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# Opinion Survey of Lublin University Students on Genetically Modified Plants

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**Abstract**

*In recent years genetically modified plants have become a subject of discussion not only among scientists but among consumers and politicians as well. This is a controversial issue, mainly due to the conflicting information appearing in the media concerning the properties of these plants, their impact on human health, and how they function in the natural environment. A survey was conducted to learn the opinions of students of Lublin universities regarding the cultivation and applications of genetically modified crops. The students surveyed claim to be familiar with issues associated with GMOs and express a desire to learn more about the subject, although their main sources of information are the Internet and television. They also perceive the need for the government to conduct a reliable information campaign on this subject. Their opinions on GMO plants are ambivalent; they have concerns about the cultivation and use of GMO plants, but also perceive the benefits that this biotechnology could provide.*

**Keywords:** GMO, plants, opinions on GMO

**JEL:** I25

## Genetically modified plants — properties, advantages and concerns

Transgenic plants, also known as genetically modified plants, are plant organisms whose genetic material has been altered using genetic engineering techniques in order to obtain a desired phenotype, and which are capable of transferring the altered genetic material to daughter cells.[1] Currently cultivated genetically modified crops are first-generation plants, in which agronomic traits have been altered. Genetic modifications of these plants mainly involve resistance to herbicides (e.g., Roundup), insects (plants producing the Bt protein — botulinum toxin) and viruses (introduction of genes of resistance to viruses) (Zimny 2007). Second-generation transgenic plants have altered qualitative traits-nutritional, sensory or processing. Varieties of rapeseed and soybean rich in polyunsaturated fatty acids, which are beneficial for human health, have been obtained (Borek and Galor 2012). Transgenic Golden Rice possesses genes enabling biosynthesis of carotenoids. Its cultivation could reduce vitamin A deficiencies occurring in the populations of developing countries (Potrykus 2012). Other varieties of rice have undergone a transformation increasing their iron content (Bhullar and Gruissem 2013). Research centers in Poland also have significant achievements in genetic engineering of plants, such as obtaining edible vaccines in plants or new genetically modified varieties of cucumber, lettuce, potato, lupine, and trees with high calorific value (Małyska and

1. See: Ustawa z dnia 22 czerwca 2001 r. o organizmach genetycznie zmodyfikowanych. DzU z 2001 r. nr 76 poz. 811.

Twardowski 2015). Intensive work is also being conducted on obtaining third-generation plants, which will accumulate large quantities of chemical substances that are useful in industry.

Genetically modified plants have been cultivated commercially since 1995 (Malepszy 2001). Currently cultivated transgenic plants belong to the first generation. Among the four commonly grown species, soybean accounts for 48,2% of transgenic crops, maize for 32,8%, cotton for 13,6% and rapeseed for 4,7%.[2] In the USA, in addition to these species, genetically modified papaya, tomatoes, courgettes, melons, chicory, rice, alfalfa, and flax are grown. The area of cultivation of transgenic crops is increasing, as well as the number of species. Production of transgenic crops takes place primarily outside of Europe (Niemirowicz-Szczytt 2012). The main producers of transgenic plants is the USA, where over 73 million ha of crops were registered in 2014, followed by Brazil (over 42 million ha), Argentina (over 24 million ha), India and Canada (nearly 12 million ha each), accounting for 85% of the area of transgenic crops (Michalczyk 2016).

Proponents of transgenic crops emphasize their resistance to pests, which ensures higher yield and products of better quality. Genetically modified plants, as compared to conventional crops, are more resistant to unfavorable environmental conditions and to viruses and fungi, and require less intensive fertilization and even shallower ploughing, which results in reduced carbon dioxide emissions. This makes it possible to reduce the amount of chemical substances used and enables more efficient environmental protection (Jurkiewicz 2012). Biotechnology corporations producing genetically modified plants emphasize that they produce greater yields than conventional plant species and offer a chance to increase food production and solve the problem of hunger.

Opponents of GMO crops perceive threats to food safety and the natural environment, particularly for biodiversity of natural species, due to the possibility of displacement by genetically modified species (Florek-Łuszczki and Wdowiak 2009, 175–182). According to Tomiałojć (2011), GM crops are in conflict with the interests of Polish agriculture and the food industry. The environmental conditions and biodiversity prevailing in Poland provide an opportunity for the development of organic agriculture. Conventionally produced Polish food also has greater sensory quality and biological value. Transgenic crops are used mainly for production of animal feed, and to a lesser extent as food for people (Malepszy 2001). Genetically modified food is food containing, consisting of, or produced from GMOs. Regulation (EC) no. 1829/2003 on genetically modified food and feed regulates the conditions for its introduction to the market.3 In Poland, as in the entire European Union, GMO products must be labelled. Currently 25 genetically modified products have marketing authorization in the European Community.

