

УДК 658.62:339.9

DOI: 10.32342/2074-5354-2020-1-52-10

BOGUSŁAW ŚLUSARCZYK,

Prof. UR, PhD, Stanisław Pigoń State Higher Vocational School in Krosno

MAŁGORZATA GÓRKA,

PhD Eng, Stanisław Pigoń State Higher Vocational School in Krosno

BARBARA KROCHMAL-MARCZAK,

PhD Eng, Stanisław Pigoń State Higher Vocational School in Krosno

ANNA PUKAJŁO,

Institution of Food Safety and Production Economist Students' Research Group
Krosno State College

SOCIO-ECONOMIC CONSEQUENCES OF GMO FOOD

The paper presents issues related to Genetically Modified Organisms, starting from characterization, through various examples of GM plants, and features that can be obtained through genetic engineering. It describes some of the opportunities and risks that may arise following the introduction of GMOs. Genetically modified organisms (GMOs) are undoubtedly an opportunity for the development of mankind, but they may also prove to be a serious threat. Their introduction to the Polish market is related to meeting many requirements aimed at food safety and human health. Although so far no one has provided evidence that genetically modified food has a negative impact on human life, a special regime has been introduced in this respect.

Genetic modifications have many benefits, including in the cultivation of plants and medicine. Thanks to them, cultivation is much easier and more profitable, reduced losses caused by diseases or pests. Cultivation of plants is resistant to a variety of environmental factors (drought, frost, salinity). Genetics also contribute to biodiversity. Lower cultivation costs result in lower food prices. This can be an opportunity to fight hunger and malnutrition in Third World countries.

Unfortunately, although genetic engineering offers completely new perspectives and can solve many problems, the dangers of genetic engineering cannot be forgotten. Above all, these are environmental threats, because the spread of genetic material in nature cannot be controlled, and the effects of this phenomenon are irreversible and, most importantly, they will only become apparent in the future. Another undoubtedly serious threat is the creation of biological weapons, the use of which can have disastrous consequences for the world. Therefore, it is important how genetic technologies are used. To date, no evidence has been presented that genetically modified food is harmless to the human body. The effects of long-term consumption of such food may only be visible after many years, or not at all.

Key words: genetically modified food, GMO, food safety, food.

Проаналізовано проблеми, пов'язані з генетично модифікованими організмами: подано загальну характеристику, наведено приклади генетично модифікованих рослин, які можна отримати за допомогою генної інженерії. Описано можливі наслідки та ризики, які можуть виникнути після споживання ГМО. Генетично модифіковані організми, безсумнівно, є можливістю для розвитку людства, але вони також можуть становити серйозну загрозу. Їх постачання на поль-

ський ринок пов'язане із задоволенням багатьох вимог, спрямованих на безпеку харчових продуктів та здоров'я людей. Хоча досі ніхто не надав доказів того, що генетично модифікована їжа негативно впливає на життя людини, у цьому відношенні було запроваджено спеціальний режим.

Генетичні модифікації мають багато переваг, у тому числі при вирощуванні рослин та в медицині. Завдяки ним вирощування набагато простіше та вигідніше, зменшуються втрати, спричинені хворобами чи шкідниками. Рослини з генетичними модифікаціями стійкі до різноманітних факторів навколишнього середовища (посуха, мороз, засолення). Генетика також сприяє біорізноманіттю. Нижчі витрати на вирощування приводять до зниження цін на продукти. Це може бути шляхом боротьби з голодом та недоїданням у країнах третього світу.

На жаль, хоча генна інженерія пропонує абсолютно нові перспективи і може вирішити багато проблем, про небезпеку генної інженерії не можна забувати. Перш за все, це екологічні загрози, оскільки розповсюдження генетичного матеріалу в природі неможливо контролювати, а наслідки цього явища незворотні і, головне, вони стануть очевидними лише в майбутньому. Ще одна, безсумнівно, серйозна загроза – створення біологічної зброї, використання якої може мати катастрофічні наслідки для світу. Тому важливо, як використовуються генетичні технології. На сьогодні не надано жодних доказів того, що генетично модифікована їжа нешкідлива для людського організму. Ефекти тривалого споживання такої їжі можуть бути помітні лише через багато років або зовсім не будуть помітними.

