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CHANCES, PERSPECTIVES AND DANGERS OF GMO IN AGRICULTURE

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A B S T R A C T

The future of agriculture is clearly connected with the production of food, feed, biomaterials, bioenergy, rare components like biopharmaceuticals and enzymes. A very important aspect is the "unknown", which means the production of goods which we are not familiar with today. This brings up the subject of GMOs. The obvious questions are: do we need GMOs and what kind of GMOs are necessary – GM plants, GM microorganisms, or GM animals? We have to recognize the different ways of using GMOs: direct consumption (food), indirect consumption (feed), raw materials (energy, biomaterials), and valuable components (like enzymes). The effects of GMOs are very different; the most visible one is the effect on the economy. There are also social, legal, environmental, international as well as religious, and mental effects that are very important. These "effects" are closely related to potential "dangers", both real (documented and reproducible) and imaginative (invented and not documented). To sum up, I would like to state the following: There is no way to avoid genetic engineering, and bioeconomy is the key to the future. However, we all have the right and privilege of free choice.

Key words: GMO, agriculture, food GM, feed GM, bioeconomy

INTRODUCTION

We should recognize different functions of modern agriculture. Definitely, in the past the basic role of agriculture was limited to the production of food and the most important goal was described through the

simple message: produce more and produce it cheaper. In today's world, the situation is more complicated. For the rich people of the Northern hemisphere (mostly OECD countries), the price of food is not a critical factor; the quality is very important. In contrast, in the Southern part of the world, quantity and price are the most important factors and they are interconnected. The future of agriculture is clearly connected with production, not only and exclusively of food and feed, but also biomaterials, bioenergy, rare components like biopharmaceuticals and enzymes. We have also recognized a very important aspect: that which is "unknown" for the present time. This means the production of goods and services which we do not recognize in the present.

1. The necessity of GMO in agriculture

The obvious questions are: do we need GMOs, and what kind of GMOs are necessary: GM plants, GM microorganisms, or GM animals? The answers are different, depending who gives the answers. In the case of the rich society of the European Union, we will learn that we do not need GMOs in any form. However, there are some exceptions concerning what we need, for example: production of biopharmaceuticals, monoclonals for diagnosis and for some more specific, high-value products, GMOs are most welcome. In the case of the countries of the Southern hemisphere, "golden rice", for example, is not only life-saving, but also a vision for thousands of children. Another example is in Brazil, which is now producing bioethanol from GM sugar cane.

In short, the answer is: we do not need any innovation if we want to continue the life standard of our grandparents. If the most important thing is quality of life, then we have to take the risk and accept the innovative technological solutions offered to us, in any form, for our every day needs, including food, medicine, energy and materials.

2. Application of GMOs

We have to recognize different ways of using GMOs: direct consumption (food), indirect consumption (feed), raw materials (energy, biomaterials), and valuable components (like enzymes) used for food production. The very important facts are:

- Corn, soybean, rape, cotton – make up 98% (out of 140 mln ha in 2009) of all genetically modified plants produced commercially for: 1/feed, 2/industry, and 3/food. The production profits for farmers are in the range of: 0% to 20%.
- In the case of these four plant species (over 98% of GMO plants cultivated) only two traits were modified: 1/herbicide resistance and 2/ insect resistance.
- Only in very few cases were the properties which are important for consumers modified.
- Most of the profit was gained by those with the technology; the owners of the technology, the seed producers and the farmers.

In 2009, 140 mln ha of GM plants were commercially produced around the world in 25 countries, by 14 mln farmers. However, in the EU only a little over 100 000 ha (in Spain, Germany, Czech Republic, Slovakia and Poland) were planted with GM corn.

The first GM plant accepted in the EU was Corn MON 810. Genetically modified maize **MON 810** is a variety developed by the Monsanto Company, USA. It contains a gene from the bacteria *Bacillus thuringiensis* that expresses a toxin (Bt toxin) poisonous to some pest insects. It was approved for use in the European Union in 1998. In March 2010, the second GM plant: AMFLORA potato was accepted by the European Commission for production in the EU. The registration period was 12 years long. The company BASF succeeded in developing this GM plant by suppressing the genes for the production of amylose; the EH92-527-1 potatoes produce over 98% of amylopectin.

In light of this information, the following questions are important: Will Europeans consume GM products, produced in other countries, not only and exclusively in USA and Canada, but mostly in China, India, South Africa, Brazil and Argentina? Does it make any sense (biologically and economically) to expect that the EU or some EU countries will keep their status as a "GMO free region"?

