UDC 338.439:606

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BIOTECHNOLOGY: SOLUTIONS TO FOOD DEFICIENCY PROBLEM

Analysis of implementation of agrobiotechnologies from the point of view of solution to global food safety has been conducted, the issue of safety of GM foods for people and expediency of agrobiotechnologies' implementation in Ukraine has been considered.
Key words: food safety, GM-crops, biosafety, biodiversity.

Problem statement. During the whole history of humanity provision of food to population has been one of the most important tasks and the topicality of food problem grows in connection with global climate, social and demography tendencies in the world. Production of food stock goes behind the tempo of population growth – 800 million people in the world suffer chronic food deficiency, and millions of others may face hunger in connection with food crisis. Food deficiency reaches 60 mln. tones, which, according to many scientists, is impossible to liquidate on account of using traditional agrobiotechnologies, widening crop areas, increasing number of cattle, productivity of cattle breeding and planting. According to many experts of the world food market, transfer to organic agrotechnologies will even more worsen the situation with food supply. Biosphere "is able" to give enough food only to one milliard people and at the same time without problems to recover [22]. Qualitatively new direction of possible solution to the problem of food supply of the planet's population – is development of agrobiotechnologies.

Analysis of scientific papers shows that the food problem has deep historical roots, which originate form works of Ancient Greece philosophers. Useful, concrete labor, manufacturing food, according to Aristotle, is the main means in solution to food deficiency problem [19]. Considerable contribution to development of food problem concept from both production and consummation points of view food was made by A. Smith, D. Ricardo, T. Malthus, K. Marks, P. Ehrlich, A. Maslow, V. Pareto, M. Laue and others. Observing scientific papers, dedicated to solving food safety, points to two ways of solving it. The first is pessimistic, based on studies of Thomas Malthus, which in his paper "The Essay on the Principle of Population" determined that growth of population happens in geometric progression, while food production increases in accordance with linear law. The scientist, basing on this conformity, determined internal reason of threat to well-being of society – advance growth of population as compared to ability to increase food production. Natural regulators of population growth and, correspondingly, solution to the food problem, according to him, are hunger, wars, diseases, poverty and different vices of society [13].

The second way is optimistic (evolutionary) for solution to food safety, it was offered by Friedrich Hayek. In the scientist's opinion, food deficiency threat is real only as far as demographic growth goes before growth of

social variety. Food safety solution, according to F. Hayek, is in increasing number of complementary services, when residuals from some industry become resources for others. In this case, growing number of producers find its place in the system without growth of pressure on natural resources [26]. In our opinion, the way, offered by F. Hayek, suggests necessity of industrial enterprise's deep recycling of materials, including also the food sector. Production of sufficient amount of food stocks is, according to many scientists, in application of agrobiotechnologies. Heavier crops, obtained with application of these technologies, can help to resolve the problem, determined by the UNO as necessity to increase world food production for 50% by the year of 2030 [20].

The objective of the article: researching the expediency of implementing agrobiotechnologies, aiming at solution of food safety – world experience of using agrobiotechnologies, aiming at solution to food safety and development of GM foods market in Ukraine.

Result of the research. Analysis of scientific and practical literature shows presence of several hundreds of definitions of the category "food safety", each of them at some degree contains indication of such food safety components as physical and economic affordability of food, quality and safety of food for human's health. Provision of these components in connected with possibility to use three food production technologies in agriculture – traditional, organic and agrobiotechnology, which is based on application of the method of recombinant DNA. This is the most famous approach, used by modern biotechnology, permitting to modify plants, animals and microorganisms genetically, giving them properties, obtaining of which is impossible with the help of traditional methods of selection. There is differentiation of products with GM-components:

- genetically modified microorganisms, which are used in closed systems – fermentors for obtaining useful substances. When microorganisms reach certain weight, the obtained biomass is used to extract useful substances with their further use in food and pharmaceutical industry;
- genetically modified animals, able to grow very fast. There is only one type – salmon, released to an open system (other animals are used only in experiments in closed systems or laboratories);
- genetically modified plants, which are used in open systems and grown on fields, but they are not separate independent system, but a part of special agrarian technologies – agrobiotechnologies [24].

Agrobiotechnology is the most urgently implemented technology, for 16 years – from 1996 to 2012 number of the world areas under GM-plants has increased in 100 times. If in 1996 GM plants were grown on 1,7 mln. ha, in 2012 – on 170,3 mln. ha (table1).

