Development of potential risk assessment of the transgenic plants for the evaluation of practical perspectives for their adoption in Ukraine

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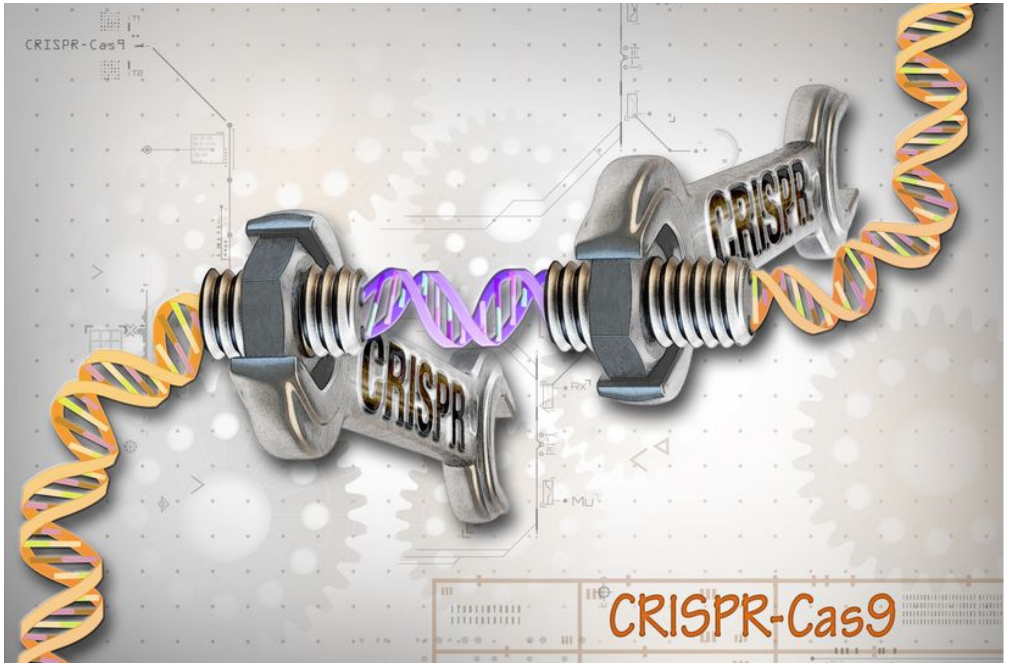
Development and adoption of universal system for scientifically based risk assessment of GM plants is extremely important taking into account wide and controversial societal attitude to new genetic engineered plants not having scientific background in most cases.

Especially this problem obtains new angle for consideration with development new breeding technologies and development of synthetic biology tools.



Mirrors on the ceiling
They bring champagne on ice
And she said
We are all just prisoners here
Of our own device
And in the master's chambers
They gather for the feast
They stab it with there steely knives
But they just can't kill the beast
Last thing I remember
I was running for the door
I had to find the passage back to the place I was before
Relax said the nightman
We are programed to recieve
You can check out any time you like
But you can never leave

Eagles

«Hotel California»

- On one hand such system must be the optimal in the terms of time consumption and cost efficiency, and on other hand it should provide the guarantee of necessary safety level.
- Respectively, this study is devoted to the development of clear scientifically based system for evaluation of an environmental (ecological) risk of transgenic crop field release in dependence of possible vertical gene flow from transgenic plants to sexually compatible species.

•Scientifically grounded risk assessment requires a multidisciplinary approach in order to make decisions that would be understandable and acceptable to all.

•For those purposes, we adopted usage of the criteria based on calculation of gene flow indices (Novozhylov & Blume, 2001) after the idea first proposed by F.T. de Vries (de Vries, 1996; de Vries, Van der Meijden, & Brandenburg, 1992) and further developed by K. Ammann for Switzerland (Ammann, Jacot, & Rufener Al Mazyad, 1996).

Respectively, we summarize main results about adaptation of the above mentioned system for potential risk evaluation of possible spread of genes from dedicated transgenic crops to wild flora of Ukraine.

Criteria for Preliminary Risk Assessment of Transgenic Plant Use in Ukraine

To address this issue, the codes proposed earlier were used to make preliminary rough estimates of the potential risk stemming from the introduction of GM sugar beet, corn, oilseed rape, potato, and false flax in Ukraine. Following this, more detailed risk assessment based on field monitoring and experimental approach—where judged necessary—were undertaken.