3. Bioeconomy

The effects of GMOs are very different. The most visible is the effect GMOs have on the economy, but social, legal, environmental, international as well as religious and mental effects are also very important. It is necessary to analyze the profits versus potential losses in different categories: the economy, society and environment. It is also necessary to remember what we live for the next generation(s). The road from the scientists' ideas to the commercial product (which means potential profit) is quite long, expensive and difficult. Schematically, it can be described as follows:

Idea → invention → patent → license → production →commercialization

In the case of a single product, the calculation of potential profit and cost of introducing it onto the market for a unique and innovative product is determined by the decision of the manager. He or she will take into account the patentability of the invention and the capacity of the market, competitive products, and level of interest of potential customers, including the public opinion and legislative system; time is also a critical factor in this calculation.

One of the critical questions is very simple: who should make the decision? This question is critical in the case of a single product as well as in the case of legislation concerning the entire sector of the market. What should be the conditions for the decision? In the case of Poland (as in the case of Greece, Austria and Hungary), the politicians clearly declared: the voice of the people and the opinions of the majority of the

citizens is critical in the decision making process. However, the common opinion is contrary to the scientifically based expertise of the EFSA (European Food Safety Authority, EU), FDA (Food and Drug Administration, US), and EMEA (European Medical Agency, EU).

4. "Dangers"

There are common opinions of many "green" experts saying that the GMO is more dangerous than any form of terrorism. The most important argumentation in support of potential risk are the following statements:

- lack of data concerning 100% safety;
- unknown future effect(s);
- short period of consumption and presence of GMO in the open environment (15 years).

The objections presented above pose a dilemma, as there is no way to prove them and no way to answer them. Not a single scientist would say, "this is 100% sure" or "this is 100% safe", and so on. Even ordinary potatoes need a quite complicated "biotechnological" procedure in order to be consumed (30 min dialysis in boiling water!). It is true that we do not know what will be the effect of innovative technologies (like genetic engineering, telecommunication, informatics, etc.) in the future. However, during the past 15 years (commercial production of GM plants started in 1996), well over 500 mln ha have been planted with GM plants by millions of farmers and the products were consumed by billions of animals and people. We do not have any tragic stories – nothing happened. It is accepted that all activities are charged with some uncertainty. There is a lot of information and reports in tabloids and from time to time in scientific literature, with data concerning the potential risk connected with genetically engineering products. The common factor for these reports is a lack of reproducibility.

However, we have to take into account several serious questions, and in many cases we do not have solid, scientific answers. It is a question of the acceptable risk vs. potential profit calculations. The exemplification of such questions is the following:

- 1. NTO = *non-target organisms*;

We have to take into account the possibility of interactions between GMO and several organisms, not only and exclusively accordingly to our expectations and plans. The analysis, the experiments *in silico*, *in vitro*, *in vivo* and in the open environment have to be performed correctly.

- 2. FT = *field trials*;

Field trial experiments are necessary to check the behaviour of a new plant in new climatic or soil conditions. That is no way to extrapolate the laboratory experiments to the open environment.

- 3. RE, EU GR = *receiving environments,* EU *geographical regions*;

We need experimental data from field trials performed in local condi-

tions. Definitely, observations done in South America are not compatible with those done in Poland, in which case a field experiment should be done again.

- 4. LT = *long term effects*;

This case is very similar to the formulation presented earlier about the short period of consumption and presence of GMOs in the open environment. We need to think about the multigenerational effects concerning human beings. Those effects are positive, in many similar cases of innovative technology (the cellular phone, microwave, computer, colour TV, etc.). No data are available concerning the influence on the next generation.

Public opinion about GMOs is a key factor for industrial development, particularly in Poland. Surveys of public awareness have been systematically conducted in Poland, five times since 1998. Poland is the only country in Central Europe where such surveys were done regularly. The investigations were done similarly as in Eurobarometer (face-to-face) on representative groups of over 1000 people above 15 years of age. The following aspects were examined: general knowledge, acceptance, social expectations, reaction to genetically modified food, environmental protection, role of legislation, and trust. In all the recent surveys, the majority of Poles were against modern biotechnology. There are two important social groups in favour of GMO: nature scientists and producers (farmers). But we have to take into account that these two groups are very small in number. For example, in Poland we do have almost 10 mln farmers, but only a small percentage of them (5%) are market-oriented. In summary, the opinion of Polish society can be presented as follows:

- Over 70% of Poles are against GMO,
- over 90% of experts are in favour of GMO,
- 80% of traders are against GMO,
- 70% of producers are pro GMO,
- Politicians reflect the voters – the majority are against GMO.