This is about 12 % of all the world crop areas and the run up of areas in 2012 as compared to 2011 is about 6 % (10,3 mln. ha). GM plants, the most part of which is soy, then corn, cotton plant and rape, are grown in 28 countries of the world 17,3 mln. farms, and at this, 15 mln. of them – are small farms of developing countries of India and China.

Table 1

Areas with biotechnological crops in 2012: world economy*

№	Country	Area (mln. ha)	Biotechnological crop
1	The USA	96.5 mln. ha	corn, soy, cotton, rape, sugar beet, medic, papaya, marrows
2	Brasil	36,6 mln. ha	soy, corn, cotton
3	Argentina	23,9 mln. ha	soy, corn, cotton
4	Canada	11,6 mln. ha	rape, corn, soy, sugar beet
5	India	10,8 mln. ha	cotton
6	China	4,0 mln. ha	cotton, papaya, poplar, tomatoes, sweet pepper
7	Paraguay	3,4 mln. ha	soy, corn, cotton
8	South Africa	2,9 mln. ha	corn, soy, cotton
9	Pakistan	2,8 mln. ha	cotton
10	Uruguay	1,4 mln. ha	soy, corn
11	Bolivia	1,0 mln. ha	soy
12	Philippines	800 th. ha	corn
13	Australia	700 th. ha	cotton, rape
14	Burkina Faso	300 th. ha	cotton
15	Myanmar	300 th. ha	cotton
16	Mexico	200 th. ha	cotton, soy
17	Spain	100 th. ha	corn
18	Chile	less than 100 th. ha	corn, soy, rape
19	Columbia	less than 100 th. ha	cotton
20	Honduras	less than 100 th. ha	corn
21	Sudan	less than 100 th. ha	cotton
22	Portugal	less than 100 th. ha	corn
23	Czech Rpublic	less than 100 th. ha	corn
24	Cuba	less than 100 th. ha	corn
25	Egypt	less than 100 th. ha	corn
26	Costa Rica	less than 100 th. ha	cotton, soy
27	Romania	less than 100 th. ha	corn
28	Slovakia	less than 100 th. ha	corn
Total		**170,3 th. ha**	

**source: [10].*

Using agrotechnologies in these economies led to increase of profit up to 250 USD from each ha on the account of two time reduce of toxic chemicals' use. Net profit for 15 years (1996–2011) made up 98,2 mlrd. USD, at this 51% of it is obtained on the account of reduce of production costs, first of all on the account of decrease of intensity of ground treatment and use of toxic chemicals, and in 49% – on the account of crop increase (for 328 mln. tones of production) [1].

For the first time in 2012 developing countries grew more GM plants (52%), than industrially developed ones (48%), and this contradicted with the forecast of some scientists, stating that biotechnological crops are profitable only to industrially developed countries and they would never be accepted and adjusted in developing ones. For the period 1996-2011 total economic effect

was higher in developing countries (49,6 mlrd. USD) as compared to industrially developed countries (48,6 mlrd. USD). Although the USA are still leading in production of biotechnological crops in the world economy, according to tempos of growth in 2012, Brasilia is the leading country, where gain of areas of GM plants summed up 21%.

Except 28 countries, which grow biotechnological crops commercially stream of GM crops is regulated in 31 countries. Average expenses for fundamental researches, practical creation, testing and implementation of one GM sort sum up 135 mln. USD. At this, no less than 70 % of total expenses (about 100 mln. USD) are spent for safety tests and certification. In 2012 general world market of GM sort seeds summed up 14,8 mlrd. USD, which is about 35 % of the whole world market of certified seeds (34 mlrd. USD) [10].

Analysis of statistic data on results of agrobiotechnologies use in the world economy permitted to differentiate contribution of these technologies to solution to global food safety according to its basic components (table 2).