Ключові слова: генетично модифікована їжа, ГМО, безпека харчових продуктів, харчові продукти.

Issues related to GMOs, more precisely researches, production and the effects of their dissemination are not only relevant and timely, but also forward-looking, as they relate to the later existence of humans and other species. The importance of GMOs can be demonstrated by hopes and concerns about the consequences of consuming or releasing these organisms into the environment. While the benefits of GMO cultivation may encourage the development of genetic engineering, the potential risks give rise to the question of whether it is worth interfering with nature? Undoubtedly, any new technology is a potential threat, and yet it allows for the improvement of the quality of human life and thus helps a man to achieve the next stages of civilizational development.

Opportunities offered by genetically modified food

Economic opportunities

Implementation of new technological methods is usually aimed at achieving high profits, improving conditions and profitability of production. The economic efficiency of technology is possible with the interaction of additional factors, which include: type of product and market situation, production organization, type of technology and raw materials used, tax system and non-taxed

production support methods legally permitted in a given country (Fiedurek 2007).

The most common economic benefits resulting from the introduction of GMO plant varieties into common cultivation are:

- reduction of yield losses and improvement of farm productivity;
- minimization of expenditure related to the use of plant protection products resulting from the reduction of their use;
- reduction of labour costs;
- savings in employment;
- lower consumption of diesel and agricultural machinery;
- higher quality yields.

Positive developments implemented along with the new technology also include improvements in agrotechnical work, e.g. the use of herbicides, in which glyphosate is an active component, for selective control of annual and multiannual weeds. The cultivation of GMO varieties has a positive impact on the introduction of a plough less system, which is more beneficial for the environment. Moreover, this system uses less agricultural machinery and consumes less fuel, which makes it more economical (Fiedurek 2007). One of the most important arguments regarding the beneficial impact of the dissemination of GMOs in agriculture is the reduction of pesticide use. This has a

positive impact on the environment as well as allows farmers to save on the purchase of plant protection products (Szkarlał 2011).

Environmental opportunities

So far, studies on the environmental impact of GM plants have shown that in the future, agriculture that relies entirely or partly on the cultivation of GMOs will have a more favorable environmental impact. To date, no evidence has been presented that the new technology would be harmful to the homeostasis of natural biosensors.

Researchers working on plant genetic modification techniques are convincingly demonstrating their safety for human and animal health as well as for the environment. At the same time, they explain that allowing further research will be an ideal way to dispel all fears and controversies regarding GMOs (Anioł 2008a).

The most common ecological benefits resulting from the introduction of GMO plant varieties into common cultivation are:

- improved pest control, as well as no harm to biodiversity,
- reduction in the use of chemical plant protection products or their replacement by less toxic to the environment and humans,
- less frequent use of agricultural machinery and fuel, which has a positive effect on the reduction of greenhouse gas emissions. Ploughless cultivation, combined with reduced use of pesticides, has a more favorable effect on inhibiting soil erosion (Łagowska 2006a).

Undoubtedly the best advantage of cultivating transgenic varieties is resistance to pests, weeds, fungi and viruses. Transgenic plants with features that make them resistant to chemicals are more willingly cultivated because their cultivation is much easier and less time-consuming. Since these plants do not require frequent and intensive treatments with pesticides, growing them is more beneficial for the environment (Hellmich and Górecka 2007).

When cultivating GMO plants it is possible to introduce a ploughless cultivation system, which is clearly more beneficial for the environment. Traditional cultivation dries the soil too much. It is much more energy intensive and contributes to wind and water erosion (Szkarlał 2011).

