technologies", "gene technology", "technology of recombinant DNA," "genetically engineered"). Individual genes allows selected are transferred from one organism to another within the species or a species.
It follows the creation of genetically modified plants whose seeds are then used to drill (GM crops).

WHY GMOs ARE PRODUCED?

GMOs produces and sells to benefit producers and consumers of food derived from GMOs. Advantages means: lower prices, greater benefits for sustainability and / or nutritional value.
The initial objective was to protect crops by creating resistance against plant diseases and pests (insects and viruses), or by creating a better tolerant to herbicides used in agriculture:
- **Insect resistance** was obtained by incorporating into the plant used as raw material for food, a gene that induces the resistance production of a toxin gene taken from a microorganism (Bacillus thuringiensis - BT). This toxin is used as an insecticide long conventional agriculture, it is non-toxic for human consumption. GM crops that permanently produce this toxin have been shown to need much smaller quantities of insecticides used for specific situations, when large populations of pest pressure is high.
- **Resistance against viruses** is achieved by introducing genes from certain viruses that cause plant diseases. Increased resistance against viruses make plants less vulnerable to diseases caused by them, thus increasing productivity.
- **Tolerance to herbicides** through the introduction of a gene is obtained from a bacterium which express resistance to certain herbicides. In situations in which the imperative use of herbicides, herbicide requisite amounts were much lower.

GMO FOOD PRODUCTS

- Bread and pastry - Bread, Biscuits, Snacks
- flour from soy
- Oil from soybeans, cotton and canola GM
- cornmeal and corn from GM maize
- Sweets - chocolate, sweets and ice cream
- Lecithin from soy
- Glucose or glucose syrup from GM maize

- Sugar from GM sugar beets
- Ingredients and additives maize GM
- Soy milk

The production of meat and meat products - soy successfully used as an additive and substitute.

CULTIVATION

The evolution of cultivated areas worldwide:

In 2014 global biotech crop surface continued to grow for the 19th consecutive year of trading; 18 million farmers in 28 countries planted more than 181 million hectares in 2014, up from 175 million in 27 countries in 2013.

Notably, Bangladesh, a small poor country approved Bt brinjal/eggplant for the first time on 30 October 2013, and in record time less than 100 days after approval small farmers commercialized Bt brinjal on 22 January 2014.

Innate™ potato, another food crop, was approved in the US in November 2014. It has lower levels of acrylamide, a potential carcinogen in humans, and suffers less wastage from bruising; potato is the fourth most important food staple in the world.

A safer product and decreased wastage in a vegetative propagated and perishable crop, can contribute to higher productivity and food security. Also in November 2014, a new biotech alfalfa (event KK179) with up to 22% less lignin, which leads to higher digestibility and productivity, was approved for planting in the US.

The first biotech drought tolerant maize, planted in the US in 2013 on 50.000 hectares increased over 5 fold to 275.000 hectares in 2014 reflecting high acceptance by US farmers.

Importantly, a new 2014 comprehensive global meta-analysis, on 147 published biotech crop studies over the last 20 years worldwide confirmed the significant and multiple benefits that biotech crops have generated over the past 20 years, 1995 to 2014; on average GM technology adoption has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%.

These findings corroborate earlier and consistent results from other annual global studies which estimated increases in crop productivity valued at US$133.3 billion for the period 1996-2013 (James, 2015)

Table 1. Surfaces cultivated with GM crops

Rank	Country	Area (million hectares)	Biotech Crops
1	USA*	73.1	Maize, soybean, cotton, canola, sugarbeet, alfalfa, papaya, squash
2	Brazil*	42.2	Soybean, maize, cotton
3	Argentina*	24.3	Soybean, maize, cotton
4	India*	11.6	Cotton
5	Canada*	11.6	Canola, maize, soybean, sugar beet
6	China*	3.9	Cotton, papaya, poplar, tomato, sweet pepper
7	Paraguay*	3.9	Soybean, maize, cotton
8	Pakistan*	2.9	Cotton
9	South Africa *	2.7	Maize, soybean, cotton
10	Uruguay*	1.6	Soybean, maize
11	Bolivia*	1.0	Soybean
12	Philippines*	0.8	Maize
13	Australia*	0.5	Cotton, canola
14	Burkina Faso*	0.5	Cotton
15	Myanmar*	0.3	Cotton
16	Mexico*	0.2	Cotton, soybean
17	Spain *	0.1	Maize
18	Colombia*	0.1	Cotton, maize
19	Sudan*	0.1	Cotton
20	Honduras	<0.05	Maize
21	Chile	<0.05	Maize, soybean, canola
22	Portugal	<0.05	Maize
23	Cuba	<0.05	Maize
24	Czech Republic	<0.05	Maize
25	Romania	<0.05	Maize
26	Slovakia	<0.05	Maize
27	Costa Rica	<0.05	Cotton, soybean
28	Bangladesh	<0.05	Brinjal/Eggplant
	Total	**181.5**	

* 19 biotech mega-countries growing 50,000 hectares, or more, of biotech crops

** rounded off to the nearest hundred thousand (Source: James, 2015).

TESTING

In the EU the field testing it is not allowed without the consent testing of a competent authority of the Member State concerned. Since 2002, all applications for authorization must be notified to the European Commission.