Table 2

Contribution of agrobiotechnologies to solution of global food safety (years 1996-2011)*

Food safety components	Result
Physical affordability of food	Increase of food production for 328 mln. tones,
Economic affordability of food	Employment and income increase more than for 15,0 mln. of small farmers and their families, total number of which is almost 50 mln. people; Decrease of food price on the account of decrease of cost value of food stocks;
Ecological stability and biodiversity	Implementation of erosion preventive means of soil treatment (beardless soil plowing secures decrease of number of herbicidal flows in average for 70 %, decrease of soil erosion for 93% and decrease of water stocks for 69% as compared to traditional plowing type); Environment improvement on account of saving 473 mln. kg of pesticide active substance; Cutting use of diesel fuel because of pesticide spraying and less plowing (in 2011 C02 blowout was reduced for 23,1 mlrd. kg, that is equivalent to disappearance of 10,2 mln. cars from roads); Keeping biodiversity on account of saving 108,7 mln. ha of unplowed ground, the most part of which is tropical forests (increase for 328 mln. tones of food, with the help of traditional crops in the period from 1996 to 2011, would have required extra 108,7 mln. ha)
Food safety	2497 permissions of regulating authorities were issued: out of them 1129 – permissions to use GMO in food industry (direct use or reprocessing), 813 – permissions to use GM sorts for feed stuffs' production (direct use or reprocessing in combined feed and premixes) and 555 – permissions to grow or implement to environment.
Food quality	Manufacturing new «functional products», possessing more nutrition value as compared to traditional analogues.

**elaborated by the author with the use of [1, 10].*

However, in spite of considerable number of permitting documents for use of food GM crops, international discussions still arise in the world association, they are dedicated to safe implementation of GMO to environment and for eating. Concerning this, numerous researches were conducted and a number of corresponding claims on safety of agrobiotechnologies' use were made (table 3).

Table 3

Organizations, which researched safety of agrobiotechnologies' use*

Year	Organization
1986	Food Technology Institute (FTI)
1987	National Academy of Science (NAS)
1989	National Research Council (NRC)
1992	National Institute of Health (NIH)
1991, 1996, 2000	UNO and the World Health Organization
1998, 2000	Organization of Economic Cooperation and Development (OECD)
2008, 2010	Centre of Common Researches of European Union Commission on Safety

**elaborated by the author based on [10, 24].*

The arguments of a number of scientists regarding the essence of GMO add up to the fact that all life organisms (starting from viruses and to mammals) contain similar four "notes" of life (A, T, G, C) in a DNA molecule, that is why recombinant (hybrid) DNA cannot be considered counter natural [21, p. 194]. There are no scientific statements that separate genes or fragments of DNA of food embed into genetic material of cells of human (or mammals in general) [2, 4, 25].

As the scientists consider, there are grounds to state, that in the process of evolution the system of human digestion produced protection mechanisms against simple transfer of genes from food products. Such task of genes is practically impossible, because of the following:

- DNA with new gene mustn't be destroyed by nucleases of digestive juice;
- DNA must be able to enter through cell wall and cell membrane of microorganisms, stay viable while action of mechanism of alien DNA deactivation;
- DNA (alien) must recombine with host's DNA and firmly integrate on the area, where gene expression is possible;
- plant food gene, even at likelihood of its transformation to microorganism must start expression in it [22, p. 4].

We must emphasize that admissible in food products norm of GMO contain is for a long time valid in Europe – no more than 0,9%; in Japan – 5%; in the USA and Canada– more than 10%. National health is thoroughly and strictly controlled in the USA, and biosafety is controlled by three federal authorities at the same time: Ministry of Agriculture, Environment Protection Agency, Commission on Controlling Food Products and Pharmaceutical Agents [2, 4]. At this, requirements to medico-genetic and technologic assessment of GM foods

are higher, than to sorts, which are obtained by way of usual selection [22].

During 10 years (2001–2010) when the European Union finances them, 50 scientific-research projects were conducted; they were dedicated to issues of food safety of agrobiotechnologies for environment, human and animals' health. According to the results of these projects, during the years of agrobiotechnologies' use in industrial scales no cases of ecological disturbance or harming human health as a result of consuming products containing GM components were fixed.

Another issue to have been researched by us is expediency of agrobiotechnologies' use in Ukraine. Land resources of the country are considerable - 0,9 ha of land is per capita, 0,7 ha of which is tilled area, but with such potential food safety is not resolved. Analysis of statistic data on consummation of basic food products per capita point to failed satisfaction of physiological needs according to a number of issues (table 4).