Social opportunities

The supporters of green biotechnology and the commercialization of further varieties of GM plants are convinced of the potential of using GMOs to fight hunger and malnutrition in the world. Unfortunately, despite a significant increase in agricultural production, according to estimates of world organizations, the rate of starving and malnourished people is still high. This has its consequences:

- direct, i.e. diseases and dysfunctions of the body, resulting from anaemia caused by lack or shortage of food, which in effect can cause death,
- indirect, which include political, social and economic consequences.

Moreover, opponents of GMO believe that this argument is just another marketing trick used by transnational corporations that want to distribute and sell their product at maximum profit. Nevertheless, the use of GMOs in agriculture is a way to improve global agricultural production. The potential that green biotechnology offers cannot be resisted. Doubts have always accompanied the development of something new, unknown, and the use of GMOs in food production can indeed prove to be an effective way to fight hunger and malnutrition in the world (Boć 2008).

Threats caused by genetically modified food

Economic threats

The most common economic risks that occur when receiving GMO food are: higher costs of seeds and a ban on sowing them in the following season, concentration of the agrotechnology sector, and farmers' dependence on agrotechnology and seed companies (Szkarlał 2011). The additional financial costs of introducing coexistence requirements for GMO products are another economic threat. It is also important to set segregation rules, e.g. designation of buffer zones separating one crop from another, setting standards for transport and storage of food or feed. Coexistence of GMO crops can be considered in two points:

- 1) This is the context of economic legitimacy of this type of conduct;

2) These are problems related to environmental opportunities and threats.

The segregation process of GMO and non-GMO products can also be divided into two stages:

– Measures are applied to limit the effects of gene transfer or contamination by genetic material from GMO crops to conventional crops.

– The second stage begins during harvest and concerns the transport of the product to the collection, storage and processing point (Kowalski 2009).

Environmental threats

The most common environmental threats that arise from the introduction of GMOs into the environment are:

– genetic contaminants caused by genetic material entering other plants;

– invasiveness of genetically modified plants;

– displacement of natural species;

– “superweeds”, i.e. weeds that are created by uncontrolled gene transfer;

– resistance of pests and weeds to insecticides and herbicides through repeated use of products with the same effect;

– spread of viruses (resistant to current control methods) in ecosystems,

– soil erosion treatment;

– risks associated with the introduction of agricultural monocultures.

The cultivation of the same plant species continuously has an adverse impact on the environment as well as is an economic threat. In addition, monocultures support the growth of pest and weed populations and the spread of disease factors (Łagowska 2006b).

Homogeneity of GMO varieties may expose farmers to serious yield losses if some genetic stimulus, affecting all plants, weakens their potential. An example is soybean grown in the United States, which is resistant to glyphosate, but not resistant to high temperatures. If this one variety of soybean is the dominant crop, the consequences of a hot summer can be disastrous, and it will be difficult to compensate for the loss by harvesting another variety. It is not acceptable to dominate agricultural production by

cultivating one species while destroying wilderness, which is invaluable for its natural wealth, and turning it into arable land. It is also punishable to give up traditional crops for a given region of the world in favour of new species (Buchowicz 2006).

Social threats

Social acceptance of technological novelties has never been automatic and just after their implementation and dissemination. There has always been a process in which the recipients of biotechnology first expanded their knowledge and then expressed their appreciation for changes that this technological novelty was supposed to bring. Comparable processes take place in relation to the phenomenon of social acceptance for new technologies, which are used in food production. However, with this discrepancy the final production resulting from the use of GMOs is one of the most important elements determining the perspective of physical survival (Kowalski 2003).

Recently, there have been a lot of technological innovations that aim to improve the food production process, improve its productivity, safety and quality of the final product. Some of them have found application and social acceptance. However, several of them, despite the guarantee of creators and scientists about their safety, have not been released from the phase of laboratory tests to the phase of common use. The reason for this was a lack of consumer confidence, such as radiation, which uses gamma rays to destroy bacteria and microorganisms for food preservation (Machalica 2008).