Classification of these codes includes:

1. codes of dispersal of pollen (Dp),
2. codes for dispersal of diaspores (Dd), and
3. codes for frequency of distribution (Df).

•This classification covers the areas of dispersal of pollen and hybridization potential, dispersal of diasporas, and frequency of distribution.
•Within each category, indexes range from 0 (lowest risk) to 5 (highest risk) and U
•(unknown).
•Below is a description of these codes in subsequent order.

Dp: Hybridization and pollen dispersal index

Dp code encompasses hybridization potential and the spread of pollen, partly including the possible negative effects of the transgene.

Dp 0 code

The plants, that belong to this category, there is no wild relatives in Ukraine, so there is no chance for hybridization, no environmental effects.

Dp 1 code

The plants, which belong to this category in Ukraine, there is no sexually compatible relatives and experimentally proved that hybridization between wild and cultivated plants is impossible.

Dp 2 code

Not registered spontaneous hybrids, but the natural hybridization is possible in the experimental conditions and offspring is fertile.

Dp 3 code

There is occasional natural hybridization, no backrosses observed in Ukraine.

Dp 4 code

There is a natural hybridization, hybrids are fertile and form a backcross.

Dp 5 code

Natural hybridization occurs fairly often, hybrids are fertile and do backcross frequently.

DpU

Data too scanty or lacking at all, no evaluation possible.

Dd: diaspore dispersal index

Dd 0 code

No chance for diaspore dispersal (seeds are sterile or deficient , lost their reproductive function).

Dd 1 code

It is possible a single diaspore dispersal at extremely successful conditions.

Dd 2 code

Diaspore dispersal slightly, but under favorable conditions possible.

Dd 3 code

Chances of diaspore dispersal is real, fruiting of cultivated plants are not desirable and should be eliminated by various methods.

Dd 4 code

The chances of the diaspore dispersal in the nature are real.

Dd 5 code

Diaspore dispersal in wild nature is the rule, fruiting occurs very frequently and is very abundant.

DpU

Data too scanty or lacking at all, no evaluation possible

Df: Dispersal frequency

Df 0 code

Wild relatives or species not known in the wild or feral populations in Ukraine.

Df 1 code

Wild relatives extremely rare in the wild and do not occur as feral populations in Ukraine.

Df 2 code

Wild relatives very rare in the wild and/or they occur sporadically as feral populations in Ukraine. Their distribution is difficult to predict, it is essentially out of control.

Df 3 code

Wild relatives and/or their feral populations not very common in the wild in Ukraine but they occupy a stable place in the ecosystem.

Df 4 code

Wild relatives and/or their feral populations not frequent in the wild but well distributed over whole regions in Ukraine.

Df 5 code

Wild relatives and/or their feral populations common in the wild and well distributed over whole regions in Ukraine. To prevent hybridization is almost impossible.

Established categories of probabilistic risk for use of transgenic plants based on these technical approaches

First category – no effect

- No related species or sexually compatible related species of the crop are known in Ukraine. Field releases of species belonging to this category are possible without any containment or short term monitoring;
- Certain trangenes have to be tested in medium term field experiments regarding their secondary effects on ecosystem.

This concerns such genes as genes for resistance to insects and pests.

Second category – minimal effect

- No records of spontaneous hybridization between the crop and the wild relatives are known in Ukraine. Field releases are possible after thorough clarification of the biogeographical situation. Short term monitoring in confinements should be done prior to large scale field releases;
- Certain trangenes have to be tested in medium term field experiments regarding their secondary effects on ecosystem (pest and insect resistance genes).

Third category – low but local effect

- Gene flow occurs toward wild or feral species existing also outside agricultural environment and control. Experiments on releasing first to be done in confinements and afterwards in small scale releases closely monitored;
- This statement is restricted to transgenes not causing enhanced competitiveness outside agrosystem, such as herbicide tolerance. Any other transgenes should be carefully tested in confinements.

Established categories of probabilistic risk for use of transgenic plants based on these technical approaches

Fourth category – substantial but local effect

- Gene flow is high and substantial, but still locally and controllable;
- Field releases could be done within strict confinements;
- A case by case analysis including potential effects of the transgene is required before any field releases are done;
- Long term monitoring of field releases under strict biological or geographical confinement condition is necessary in order to study competitiveness of transgenic crop. Risky transgenes have to be avoided.