Table 4

Dynamics of factual consumption of food in respect to minimal and physiological consumption norm in Ukraine (kg)*

Consumer basket products	Minimal consumption norm	Physiological norm	Year								
			1990	2000	2005	2006	2007	2008	2009	2010	2011
Bread and bread products	94,0	101,0	141,0	125,0	124,0	120,0	116,0	120,0	112,0	111,0	110,0
In % to minimal norm			150,0	133,0	131,9	127,7	123,4	127,7	119,1	118,1	117,0
In % to physical norm			139,6	123,8	122,8	118,8	114,9	118,8	110,9	109,9	108,9
Meat and meat products	52,0	83,0	68,0	33,0	39,0	42,0	46,0	43,0	50,0	52,0	51,0
In % to minimal norm			130,8	63,5	75,0	80,8	88,5	82,7	96,2	100,0	98,1
In % to physical norm			81,9	39,8	47,0	50,6	55,4	51,8	60,2	62,7	61,4
Milk and dairy products	341,0	380,0	373,0	199,0	226,0	235,0	224,0	225,0	212,0	206,0	205,0
In % to minimal norm			109,4	58,4	66,3	68,9	65,7	66,0	62,2	60,4	60,1
In % to physical norm			98,2	52,4	59,5	61,8	58,9	59,2	55,8	54,2	53,9
Fish and sea food	12,0	20,0	18,0	8,0	14,0	14,0	15,0	14,0	15,0	15,0	13,0
In % to minimal norm			150,0	66,7	116,7	116,7	125,0	116,7	125,0	125,0	108,3
In % to physical norm			90,0	40,0	70,0	70,0	75,0	70,0	75,0	75,0	65,0
Eggs, items	231,0	290,0	272,0	166,0	238,0	251,0	252,0	245,0	272,0	290,0	310,0
In % to minimal norm			117,7	71,9	103,0	108,7	109,1	106,1	117,7	125,5	134,2
In % to physical norm			93,8	57,2	82,1	86,6	86,9	84,5	93,8	100,0	106,9
Vegetables and gourds	105,0	161,0	103,0	102,0	120,0	127,0	118,0	120,0	137,0	144,0	146,0
In % to minimal norm			98,1	97,1	114,3	121,0	112,4	114,3	130,5	137,1	139,0
In % to physical norm			64,0	63,4	74,5	78,9	73,3	74,5	85,1	89,4	90,7
Fruit, berries and grapes	68,0	90,0	47,0	29,0	37,0	35,0	42,0	41,0	46,0	48,0	53,0
In % to minimal norm			69,1	42,6	54,4	51,5	61,8	60,3	67,6	70,6	77,9
In % to physical norm			52,2	32,2	41,1	38,9	46,7	45,6	51,1	53,3	58,9
Potato	96,0	124,0	131,0	135,0	136,0	134,0	130,0	135,0	133,0	128,0	136,0
In % to minimal norm			136,5	140,6	141,7	139,6	135,4	140,6	138,5	133,3	141,7
In % to physical norm			105,6	108,9	109,7	108,1	104,8	108,9	107,3	103,2	109,7
Sugar	32,0	38,0	50,0	37,0	38,0	40,0	40,0	40,0	38,0	38,0	38,0
In % to minimal norm			156,3	115,6	118,8	125,0	125,0	125,0	118,8	118,8	118,8
In % to physical norm			131,6	97,4	100,0	105,3	105,3	105,3	100,0	100,0	100,0

Vegetable fats	8,0	13,0	12,0	9,0	14,0	14,0	14,0	14,0	15,0	15,0	14,0
In % to minimal norm			150,0	112,5	175,0	175,0	175,0	175,0	187,5	187,5	175,0
In % to physical norm			92,3	69,2	107,7	107,7	107,7	107,7	115,4	115,4	107,7

**calculated by the author based on [16].*

At such groups as milk and dairy products; meat and meat products; fruit, berries and grapes even minimal consummation norm is not reached, that is why the issue of expediency of using agrobiotechnologies for solution of food safety in Ukraine requires scientific grounding.

The conducted analysis of legislation base of Ukraine points to absence of general state policy in this issue. Almost two thousand permissions for use of GM foods were issued in the whole world, in some countries more over hundreds of permitting documents were issued and, according to many lawyers, native legislative base regarding this issue (table 5) requires improvement [3].