Food produced using genetically modified organisms (GMOs) raises a number of controversies among both the public and experts. Opponents of GMO foods emphasize that the lobbying practices of biotechnology corporations lead to misrepresentations of information about GMOs. Such practices include regulations stating that a product containing less than 0,9% genetically modified protein is not GMO. This results in the import of unlabeled GMA products (e.g., containing less than 0,9% transgenic soy protein) (Cichosz and Wiąckowski 2012). In comparing the composition of GMO and conventional food the principle of "substantial equivalence" is applied. This means that in terms of the content of their main ingredients GMO products should be equivalent to the values characteristic of the original species and are thus equally safe. This principle was formulated by bureaucratic and political bodies and has no scientific basis. In practice the substantial equivalence principle releases biotechnological companies from the obligation to perform toxicological tests (associated with the presence of botulinum toxin in GMO products, the ingredients of Roundup, or acrylamide) and makes it easier to meet the legal provisions necessary to market GMO products (Lisowska and Chorąży 2011).

Numerous authorities emphasize that it cannot be conclusively stated that GMO food does not pose a health threat. The potential risk in consuming GMO food is associated with the presence of the genes of various viruses introduced in genetic engineering. Molecules of viral RNA present

2. [In the journal European practice of number notation is followed — for example, 36 333,33 (European style) = 36 333.33 (Canadian style) = 36,333.33 (US and British style). — Ed.]

3. See: Regulation (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed (Text with EEA relevance). OJ L 268, 18.10.2003.

in transgenic rice may penetrate human cells and actively regulate the expression of human genes (Zhang et al. 2012). The instability of the genetic material of transgenic plants has also been confirmed. An analysis of the genetic sequences of five different varieties of Roundup Ready transgenic soybean showed that they were not as described and claimed by biotechnology corporations (Unstable Transgenic Lines Illegal 2003). A similar lack of stability of genetic material was found in MON 810 maize. In samples of these transgenic plants the concentration of the Bt toxin was highly varied, from very high to complete absence of the protein (Lorch and Then 2007; Nguyen and Jehle 2007).

One of the most important problems associated with GMO food safety is its potential allergenicity. Transgenic soybeans, even after boiling, contain seven times as much trypsin inhibitor as traditional soybeans. Trypsin inhibitor inhibits the activity of this enzyme in the gastrointestinal tract, so that food is not thoroughly digested, which increases the risk of gastrointestinal diseases and allergies. In Great Britain, the incidence of allergies increased 50% in one year following the introduction of imported transgenic soybeans (Cichosz and Wiąckowski 2012). Genetically modified food may pose a threat to reproduction in humans and animals. Genetically modified soybeans contain several times more phytoestrogens than natural soybeans. These compounds cause endocrine disruptions in the human body, which may lead to male infertility. Similarly, Roundup displays estrogenic activity, which may affect the development of the mammary gland and increase the risk of breast cancer (Richard et al. 2005).

The largest producer of GMO foods is the USA, and the legal standards there are characterized by a liberal approach to cultivation and marketing of GMO crops. In the EU, the quantity of transgenic crops is marginal in comparison with the leading producers, but the impact of these countries on international economic relations, including trade, is enormous (Michalczyk 2016). Legal and institutional/organizational solutions implemented in the EU are aimed at restricting the use of GMOs, and have to do with the procedures and conditions for placing genetically modified food and feed on the market, cultivating transgenic crops, and monitoring trade in GMOs. The genetically modified crops currently cultivated in the European Union are Amflora potato and MON 810 maize, as well as — only in Spain — the Bt176 line of maize. Council Directive 2002/53/EC of 13 June 2002 on the common catalogue of varieties of agricultural plant species stipulates that member states cannot completely prohibit cultivation of genetically modified crops.[4] In Poland questions associated with the marketing of seeds of genetically modified plants are regulated by the Seed Act of 21 December 2012. The prohibition on the use of seed material of Amflora potato and MON 810 maize is regulated by the regulation of the Council of Ministers of 2 January 2013.