Balanced, fair information and advanced public debate are needed to formulate the future of biotech in the EU. The perspective results from the combined contributions of scientists, industrialists, and governmental and public interest organisations across Europe. The most important opinions of the expert's are presented by the EFSA (European Food Safety Authority), EMEA (European Medical Agency), and in the US by FDA (Food and Drug Administration). During the period of 1997 – 2002, the European Commission sponsored 81 projects (with total budget over 500 mln Euros) in order to determine the safety of GM food and GM feed. The overall conclusion was very simple: GM food and GM feed are the same quality as "standard food and feed". The determined fundamental data concerning DNA and peptides in GM food and feed are as follows:

- All DNAs and peptides (including rDNA and peptides as the products

of expression of rDNA) are composed of the same 4 nucleotides and 20 amino acids, respectively;
- Recombinant DNA technologies neither change the chemical properties of DNA or peptides;
- DNA and rDNA are hydrolysed according to the same kinetics;
- DNA and rDNA are not toxic (at standard consumption levels);
- DNA and rDNA are neither allergenic nor immunogenic according to available data;
- DNA and rDNA are not incorporated into a genome of vegetables during the consumption;
- Consumption of GM food or feed does not change the total amount of consumed DNA or proteins.

Religions, philosophy and bioethics are also very important factors for the future of any innovative technology. All three monotheistic religions in general accept genetic engineering as a tool focused on a higher quality of our life. This is very clearly summarised by the following statement: **"...**God gives man a spiritual nature by virtue of which he is responsible for the other creatures. The other creatures have been created for man's good, but in turn man is called to direct creation to the good of humanity and the glory of God..." (Zenit, October 8, 2002; http://www.zenit.org/english/).
Bishop Jesus Y. Varela, of the Diocese of Sorsogon, emphasized the importance of GMOs: "...There is no human activity that does not present risks, and the GMOs are certainly not more risky than the foods we already consume..." Bishop Varela said. He added that from the ethical-moral point of view "...everything that can be done to surmount hunger, to avoid children becoming blind for lack of vitamin A, and to protect the environment, is welcome...".

In contrary to the objections against modern biotechnology originating in Europe , it is possible to observe the very dynamic progress and development of bioindustry in both Americas, and Asia.

5. Conclusions and perspectives

We all have the right and privilege of free choice. The duty of our governments is to guarantee fair, solid, and clear information given in plain language available for all consumers. However, only an educated consumer is able to understand the information printed on the label. Education is one of the imperatives for the future.

In many cases, Europeans do not need cheaper or big quantities of GMO products. For many Europeans it is more fashionable to eat or to use eco-products (usually more expensive). However, as it was described, the GM products are not only and exclusively cheaper, but many GM products are characterized by specific properties (e.g. high level of iron in rice), or are impossible to achieve any other way (biopharmaceuticals).

Bioeconomy is based on reusable biomaterials in order to gain a sustainable economy. I would like to express my opinion that there is no way to avoid genetic engineering in agrobiotechnology, and bioeconomy is the key to the future.

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SZANSE, PERSPEKTYWY I ZAGROŻENIA GMO W ROLNICTWIE

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S T R E S Z C Z E N I E

Przyszłość rolnictwa związana jest nie tylko z produkcją żywności (w tym pasz), ale także biomateriałów, bioenergii i cennych surowców (jak enzymy i biofarmaceutyki). Dla spełnienia tych zadań niezbędne jest wykorzystanie innowacyjnych technologii. Istotnym pytaniem jest, czy GMO jest niezbędne dla rozwoju gospodarki, a w szczególności rolnictwa. Niezależnie od zagadnień ekonomicznych równie ważne są społeczne, środowiskowe, legislacyjne, jak również filozoficzne. Te różnorakie aspekty są ściśle powiązane ze społecznym odbiorem nowoczesnej biotechnologii. W mojej ocenie nie ma możliwości „ucieczki" od inżynierii genetycznej i jej produktów w żadnej sferze naszego życia. Natomiast my wszyscy mamy prawo i przywilej wolnego wyboru.

Słowa kluczowe: GMO, agrobiotechnologia, żywność GM, pasze GM, biogospodarka