Opportunities for the GMO and risks arising from its use

Genetically modified organisms (GMOs) are very controversial. On the one hand, they hope to solve many problems: in medicine, agriculture or environmental protection, and on the other hand, there are concerns among the community: Is GMOs safe? Is it a threat to human health? Does its creation threaten the environment? (Pruszyński 2009). The arguments for both supporters and opponents of GMOs were presented in Table 1.

Arguments of GMO supporters and opponents

No.	Arguments in favor	Arguments against
1	Cheaper agricultural production (pesticide reduction)	The GMO is still poorly studied and the effects of its presence in the environment on humans, animals and nature are unknown
2	Better crop yielding (resistance to pests and diseases)	GMOs can cause allergies and diseases in humans
3	Inclusion of previously untillable land (saline, dry, wetland) in agriculture	The so-called coexistence is impossible and organic production will be hindered
4	Less use of chemical plant protection products	Natural biodiversity will be destroyed
5	Production of fortified food (e.g. vitamins and trace elements)	GMO plants can cross with the wild and create "superweeds"
6	The plants will become resistant to environmental conditions (frost, drought, salinity)	A monopoly of seed producers will be created

Source: T. Czubiński, Much noise around GMOs, Top Agrar Polska No. 5, Poznań 2008, p. 106.

Many scientists, including environmentalists, geneticists, food producers and consumers, create many different, often different perspectives on the production and use of GMOs (Sękowski 2008). Through genetic engineering, many global problems such as hunger and malnutrition may be solved in the future. But it also brings many risks that we cannot underestimate. It is, for example, the creation of new biological weapons that can help in the world's destruction. Without a doubt, genetic engineering provides a number of different possibilities, but much depends on how we use it (<http://www.biolog.pl>). Genetic modifications enable the introduction and use in plants of the genes responsible for the appearance of features and characteristics desired by farmers, producers and consumers. Despite the many possibilities for manipulating genetic material, their practical use is very limited. Despite this, plants are improved every day by increasingly new modifications, some of them are only experimental in nature and undergo many expensive and time-consuming tests (Jaworska 2006).

The use of GMOs has many potential benefits and creates new opportunities. However, there is strong opposition from people who believe in the harmful effects of GMOs on the environment and humanity. The

use of GMOs in cleaning up the environment and in the production of medicines and vaccines is most accepted (Spiss 2008).

GMOs are used in the production of new products or in processing operations carried out in industry, medicine and environmental protection. It is used in the production of biomaterials (biodegradable plastic) and biofuels from renewable resources, as well as in bioremediation (Warzecha 2009). The greatest risks resulting from the use of GMOs are the consequences of its release into the environment and the health effects of consuming food produced from GMO. These are likely because it is virtually impossible to control the spread of GMOs once released into the environment. The results of their spread in the environment and the impact on biodiversity are not yet fully known (Dąbrowski 2009a). The use of herbicides for dusting transgenic, herbicide-resistant crops can seriously damage the biodiversity of agricultural ecosystems. In addition, uncontrolled cross-breeding of herbicide-tolerant GMO varieties with other weeds can result in the appearance of "superweeds" (Anioł 2006). Unfortunately, it is impossible for conventional crops to coexist with GMO crops because there is no effective isolation between them. Pollution of organic farming with pollen from transgenic plants disqualifies organic

plantation, which results in serious losses for the farmer. Transgenic plants resistant to pests and containing the gene that determines the synthesis of protein poisonous to insects, can simultaneously harm beneficial insects (bees, goldfish), birds feeding on poisoned insects, soil microorganisms and even humans (Tomiałojć 2007).

Scientific reports claim that human consumption of GMO food can cause allergies and serious gastrointestinal diseases, and even contribute to the formation of cancer. Feed containing GMOs may adversely affect the health and productivity of farm animals. In contrast, yields of GMO plants may be lower than those of conventional varieties because they do not have the genetic stability that weakens or blocks the functions of foreign genes (Dabrowski 2009b).