Binding legal standards are extremely important for the agrobiotechnology products market, but political decisions and legislative work are based on public opinion rather than on the results of scientific research on GMOs (Małyska and Twardowski 2015). The negative attitude of society towards GMOs has been the basis for legal restrictions on commercial cultivation of transgenic crops in nine of the 28 member states of the UE (Austria, France, Germany, Hungary, Luxembourg, Greece, Bulgaria, Poland and Italy) (Twardowski and Małyska 2015).

Due to the intensive development of biotechnology, questions related to GMOs have not only become a scientific problem but also involve environmental, ethical, health, economic and legal issues (Maciejczak 2010). Public opinion on genetic modification of organisms and consumers' attitude towards GMO products must be known and respected in order to create an innovative bioeconomy, ensure economic growth, and improve lives (Małyska and Twardowski 2011b). In Poland, public opinion surveys on the introduction of new biotechnologies have been conducted since 1998. Of the various aspects of biotechnology, Polish people are most accepting of its medical applications (55%-69% in 2010) with 53% in favor of research on regenerative medicine, 54% supporting the continuation of stem cell research, and 49% in favor of the use embryonic cells. In contrast, when asked about the use of GMOs in food production, opinions were predominantly negative (Małyska and Twardowski 2011a).

4. See: Council Directive 2002/53/EC of 13 June 2002 on the common catalogue of varieties of agricultural plant species. OJ L 193, 20.7.2002.

The aim of the study was to learn the opinion of university students on the subject of genetically modified plants and the level of their support for the use of these organisms in food. Apart from furthering knowledge on the subject, the research may also have practical application, as the information obtained is essential to a substantive public debate. The choice of this group of respondents is justified by the fact that they will soon be the country's intellectual elite and will perhaps be making decisions on the introduction of new biotechnologies.

## 1 Material and methods for the survey

The survey was conducted among a group of students of various universities in Lublin. Fifty-seven per cent of respondents had in-depth knowledge of biology drawn from their area of study; these were students of the Faculty of Medicine with Dentistry Division of the Medical University and the Faculty of Food Sciences and Biotechnology of the University of Life Sciences. Students of sciences unrelated to biology attended the Maria Curie-Skłodowska University in Lublin, Poland, where they studied in the Faculty of Economics or the Faculty of Mathematics, Physics and Computer Science. From April to June 2016 randomly selected students in these areas of study received questionnaires. The questionnaire was completed by 133 students. This included 25 students whose area of study was economics, 32 students of information technology, 38 medical students, and 38 studying biotechnology. Other authors have conducted surveys related to genetically modified organisms on similarly sized groups of respondents (Wilczyńska and Wittbrodt 2012). Our own, original questionnaire contained a section with questions differentiating the respondents according to age, sex, attitudes towards religion, and area of study, while the main part of the questionnaire consisted of questions regarding their opinions on genetically modified plants and GMO food. All questions were closed-ended. The respondents were 20–24 years old; 64,7% were women and 35,3% men. Sixty-five percent of those surveyed stated that they practice a religion. The results were analyzed statistically by the chi-square test, but the results obtained for the test did not statistically confirm any relationship between the response given and the students' area of study, religiousness, or sex, so they were not included in the article.

## 2 Respondent opinions and discussion

In the present study as many as 93% of the students surveyed claimed to know the term "GMO" ("definitely" and "somewhat" answers combined). The students' main source of information about GMOs was the Internet and television (40,6%), followed by scientific journals (25,6%), books (21,8%), popular magazines (9%), and friends and family (3%). Students with in-depth knowledge of biology (those studying biotechnology or medicine) learned about issues related to GMOs mainly from scientific journals and books, while the main source of information for those studying economics or information technology was the Internet or television (fig. 1). Analysis of the results of surveys on GMOs published in scientific articles revealed substantive differences, different methodological approaches, and different tools used by different authors in their analyses. In spite of this, the present discussion will cite previously published results, as they can form the basis for conclusions about public opinion on GMOs.