Fifth category – substantial and wide-spread effect

- Gene flow is high, substantial, and wide-spread and will not be controllable by any means;
- No field releases of species belonging to this fifth category are possible;
- Medium term monitoring under strict confinement condition is necessary in order to find out about competitiveness of transgenic varieties;
- Experiments with less risky crop varieties (e.g. with male sterility) having the same favourable effect desired.

Sixth category – unknown *(one of the three indices is unknown)*

More studies are needed before any field releases are done.

Dispersal index and risk categories of most important crops in Ukraine

Species	English name	Dispersal index Dp, Dd, Df	Risk category
Brassica napus	Oilseed rape	4, 4, 4	Substantial but local effect
Beta vulgaris	Sugar beet	2, 2, 2	Minimal effect
Solanum tuberosum	Potato	1, 0, 1	No effect
Zea mays	Corn	0, 0, 1	No effect
Camelina sativa (L.) crantz	False flax or camelina	3, 4, 4	Substantial but local effect

The potential economic and environmental impact of using current GMO traits in Ukraine arable crop production

Briefing document by Prof. Yaroslav Blume (IFBG, Kiev, Ukraine) and Graham Brookes (PG Economics Ltd, UK)

Summary of likely farm level economic impacts of using GM technology in Ukraine ($/ha)

	Yield impact % change	Seed premium	Cost of crop protection	Impact on profitability	% change in profitability
GM HT oilseed rape (tolerant to glyphosate)	+3 to +12	+18	-11 to -22	+14 to +108	+2.7 to +21
GM HT oilseed rape (tolerant to glufosinate)	+10 to +12	+18	+18 to +55	+37 to +76	+7.2 to +14.8
GM HT soybeans	+5 to +15	+15 to +20	-23 to -26	+47 to +111	+11.3 to +26.9
GM HT sugar beet	+3 to +15	+50 to +140	-94 to -104	+8 to +322	+1 to +40
GM HT maize	Zero to +5	+20 to +25	-8 to -28	+35 to +60	+6.8 to +11.7
GM IR maize (targeting corn boring pests)	+10	+41	-12 to -25	+67 to +80	+13 to +16.4
GM IR maize (targeting corn rootworm)	+9 to +28	+32	Zero	+68 to +126	+13.6 to +25.2

Potential annual national level farm economic benefits of using current GM technology ($ million)

	50% adoption	Maximum adoption
GM HT oilseed rape (to glyphosate) OR GM HT oilseed rape (tolerant to glufosinate)	6.4 to 49.1 Or 16.8 to 34.6	11.5 to 88.4 Or 30.3 to 62.2
GM HT soybeans	28.0 to 66.0	50.3 to 118.9
GM HT sugar beet	29.7 to 88.5	53.5 to 159.4
GM HT maize	46.3 to 79.4	64.9 to 111.2
GM IR maize targeting corn boring pests	26.8 to 32.0	33.5 to 40.0
GM IR maize targeting corn rootworm	1.4 to 2.8	3.4 to 7.0
Total	138.6 to 317.8	217.1 to 524.9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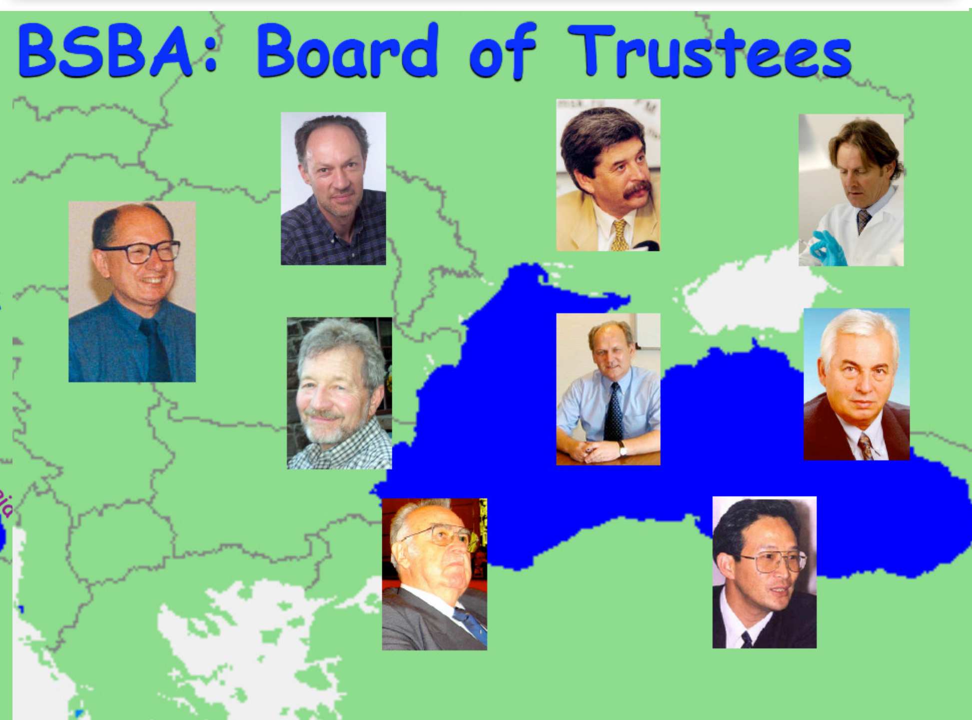
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Yalta Declaration