The purpose of the field test is examining insect resistance, herbicide tolerance, modified composition, resistance to viruses.

Testing in the EU (1992 - 2012): 2589 events

- 85 species tested
- Most tests in descending order were made on: corn, rapeseed, potato, tomato, cotton, soybeans.

Testing in Romania

Electronic registry managed by the National Environmental Protection Agency contains:

- operator data;
- no. authorization; validity; no. European;
- information on the event tested (species identification code, characteristics);
- the purpose of the release into the environment; authorized area, the distance protection;
- import Agreement; results

So far have been tested in field several transformation events for soybeans, corn and plum genetically modified to assess tolerance to herbicides glyphosate and resistance to attack by lepidopteran insect pests and environmental effects or resistance to plum pox virus if plum.

REGULATORY, CONTROL AND LICENSING

Marketing of food and feed containing, consisting of or produced from GMOs is regulated by EU Regulations no. 1829/2003 / EC and 1830/2003/EC. Regulation no. 1829/2003 / EC establishes European procedure for authorizing GM food and feed, proceeding directly involving the 27 Member States, the European Food Safety Authority (EFSA), the European Commission and Council. Regulation 1830/2003 / EC lays down the principles of traceability and labeling to be respected by food business operators when using a GMO activity. The legal framework for the implementation of these regulations into national Romanian law was adopted in March 2006 Government Decision no. 256/2006 on genetically modified food and feed and the Government Decision no. 173/2006 on traceability and labeling of GMOs and the traceability of food and feed produced from GMOs.

Regarding the deliberate release into the environment for testing EU legislation is Directive 2001/18 / EC of the European Parliament and of the Council on the deliberate release into the environment of genetically modified organisms.

At European Union level, in the authorization process, it has a special role to the European Food Safety Authority (EFSA) - the independent scientific institution with primary role in the risk assessment of food on human health, animal health and environmental protection across the European Union. EFSA's scientific opinions and policy are the basis for European legislation on food safety - a GMO is not subject to Community authorization procedure if you do not enjoy a favorable scientific opinion of the EFSA. According to a basic principle of food safety introduced by the European Parliament and Council Regulation no. 178/2002 / EC on the safety of food and feed, confidence in food should be linked to confidence in science, which is the foundation that led to the establishment of EFSA.

In the European Union (April 2016) are authorized for use as food and feed a number of 55 transformation events as follows:

- 28 types of genetically modified maize
- 12 types of genetically modified soybean
- 10 kinds of genetically modified cotton
- 4 types of genetically modified oilseed rape
- One type of genetically modified sugar beet

National level

The establishments subjected to supervision and official control at the level of 2014 were deposits of soy, corn and canola plants, feed factories, soybean oil factories, corn germ oil or rapeseed processing units soy, corn and canola, to obtain food other than those for the production of oil, soybean trading units / maize to products which contain or are constituted derived from soy / maize. Also, the desk review for compliance with European legislation has been conducted for other products that may contain genetically modified organisms authorized or rapeseed, cotton, sugar beets, etc., products authorized at European level and in the Register Community Genetically modified food and feed. In accordance with Commission

Decision 289/2008 on emergency measures relating to genetically modified organism "Bt63" in rice products was paid special attention to the types of controls on imports rice from China. There were imports of products subject to that decision, all of which are subject to control and sampling. Following checks analytical in the Laboratory of Molecular Biology and GM of the Institute for Diagnosis and Animal Health (National Reference Laboratory for Food and Feed GMO), there were no positive results that highlight the presence of unauthorized GMO Bt63 in rice and rice products.

Results of official controls

Following the official control for traceability and labeling of genetically modified food and feed, Program supervision and control food safety for 2014 were achieved controls and sampling, as follows in Tables 2 and 3.