In Poland, surveys on GMOs have been conducted as part of EU projects since the end of the 1990s. In a survey carried out in 1998 asking about the possibility of using genetic engineering methods to produce food, only 14% of respondents were interested in the issue, 48% had heard about it, and 38% had not heard about it at all (Twardowski 2007). Years later public knowledge of GMOs remained superficial. The results of a 2012 survey showed that most Polish people (66%) still did not know what the abbreviation "GMO" means, and 48% were completely unfamiliar with the concept of genetically modified food.[5] The main factor determining the low level of acceptance of GMOs in Polish society is a lack of knowledge of modern technologies. The fears of the populations of EU countries concerning biotechnologies arise from a lack of specific information on the

5. According to PENTOR survey in 2012.

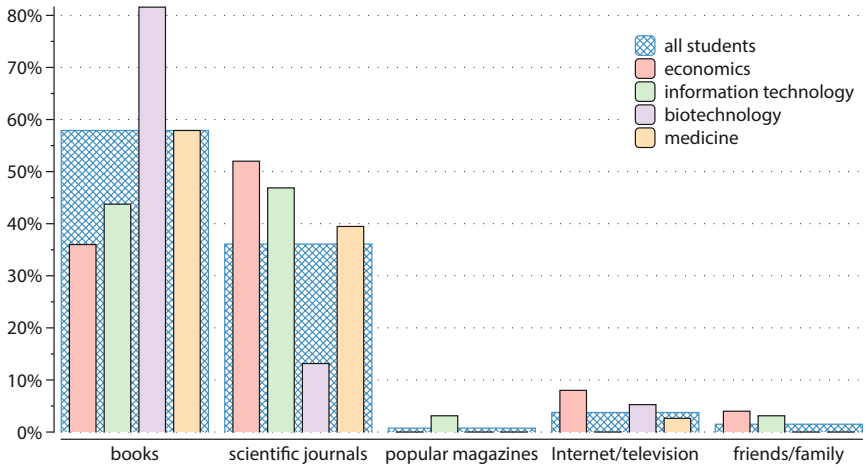


**Fig. 1.** Surveyed students' sources of information on GMO

consequences and threats that may appear in the future following application of these techniques in food production (Twardowski 2007). The highest level of support for research on GMOs is noted among educated people, with secondary or higher education, and those who feel adequately informed about GMOs.[6]

Nisztuk et al. (2012) also confirmed that education is a factor determining knowledge of GMO-related issues, as in their study the term "GMO" was correctly understood by 56% of secondary school pupils, 64% of university students and 47% of adults. Other authors also emphasize that the term "GMO" is widely known among students. In a study by Wilczyńska the main source of information about GMOs (as many as 47% of respondents) was the media, while only 4% learned about the issue from books. Among students whose area of study was food-related, 32% derived information from their studies (Wilczyńska and Wittbrodt 2012). The Internet is a common source of information on GMOs (33%, 39% and 48% for school pupils, university students and adults, respectively), while only 19% of university students state that they have obtained information from books or scientific journals (Nisztuk et al. 2012). Most respondents express the need for information on GMO plants; 79% (answers of "definitely" and "probably") are interested in learning more about the subject, but as many as 88% (as above) expect the government to conduct an information campaign. The students surveyed expect reliable information on both the risks (90%, as above) and benefits (89%, as above) associated with these organisms (fig. 2).

For most Polish people the main source of knowledge is the media, which do not provide balanced information on GMOs (Małyska and Twardowski 2015). Issues related to GMOs appear very