Table 5

Basic legislative acts concerning use of GMO in Ukraine *

Document's name	Date
Ratification of Cartagena Protocol on Biosafety to the Convention on Biodiversity.	2002
Adoption of the Law of Ukraine "On state system of biosafety at creation, experimenting, transportation and use of genetically modified organisms"	2007
Adoption of the Law of Ukraine as of 17.12.2009 №1778-VI "On introduction of alterations to the Law of Ukraine "On safety and quality of food products" concerning informing citizens on presence of genetically modified organisms (GMO) in food products"; Adoption of the Law of Ukraine as of 17.12.2009 №1779-VI "On introduction of alterations to some legislative acts of Ukraine concerning informing on presence of genetically modified components in production"; Resolution of the Cabinet of Ministers of Ukraine as of 13.05.2009 №468 "On approving order of labelling food products, containing genetically modified organisms or produced with their use and are introduced to sales" Resolution of the Cabinet of Ministers of Ukraine as of 1.07.2009 № 661 «On introduction of alterations to Resolution of the Cabinet of Ministers of Ukraine as of 13 of May 2009 №468».	2009
Order of the Ministry of Agrarian Policy and Food of Ukraine as of 24.02.2011 №52 "On strengthening state control over safety of agricultural production with presence or absence in it of genetically modified organisms". Order of the Ministry of Agrarian Policy and Food of Ukraine as of 16.03.2011 №78 "On selection of tests of seeds, imported to Ukraine, aiming at determination of presence or absence in them of genetically modified organisms".	2011
Adoption of the law of Ukraine as of 23.02. 2012 № 4441-VI " On introduction of alterations to some legislative acts of Ukraine concerning informing on production of genetically modified components". Article 36. Requirements to application of sanitary measured objects Application of food products, which contain genetically modified organisms or produced with their use, before state registration. Article 38. Requirements to labelling food products: 10) presence in food products, registered according to specified order, of genetically modified organisms or components (ingredients), which were elaborated from registered genetically modified organisms, that is reflected on the label of the food product, is the part of genetically modified organisms in the product exceeds 0,9 % or less part of GMO, if such presence is accidental or is was possible technically to avoid. The order of labelling food production, containing or produced with the use of genetically modified organisms, is approved by the Cabinet of Ministers of Ukraine. Resolution of the Cabinet of Ministers of Ukraine "On approving order of labelling (marking) food products concerning containing genetically modified organisms in them".	2012

**elaborated by the author based on [17].*

Legislative alterations in 2012 concerned two Articles 36 and 38, at this Article 38 brings labeling of GMO foods in compliance with legislation of the European Union.

It is necessary to note that by the Law of Ukraine "On state system of biosafety at creation, experimenting, transportation and use of genetically modified organisms" industrial manufacturing and sales of GMO and also production, manufactured with use of GMO, before their state registration is forbidden. Although at the present in Ukraine in the state register of GMO none of the sorts of agricultural plants is registered [7].

However, Ukraine, being one the first of post-Soviet countries, started to use GMO plans. While 37 t of potato with ground bacteria gene, produced by the company "Monsanto", was put for testing in 1997 for the first time, in 1998 – there was already 367 t of seed potato from Canada. In 2012 70 % of soya, 30 % of corn and more than 10 % of sunflower were grown by native agrarians with the use of GM seeds [15].

According to a number of native experts of agrarian market, economic expediency of new agrobiotechnologies' implementation consists in increase of GDP percent in Ukraine on the account of growth of yields amount of such crops as corn, sugar beet, rape and soya within 1,5...9,5%.

Besides, use of herbicides may be reduced to 4...7%, that will positively influence the ecology [14]. Ukrainian farmers can considerably increase profitability of their production, minimally for 4 mlrd. UAH per year on condition of using new biotechnologies [9].

Within the issue of expediency of agrobiotechnologies' use in Ukraine the central place is taken by GM foods safety for human's health. According to experts, about 40 % of products, sold in shops, include GM components: sausage products are leading, especially cooked sausages, sausage-rolls, wieners, and meat semi-finished food; the second place according to GM component ingredients is taken by baby foods (70 % of all baby foods in Ukraine contain GM components); the third position is taken by confectionery and bakery [23].

The topicality of the issue of GM foods safety rises in connection with constant widening of assortment of products with GM components on native food market. By Resolution № 761-p as of 10.10.2012 testing of genetically modified organisms (GMO), testing and elaboration of methods of detection of genetically modified components is imposed on «The Institute of food biotechnologies and genomics» of the National Academy of Sciences of Ukraine [12]. From the point of view of many native scientists, products, which can harm human's health, are not grown [5]. Spreading and using genetically modified organisms (GMO) is an irreversible process and as any other human creation GM plants cause definite risk, but direct threat to human's health or farm animals is not scientifically proved [12].