Table 2. Control activities for soy

Establishment type	No. Carried out controls	No. Taken samples
Storage house	115	42
Fodder	130	13
Soya oil establishment	6	0
Other food processing	225	89
Trading	402	111
TOTAL	**878**	**255**

Table 3. Control activities for maize

Establishment type	No. Carried out controls	No. Taken samples
Storage house	156	75
Fodder	148	68
Establishment of corn germ oil	0	0
Other food processing	78	37
Trading	281	112
TOTAL	**663**	**292**

Actions taken to ensure the effectiveness of control activities

The National Reference Laboratory for Genetically Modified Food and Feed continued modernization and optimization procedures and working methods was developed discernible annual counties for sending samples to the national network of GMO laboratories of molecular biology. Also it involved in a number of official control laboratories 8 DSVSA for the detection of genetically modified soya and 2 for detection of genetically modified maize.

RISK ASSESSMENT OF FOOD FROM OMG GMOs AND HUMAN HEALTH

GMOs risk assessment at EU level is a complex process involving most institutions with scientific role in biotechnology and is coordinated by EFSA.

By evaluating the safety of foods derived from GMOs are envisaged:

(A) direct health effects (toxicity)

(B) tendencies to provoke allergic reaction;

(C) specific components thought to have nutritional or toxic properties;

(D) the stability of the inserted gene;

(E) nutritional effects associated with genetic modification;

(F) any unintended effects which could result from the gene. Thus although Romania's involvement in the GMO risk assessment at the European level is limited, there is scientific bodies holding this role - the Scientific Council and the Commission of Biosafety ANSVSA Ministry of Environment who provided scientific advice and opinions to GMOs.

HEALTH CONCERNS RELATED TO GMOs USAGE

- **Allergic reaction**: there was no evidence of allergic effects related to GM food sold so far.

- **The transfer of genes from GM foods into the human body** or to bacteria found in the human gut: if possible, and if so, the genetic material transferred can affect people's health? This issue is particularly important for the genes which induce resistance to chemicals, in this case, antibiotic, if the transfer of genes as possible. Although the likelihood of this transfer is very small, experts -FAO Fund Food and Agriculture Organization and WHO experts recommend not using the processes of gene transfer of antibiotic resistance to new GMOs.

- **Natural transfer of mixing cultures and seeds from natural crops**, with the gene transfer would affect food safety. This risk is real and has been shown when traces of rice approved to be used only for feed, was found in rice products for human consumption, obtained from genetically modified crops that had not

been voluntary in the US. They have adopted national strategies to reduce mixing, separating clearly the perimeters of crops (GMOs and conventional crops).
Now put in place worldwide for details: monitoring after the marketing of GMOs and GM food new, continuous monitoring of food safety derived from GMOs.

OMGs-BENEFITS AND CONTROVERSY
BENEFITS
Crops
- Improvement of taste and quality;
- Reducing of vegetal growing;
- The growth of nutrient elements, of harvest and stress tolerance;
- Improve resistance to diseases, pests and herbicides;
- New products and growing techniques.

Animals
- Increased resistance, productivity and efficiency of feed conversion
- Improve efficiency in terms of meat, milk or eggs
- Improving diagnostic methods

Environment
- Bioherbicides and bioinsectycides friendly to environment
- Soil, water and energy preserving
- A better management of natural wastes
- Efficient processing

Social
- Increasing food security for growing populations

CONTROVERSY
Safety
- Potential impact on human health - allergens, transfer of antibiotic resistance genes, unknown effects
- Potential environmental impact: unintended transfer of genes through cross-pollination, unknown effects on other organisms, affecting biodiversity

Intellectual property
- The dominance of few companies on global food production
- Increased Independence developing countries of the industrialized

Ethics
- Damage to natural organisms values
- Interference with nature by "mixing" of genes between species
- Objections regarding the consumption of animal genes in plants and vice versa

Labeling
- It is not mandatory in some states

CONCLUSIONS

GMOs can represent an alternative to conventional food & feed in the context of permanent growing of world population and the rapid developments in genetic engineering with appliance in agriculture and medicine.
We can underline here that the US and EU feed industry (98% of GMO imports are used for feed) rely more and more on GMOs, fact that leads to a certain dependency on GMOs in this industry.
Although the food & feed safety concerns are more and more scientifically assessed and no real evidence of harmful effects is found, the issues of preserving the environment and biodiversity is an important aspect that comes along with the debate on the coexistence possibility.