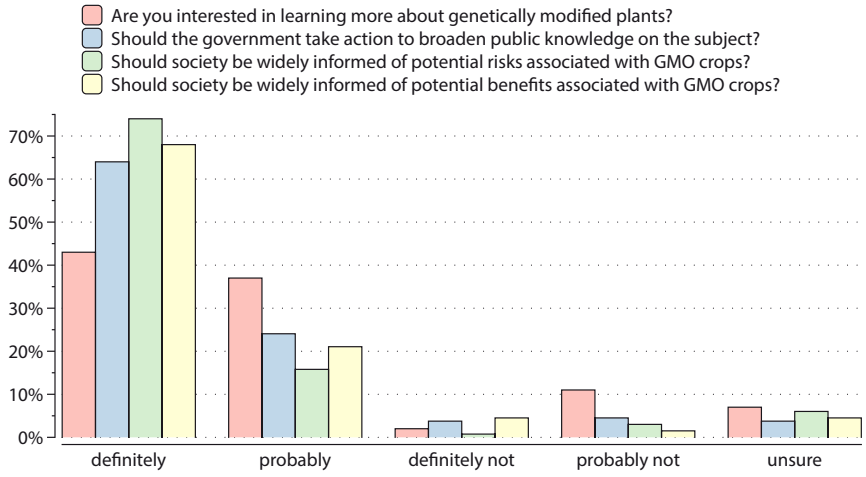


**Fig. 2.** Attitudes of respondents regarding the need for information on GMO plants

6. See: TNS OBOP survey „Polacy o biotechnologii i inżynierii genetycznej", for year 2005.

often in the media and elicit strong responses, but, according to Małyska, Filipiak and Twardowski (2013), the public is still lacking reliable knowledge on the subject. Only 42,8% of the students surveyed (combined "definitely" and "probably" answers) wanted a ban on GMO crops, while 36,1% ("definitely not" and "probably not") of respondents were opposed to such a ban (tab. 1). A study by the Public Opinion Research Centre (CBOS) conducted in 2013 found that 65% of Poles were in favor of a ban on cultivation of genetically modified crops.[7] The level of fear of GMOs may be reflected in the respondents' answers to the question regarding consent to cultivation of GMO crops near their homes and the distance from these crops. While the number of respondents indicating consent (38% "definitely" + "probably" answers) was similar to the number opposed to crops near their homes (43% "definitely not" + "probably not" answers), the largest percentage, 30%, indicated that these crops should be located over 100 km from their homes, and 22% indicated a distance greater than 10 km and less than 100 km.

Students' opinions on genetically modified crops show that the subject raises many concerns. Among those surveyed 50% ("definitely" + "probably" answers) are afraid of the risk of new diseases and allergies appearing in humans, and 45% (as above) fear an exacerbation of existing diseases and allergies or uncontrolled genetic changes in humans (36%). Most of the students surveyed, 58% (as above), believe that genetically modified crops threaten the natural environment, while only 24% (as above) perceive a potential for improving environmental protection, and 49% (as above) state that they constitute an unacceptable interference with the laws of nature. The statement that genetically modified plants offer a chance to protect the environment is rejected by 48% of Poles, while 26% agree with it.

In a survey conducted by Borek-Wojciechowska (2010) in an academic environment, the respondents indicated that the most important aspects of GMOs were that the use of genetic engineering methods will make it possible to eliminate world hunger and reduce the importance of traditional food. Cultivation of GMO crops is also associated with the risk that multinational corporations will dominate the market of agricultural products (68%, as above) and may exacerbate economic differences between countries and people (47%, as above). The opinion of the students surveyed is consistent with the views of the public as a whole. Awareness of the expansion of multinational corporations dealing in GMOs has also been shown in a survey by CBOS, in which 71% expressed fear of their dominance of the market and 52% believe that GMO crops exacerbate global economic differences.

In a survey of scientists who were experts in this field, the threat of monopolistic practices by biotechnological corporations was also the most frequently cited argument against implementation of GMOs. The experts emphasized, however, that intellectual property rights concern not only GMOs but other innovative products as well. Like GMO seeds, traditional seed material may also be burdened with a license fee. However, the higher cost of growing transgenic crops may be compensated for by the lower costs of protection against pathogens (Małyska, Filipiak, and Twardowski 2013). The students surveyed also perceive potential benefits of GMO crops: the possibility of progress in agriculture (71%, as above) or food production (76%, as above), economic benefits for farmers (51% as above), and lower food prices (53%, as above). The students present less optimistic opinions regarding improved food quality (37%, as above) and the elimination of hunger owing to GMO crops (35%, as above). They are also more skeptical than the public as a whole, as according to the CBOS survey opinions of Poles regarding the chance to eliminate hunger are divided, with the same number agreeing with and rejecting this claim (41%). Most of the students surveyed (63%) had encountered food produced from GMOs (fig. 3). It should be noted that they indicate the need for labelling of products directly produced from genetically modified organisms (90%) as well as products derived from animals whose feed contained GMOs (88%). Willingness to buy GMO food was expressed by 33%, and the same number of students would not buy such food. However, 58% of respondents ("definitely not" and "probably not") would not give GMO food to their child. The results of a survey conducted by the Eurobarometer on production of GMO-based food and

7. See: Polacy o bezpieczeństwie żywności i GMO. Komunikat z badań CBOS, Warszawa, styczeń 2013, [@:] http://www.cbos.pl/SPISKOM.POL/2013/K_002_13.PDF.