However both supporters and opponents of using agrobiotechnologies agree with necessity of compulsory informing of consumers on food products' contents and GMO components. Article 50 of the Constitution of Ukraine guaranties each citizen of Ukraine the right of free access to information on quality of food products. Consumer, purchasing one or another goods, must have

clear notion of contents, quality characteristics and presence of GM components, to make conscious choice, taking into account price-quality ratio.

Considering expediency of agrobiotechnologies' use in Ukraine, we would like to point out the statement, made by FAO UNO – biotechnologies are a powerful instrument for stable development of agriculture, permitting to solve the issue of food under conditions of population growth [20]. Namely the last words "under conditions of population growth", to our mind, do not exclude likelihood of negative influence of agrotechnologies' use on human reproductive function. Agrobiotechnologies' use for a number of developing countries with high birth rate can be solution of both demographic issue and food safety on macro level. For countries with low birth rate (Ukraine) this specification can become serious obstacle at decision making on expediency of agrotechnologies' implementation.

Analyzing possibility of agrotechnologies' use, we also consider in wrong to ignore P. Krasnov's point of view. According to it, the issue itself, which is put off to people as the false dilemma: "usefulness or harmfulness for health of genetically modified products", is part of special operation aimed at hiding real objectives of organizers of this truly monstrous campaign – instituting total control over food safety of many countries" [11]. It is difficult to disagree with it, as expenses for testing safety and certification sum up about 100 mln. USD and most universities, which are capable of making new GM-product, have no financial opportunity for safety testing. To our mind, such expenses are a barrier to entrance to GMO market, and high stake secures low competitiveness on this market, the main members of which are giant companies – Monsanto, Bayer and Syngenta. These companies obtained, obtain and will obtain super profits, totally controlling all the stages of manufacturing and consummation of food, starting from sowing seeds. Namely the companies, manufacturing seeds of GM sorts, are the most interesting ones in promotion to the Ukrainian GMO market.

It is necessary to note that native seeds cost about 100 -180 UAH/ha for farmers, and seeds of GM sorts are 4-7 times more expensive, but at this the high price is fully compensated by rise of yield and reducing expenses for toxic chemicals [18]. Legalization of GM sorts in Ukraine can lead to bankrupting of Ukrainian selection breeders and seed growers in the near term and in the longer term the choice of what to grow or whether to grow at all can be taken away from the Ukrainian farmers. Namely this fact requires, at grounding expedience of agrotechnologies' use in Ukraine, solution of the issue of target financing of elaboration and implementation of native GM sorts.

Conclusion. Conducted analysis of statistic, scientific and legislative information permits to state that agrotechnologies' use positively influences the solution to such food safety components as physical and economic food affordability, ecological stability and biodiversity. Because of lack of scientific acknowledgement of harmfulness of GM components to human health at present, we are inclined to agree with possibility to solve food safety on account of agrotechnologies' use. Use of agrobiotechnologies for Ukraine can positively influence such aspects of food safety as social, economic and ecological. The influence on demographic and political aspects requires additional researches and decision making on the legislative level.

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АГРОБІОТЕХНОЛОГІЇ: РІШЕННЯ ПРОДОВОЛЬЧОЇ БЕЗПЕКИ

Резюме
У роботі проведено аналіз впровадження агробіотехнологій з позиції вирішення глобальної продовольчої безпеки, розглянуто питання безпеки ГМО-продуктів для людини і доцільності впровадження агробіотехнологій в Україні.
Ключові слова: продовольча безпека, ГМ-культури, біобезпека, біорізноманіття.

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АГРОБИОТЕХНОЛОГИИ: РЕШЕНИЕ ПРОДОВОЛЬСТВЕННОЙ БЕЗОПАСНОСТИ

Резюме
В работе проведен анализ внедрения агробиотехнологий с позиции решения глобальной продовольственной безопасности, рассмотрен вопрос безопасности ГМО-продуктов для человека и целесообразности внедрения агробиотехнологий в Украине.
Ключевые слова: продовольственная безопасность, ГМ-культуры, биобезопасность, биоразнообразие.