Agricultural Biotechnology to Serve Social and Economic Development through Global Cooperation

Recognising that **innovation** has for centuries led to advances in human well-being and economic and social development;

Noting that innovation in ag-biotechnology in particular is a potentially significant driver of **sustainable economic growth,** improved food security, human health, environmental safety, and social well-being, and will also be a crucial element in any future bio-based economy;

Acknowledging that the successful development and safe use of ag-biotechnology in the greater Black Sea Region, to be successful, requires scientific and technological **cooperation**, particularly among and between public and private sectors at the national, regional, and global levels;

Observing that the international **exchange** of knowledge, information, and technology contributes decisively to the advancement of research and innovation;

Considering that over a decade of **responsible use** of ag-biotechnology already demonstrated positive impact by providing millions of farmers and consumers in countries where biotechnology has been adopted with a better quality of life, higher incomes, and a safer environment;

In view of the fact that emerging ag-biotechnology applications offer excellent **prospects** with potentially far reaching benefits;

Therefore,

We express our strong **support** for the use of ag-biotechnology as an integral component in our countries' strategies to continue to provide safe, healthy, and nutritious foods, and practices that lead to a more sustainable and economically viable agriculture and socio-economic benefits.

We call for increased **public and private investments** in ag-biotechnology research, capacity building, and plant breeding to enhance our participation in the global innovation systems.

We urge policy makers to devise, adopt, and apply sound scientific principles leading to the formulation of the **sensible and rational regulation** of ag-biotechnology, which will accelerate innovation and the realisation of biotechnology's promise.

We agree to make every effort to strengthen complementary national, regional, and international **cooperation** by sharing knowledge and scientific resources, and by encouraging technology transfer and strong science-industry linkages that are required for the development of appropriate solutions to pressing agricultural and environmental problems.

We support the establishment of **intellectual property** systems that are conducive to the quality and productivity of science systems, to the development of home grown **innovation**, to the exchange of and **trade** in technologies and products, to the fostering of **entrepreneurship**, and to the building of a wide range of beneficial **partnerships**.

And above all, we pledge to share information and knowledge to encourage **dialogue** about the scientific, environmental, economic, and social issues related to ag-biotechnology so that society in general and policy makers in particular may make sound decisions for the benefit of present and future generations.

We, the undersigned, being scientists, policy makers, members of civil society, and other stakeholders from the public and private sectors:

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Prof. Yaroslav Blume, Full Member of the Natl. Academy of Sciences of Ukraine (2006), Director of Inst. of Food Biotechnology and Genomics (from 2008), Head of Department of Genomics and Molecular Biotechnology. M.S. (Biochemistry) from Kyiv State University (1978), Ph.D. (1982), Dr. Sci. (Dr. Hab.) (1988), Prof. (2006). His scientific career started in Kyiv Univ., continuing in Natl. Acad. of Sci. of Ukraine, long time in Inst. of Cell Biology and Genetic Engineering (1989-2008). He was a visiting scientist at Univ. of Freiburg (1997), Canadian Food Inspection Agency, Ottawa (1998), John Innes Center, Norwich (1998-2003), Antwerpen Univ. (2005-2006), invited professor at Schiller Univ., Jena (2001).

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