**Tab. 1.** Respondents' opinions on the risks and benefits associated with genetically modified crops

| Question | % | | | | |
|---|---|---|---|---|---|
| | **Definitely** | **Probably** | **Definitely not** | **Probably not** | **Unsure** |
| Should cultivation of GMO crops be prohibited in Poland? | 15 | 28 | 10 | 27 | 20 |
| Is cultivation of genetically modified crops associated with: | | | | | |
| a risk of new diseases or allergies appearing in people? | 17 | 32 | 11 | 20 | 20 |
| a risk of exacerbation of existing diseases and allergies in people? | 16 | 29 | 12 | 21 | 21 |
| a risk of uncontrolled genetic changes in humans? | 15 | 21 | 16 | 24 | 24 |
| a risk of exacerbating economic differences between people and countries? | 19 | 28 | 12 | 20 | 21 |
| a risk of multinational corporations dominating the market of agricultural products? | 31 | 37 | 8 | 13 | 11 |
| a risk to the natural environment? | 30 | 28 | 9 | 19 | 14 |
| an unacceptable interference in the order established by God? | 11 | 12 | 18 | 17 | 43 |
| an unacceptable interference in the order established by nature? | 20 | 29 | 11 | 18 | 23 |
| Do genetically modified crops benefit farmers? | 26 | 25 | 11 | 20 | 19 |
| Do genetically modified crops improve food quality? | 14 | 23 | 24 | 21 | 17 |
| Do genetically modified crops lead to lower food prices? | 17 | 36 | 14 | 19 | 13 |
| Will genetically modified crops eliminate hunger? | 12 | 23 | 20 | 29 | 16 |
| Do genetically modified crops enable more effective environmental protection? | 14 | 10 | 24 | 30 | 23 |
| Are genetically modified crops an achievement of science and human reason? | 49 | 32 | 3 | 6 | 9 |
| Are genetically modified crops associated with agricultural progress? | 36 | 35 | 7 | 8 | 14 |
| Are genetically modified crops associated with progress in food production? | 38 | 38 | 7 | 9 | 9 |
| Would you agree to have GMO crops grown near your home? | 13 | 26 | 19 | 23 | 19 |
| | **km** | | | | |
| | **$\leq 1$** | **1–5** | **5–10** | **10–100** | **$> 100$** |
| At what distance from your home could GMO crops be located? | 14 | 18 | 16 | 22 | 30 |


**Fig. 3.** Respondents' opinions on GMO food

feed reflect a negative attitude towards GMOs. According to the Eurobarometer 73.1 biotechnology report,[8] only 22% of Poles perceive genetically modified food as safe for their health, while 61% fear potential harm to future generations (Małyska and Twardowski 2011a). According to the CBOS survey, 54% of respondents claim not to have encountered animal products containing genetically modified organisms on the Polish market. The vast majority of Poles believe that animal products containing GMO should be labelled (Małyska and Twardowski 2011b).

## 3 Recapitulation and conclusions

The survey provided answers regarding opinions on the cultivation and use of genetically modified plants, but did not indicate the reasons for positive or negative viewpoints, because, as mentioned in section 1, no statistical correlations were confirmed with sex, area of study or religiosity. Other authors similarly state that the origin of Polish prejudices towards GMOs is not entirely clear. The prospects of commercial use of GMOs are not determined by technological barriers but by political decisions and public opinion. Taking into account the current legal situation, experts are generally skeptical about the possibility of using agrobiotechnologies based on transgenic organisms in Poland in the next decade or two (Małyska, Filipiak, and Twardowski 2013). According to Matyska et al. (2011b), the negative attitude towards GMOs and GMO food in Poland is due to poor knowledge of biology, a failure to promote scientific achievements and innovative technologies, and negative media campaigns and propaganda organized by various environmental organizations. According to these authors the public's negative attitude and strong opposition will prevent the introduction and distribution of GMO food and feed.

The students surveyed claimed to have knowledge of issues related to GMOs and most of them showed considerable interest in the subject and would like to learn more about these matters. They also observe the need for the government to conduct a reliable information campaign. Their opinions on GMO plants are ambivalent, like those of the rest of society. Students have fears regarding the cultivation and use of GMO crops, but also perceive benefits that this biotechnology could bring. Although the respondents can be considered an educated group, there is a need to provide reliable information so that the public can form objective views on GMOs.

8. See: Eurobarometer 73.1: The European Parliament, Biotechnology, and Science and Technology, January-February 2010 (ICPSR 31483). [@:] http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/31483.

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