Finding an outlet for GMO products may also become a problem. Consumer fears, compounded by the media, may result in lower prices for GMO products, which will offset the benefits of higher production and lower costs. This is more true for man-consumed products, while there should be no difficulty in selling for non-food products. This is the case for crops grown for energy, industrial purposes (cotton) and for feed (Seremak 2008).

During the introduction of GM plants to the market, large corporations promised higher yields, lower herbicide consumption and a solution to world hunger. It was also claimed that transgenic plants could be grown in the vicinity of conventional crops. Meanwhile, GMs have not yet fulfilled any of these promises. Herbicide-resistant GM plants require even more spraying during the next sowing to be effective. Many crosses between GM plants and conventional ones occur. The transfer of pollen from GM plants by wind, insects, people to adjacent crops cannot be prevented. The fields of organic and conventional farmers are contaminated, thus farmers cannot earn money from selling GMO-free products. In turn, farmers buying GM seeds are associated with large corporations because the seeds are patented and must be bought every year. The profit from GM crops goes mostly to large

corporations and patented seed producers. Rather than helping to solve the problem of hunger and malnutrition in the world, GMO cultivation further exacerbates it. GMO technology violates the order of nature and causes fatal consequences, such as low yields, soil sterilization and the threat of disease. In addition, land prices in tourist areas will fall. Revenues of tourist and health institutions will also fall significantly, and local governments will have to bear higher costs associated with monitoring and securing food for illegal GM content (Wiackowski 2008).

Conclusions

Genetically modified organisms (GMOs) are undoubtedly an opportunity for the development of mankind, but they may also prove to be a serious threat. Their introduction to the Polish market is related to meeting many requirements aimed at food safety and human health. Although so far no one has provided evidence that genetically modified food has a negative impact on human life, a special regime has been introduced in this respect.

Genetic modifications have many benefits, including in the cultivation of plants and medicine. Thanks to them, cultivation is much easier and more profitable, reduced losses caused by diseases or pests. Cultivation of plants is resistant to a variety of environmental factors (drought, frost, salinity). Genetics also contribute to biodiversity. Lower cultivation costs result in lower food prices. This can be an opportunity to fight hunger and malnutrition in Third World countries.

Unfortunately, although genetic engineering offers completely new perspectives and can solve many problems, the dangers of genetic engineering cannot be forgotten. Above all, these are environmental threats, because the spread of genetic material in nature cannot be controlled, and the effects of this phenomenon are irreversible and, most importantly, they will only become apparent in the future. Another undoubtedly serious threat is the creation of biological weapons, the use of

which can have disastrous consequences for the world. Therefore, it is important how genetic technologies are used. To date, no evidence has been presented that genetically modified food is harmless to the human body. The effects of long-term consumption of such food may only be visible after many years, or not at all.