Annex*

INFORMATION ON THE MARKET genetically modified products

1. SOYBEAN

Soybean is one of the agricultural crops of greatest importance for human nutrition and animal nutrition industry. Soybean seeds contain 30% protein and 17-25% oil substances. By processing the soybeans are obtained:
- Soybean meal, used in food industry (milk, cheese, chips, coffee, chocolate, pasta, biscuits, meat substitute etc.)
- Soybean oil (used in the manufacture of margarine, soap, lecithins, etc.
- Soy grits (resulting from oil processing) used in animal feed

Professional organizations on product chain
- Industry Employers' Association of vegetable oils and fats (Ulprod)
- National Union of Agricultural Producers in Romania (Unpar)
- Farmers Association of Romania (AFR)
- National Association of Manufacturers Employers fodder - (Nutricomb)
- Employers' Federation of Food Industry (Romalimenta)

In Romania about 11.000 operators are involved in this industry including both units of sale to the consumer of soy and soy products, and processing technology.
According to ANSVSA statistics and specific activities, processors are using soy:
- Obtaining oil which may have the domestic or export destination;

- Combined feed factories that use soy as a feedstock for the production of animal feed. Thus processed soybean meal as animal feed can be used in livestock farms or households own;
- Soybean processing plants for the production of foodstuffs, other than for oil production (meat processing plants that use soy products mills, sugar confectionery, biscuits, etc.).

Soybeans through properties and texture can be a substitute for meat and meat processors use this product in the process.

The products of soy food chain to reach the following consumer storage networks, distribution and sales in certain forms:

- Soybean oil;
- Soya granules, schnitzel or cubes for household use;
- Soy incorporated into meat products.

To those listed above, soy may be present in chocolate (soy lecithin), ice cream, biscuits etc.

Medical uses:

Some research suggests that if consumed regularly, soy lowers cholesterol, relieves hot flashes, prevent prostate and breast cancer, helps in weight loss and prevents osteoporosis. These effects may be due to a characteristic of soybeans, namely increased isoflavone concentration, a type of estrogen produced by the plant. This research led food manufacturers to develop various types of soy market that is growing.

2. MAIZE

Corn (*Zea mays* L.) is one of the most important crops with multiple uses in human food industry, feed. (According to FAO statistics, distribution, consumption is 21% human food, animal feed 72%, 7% industry). Corn is used in the starch industry, the spirits, glucose and dextrin; the seeds are used for extracting oil, used in foods diet; Corn is used in animal feed as fodder concentrate (grain), corn, green grass (silage), stems (stalks) mixed with urea and molasses and silage (fodder juicy).

Professional organizations on product chain

- Farmers Association of Romania (AFR)
- National Association of Milling and Baking Romania (Anamob)
- Romanian Employers Milling Industry, Bakery and Flour Products (Rompan)
- League of Associations of Agricultural Producers in Romania (Lapar)
- National Union of Agricultural Producers in Romania (Unpar)
- National Association of Manufacturers Employers fodder - (Nutricomb)
- Employers' Federation of Food Industry (Romalimenta)

In Romania around 1000 operators are involved in this industry, consumer marketing units excluding maize and maize products.

3. COTTON

The main uses of cotton refers to the textile industry, but the seeds of *Gossypium*, the source of the cotton-containing oil, vitamins, minerals, salt and food protein, and the pressing are used in the manufacture of cooking oil, soap, margarine, cosmetics, bitumen and production of wax and can be used as animal feed. Cotton is also widely used in medicine, for example refined oil seed *Gossypium* can be used during breastfeeding as a preventive method for arteriosclerosis.

4. RAPE

The main uses of rape refer to the manufacture of biodiesel, a fuel that is used instead of diesel cars, which is cheaper and less polluting. Also it produced by processing rapeseed cakes with high forage value containing 38-42% protein, carbohydrates and minerals. Rapeseed oil is widely used in industry and nutrition. It can also be used in medicine in the treatment of digestive or dermatological disorder.

5. SUGAR BEET

Worldwide, it is the second source beet sugar after sugar cane indispensable product for human nutrition due to high energy value (4000 cal/kg meat and bread to 1500, respectively 2200 cal/kg). Beets provide about 40-45% of world production of sugar.

REFERENCES

Badea E., Otiman I., 2011. Plante transgenice – Obţinere, testare, cultivare. Editura Academiei Romane, Editura Mirton.

James C., 2015. Global status of traded transgenic crops. International Service for the Acquisition of Agri-biotech Applications.

GM Crops, 2011. Global socio-economic and environmental impacts, G. Brookers & P. Barfoot.

Rusu L., Rădulescu S., Pătru Nina, 2011. Siguranţa Alimentelor – Legislaţie. Editura Spiru Haret.

DG-RESEARCH, 2012. A decade of EU financed research on GMOs (2001 - 2010), European Commission.

World Health Organisation, 2009. Foods derived from modern biotechnology. Second edition.

www.anpm.ro

www.ansvsa.ro