Bibliography

1. Anioł A. Kontrowersje wokół transgenicznych odmian roślin uprawnych: przezorność czy technofobia? / A. Anioł // *Postępy Nauk Rolniczych*. – Warszawa, 2008a. – № 3. – S. 13.
2. Anioł A. Uprawa roślin odmian konwencjonalnych i transgenicznych (GMO), czy koegzystencja jest możliwa? / A. Anioł // *Wieś Jutra*. – Warszawa, 2008b. – № 1. – S. 34.
3. Boć J. Kontrola postępowania z organizmami zmodyfikowanymi genetycznie / J. Boć, E. Samborska-Boć // *Ochrona środowiska* / pod red. J. Boć, K. Nowicki, E. Samborska-Boć. – Wrocław, 2008. – S. 270.
4. Buchowicz J. Problem organizmów genetycznie zmodyfikowanych (GMO) / J. Buchowicz // *Biotechnologia molekularna* / pod red. J. Buchowicz. – Warszawa: Wydawnictwo Naukowe PWN, 2006. – S. 95.
5. Dąbrowski Z.T. Genetycznie modyfikowane organizmy / Z.T. Dąbrowski // *Wieś Jutra*. – Warszawa, 2008. – № 1. – S. 25.
6. Fiedurek J. Informacje wstępne / J. Fiedurek // *Podstawy Biotechnologii przemysłowej* / pod red. W. Bednarski, J. Fiedurek. – Warszawa: Wydawnictwo Naukowe PWN, 2007. – S. 21–22.
7. Hellmich R.L. Możliwości i wyzwania związane z wprowadzeniem do uprawy odmian zmodyfikowanych genetycznie odpornych na szkodniki / R.L. Hellmich, J. Górecka // *Kosmos*. – Kraków, 2007. – № 3–4. – S. 255.
8. Jaworska M. Badania nad GMO / M. Jaworska // *Aura*. – Warszawa, 2006. – № 2. – S. 7–8.
9. Kowalski A. Ekonomiczne znaczenie roślin modyfikowanych genetycznie / A. Kowalski // *Ekonomiczne i społeczne aspekty biotechnologii w Unii Europejskiej i Polsce* / pod red. S. Zięba. – Warszawa: Wydawnictwo ALMAMER, 2009. – S. 32–61.
10. Łągowska B. Wpływ GMO na rozwój rolnictwa / B. Łągowska // *Bezpieczeństwo biologiczne w Polsce* / pod red. B. Łągowska. – Białystok: Dział Wydawnictw i Poligrafii Politechniki Białostockiej, 2006a. – S. 13.
11. Łągowska B. Zagrożenia wynikające z użytkowania roślin transgenicznych / B. Łągowska // *Bezpieczeństwo biologiczne w Polsce* / pod red. B. Łągowska. – Białystok: Dział Wydawnictw i Poligrafii Politechniki Białostockiej, 2006b. – S. 60–76.
12. Machalica B. Czy GMO to zło? / B. Machalica // *Angora*. – Łódź, 2008. – № 12. – S. 28.
13. Pruszyński S. Modyfikowane genetycznie organizmy żywe – problem realny czy wywołany sztucznie / S. Pruszyński // *Wieś Jutra*. – Warszawa, 2009. – № 1. – S. 28.
14. Seremak-Bulge J. Rośliny genetycznie zmodyfikowane – uwarunkowania ekonomiczne i prawne w Polsce / J. Seremak-Bulge, K. Hryszko // *Wieś Jutra*. – Warszawa, 2008. – № 1. – S. 40.
15. Sękowski M. Genetycznie modyfikowane organizmy w środowisku / M. Sękowski, B. Gworek. – Warszawa: Dział Wydawnictw IOŚ, 2008. – S. 7.
16. Spiss L. Wszystkie odmiany roślin uprawnych są genetycznie modyfikowane / L. Spiss // *Aura*. – Warszawa, 2008. – № 9. – S. 8–10.
17. Stankiewicz P. Społeczne konsekwencje wprowadzenia do uprawy roślin genetycznie modyfikowanych / P. Stankiewicz // *Biuletynie Forum Debaty Publicznej*. – Warszawa, 2012. – № 16. – S. 11–13.

18. Szkarłat M. Żywność genetycznie zmodyfikowana w stosunkach międzynarodowych / M. Szkarłat. – Lublin: Wydawnictwo Uniwersytetu Marii Curie – Skłodowskiej, 2011. – S. 79–176.
19. Warzecha R. Biotechnologia a problemy światowego rolnictwa / R. Warzecha // Wieś Jutra. – Warszawa, 2009. – № 1. – S. 39.
20. Wiąckowski S.K. 2008. Genetycznie modyfikowane organizmy. Obietnice i fakty / S.K. Wiąckowski. – Białystok: Wydawnictwo Ekonomia i Środowisko. – S. 27–33.