BIOTECHNOLOGY IN EUROPEAN AGRICULTURE

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Summary

Last century brought several biotechnology methods in breeding and plant and animal propagation. This contribution is focused on plant breeding, which was up to the seventies based on random occurrence of new traits. Recombinant DNA technique provided an opportunity to introduce desired new traits selectively and rationally by transgenesis. This breeding technology when used properly brings benefit to farmers, consumers and environment. It started fast expansion since 1995. Economy and politics led to European legislation treating transgenic organisms even more stringent than dangerous chemicals. Such approach has no support in science and put serious burden on the competitiveness of European agriculture. It also prevents transgenesis to bring benefits to consumers. As soy meal suppliers may introduce new GM varieties there is serious problem how to feed European livestock when the GMO regulation based on "zero tolerance" of unapproved GMO remains unchanged. The breaking point in agriculture economy that came in 2007 may improve the restrictive approach of EU. In the Czech Republic transgenesis may be also beneficial in non-food agriculture.

Since the beginning of agriculture people picked up best plants for propagation. They took advantage of random natural changes in hereditary traits – mutations. Crossing such selected lines brought improvement by assembling several useful traits in one variety. Mendel laws further improved breeding by introducing rational rules in the transfer of traits from parents to progeny. However, random mutations were the only source of new traits. In order to speed up their occurrence breeders started to use damaging measures – radiation or genotoxic chemicals. The barley Diamant selected after irradiation of the variety Valtický by prof. Bouma is the best known example in our country.

Nevertheless, randomness remains the nature of the process even after introduction molecular methods like marker assisted breeding and breeders notice only obvious traits; molecular changes remain unknown. Consequently, genome alterations introduced by mutations are not evaluated regarding to the health impact neither from ecology point of view. Since induced mutagenesis is cheap and available for everybody, it has not turned into politics. Even in times when public was alert by radiophobia no political interest existed in propaganda against "eating radiomutants". The FAO/IAEA Mutant Varieties Database[1] referred to thousands of them. Although much of them represent decorative plants, several crops and fruits developed in this way come to our dishes. The most common example is Triticum durum, the durum wheat used for all pasta. It caused political stirring in May 2001 when Frankfurter Algemeine Zeitung published this fact.

Advances in molecular genetics and in plant biotechnology gave birth to the transgenesis, a breeding method that introduces the desired trait specifically and selectively. The gene coding for such trait is taken from any organism in nature and is transferred in the crop plant genome. The gene is a product of natural evolution and is relatively well described, as well as the protein it determines. The intervention with other genes is minimal. Naturally, as all new and sophisticated methods, improvement is in progress to make transgenesis

[1] FAO/IAEA Mutant Varieties Database http://www-mvd.iaea.org/MVD/default.htm

transparent and resulting organisms called genetically modified (GMO) efficient and safe. E.g. methods are available to delete trangenes from pollen and seeds to prevent the horizontal transfer[2]

Although the breeding by this technique is very expensive resulting GM crops are quite efficient. Due to the former attribute its development has been limited to big rich multinational companies and necessary large investments ask for tight patenting. The effectiveness of GM crops has contributed to the economy of agriculture so that transgenesis has turned it into an important player in the global agro market. It is quite natural that these factors generate strong competition not only between companies, but also between governments and state associations and pushed transgenesis from science into politics.

The concern about national agriculture led in the Europe to steps erecting a barrier to oversee import of agroproducts. As they come from countries employing transgenesis abolishing the public demand of such "genetically unnatural products" seemed to be the best way how to avoid problems with GATT (WTO). In July 1985 European Commission established Biotechnology Regulation Inter-service Committee (BRIC) with DG XI (Environment) and DG III (Internal Market and Industrial Affairs) co-chairing[3]. In the next year DG XI handled the biotechnology issue in the same way as it used previously for safety legislation in two other fields – chemicals and potentially hazardous industrial activities. It was agreed that the responsibility for contained use of GMO in industrial processes would be divided between DG III and DG XI, whereas the release to the environment would be left to DG XI only. Council Directive 89/391[4] resulted from the former type of use. A group of specialists from the DG V (Employment and Social Affairs) prepared the final Directive 90/679[5]. It defined 4 risk categories of biological agents but did not include specific references to genetic modification.

The chemicals model applied by DG XI introduced analogy to the GMO regulation proposal: compulsory notification, testing, assessment of harmful effects, labelling and establishment of Competent authority in Member States responsible for inspecting the notification and sending it to the Commission, who would forward it to Member States. Between 1986 and 1988 BRIC met ten times and prepared proposal for two Council Directives – 90/219[6] and 90/220[7].

There we several efforts to introduced scientific principles in the legislation. European Federation of Biotechnology, World Health Organization and particularly DG XII (Science, Research and Development) made many attempts. DG XII suggested the establishment of "European Bio-Safety Science Board". But final decision made solely on political grounds formulated in the above two directives the key dogma of European biotechnology regulation:

(a) The risk of novel strains, breeds and varieties follows from the breeding method and

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[2] Yi Li, Hui Duan, and Smith W. Gene-Deletor: A New Tool to Address Concerns over GE Crops. Plant Biotechnology Journal doi:10.1111/j.1467-7652.2006.00237.x

[3] Cantley, M.,The regulation of modern biotechnology: A historical and European perspective. In H.-J. Rehm and G.Reed: Biotechnology, Weinheim, Berlin 1995.

[4] Council Directive 89/391/EEC on the introduction of measures to encourage improvements in the safety and health of workers at work.

[5] Council Directive 90/679/EEC on the protection of workers from risk related to the exposure to biological agents at work.

[6] Council Directive 90/219/EEC of 23 April 1990 on the contained use of genetically modified micro-organisms. Off.J.Eur.Commun. L117, 8 May 1990

[7] Council Directive 90/220/EEC of 23 April 1990 on the deliberate release into the environment of genetically modified organisms, Off.J.Eur.Commun. L117, 8 May 1990

(b) The only risky breeding method to be regulated is transgenesis. Other methods (including, e.g., irradiation) are in principle safe and need no regulation.

Naturally, this has nothing to do with science. Table I demonstrates schematically the comparison of potential risk sources in GMO and radiation mutants. There are more reasons to consider the risk of the latter being higher that that of the former, but still the risk of radiation mutants is classified as an acceptable risk. In short – the rational approach was best characterized by Anonymous in 1992[8] "Products pose no special risks just because of the processes used to make them."

The European GMO legislation supported by propaganda of certain pressure groups and sensation-loving media imposed fear of GMO on public resulting in an atmosphere classified by ex-commissioner David Byrne (Health and Consumer protection) as "GMO psychosis."[9] Particularly the well founded and organized NGO demagogy, e.g. the ´Pure Food Campaign´, later known as the ´Campaign for Food Safety´, ´The ´Global Days of Action Against Gene-Foods´ (spring 1997)[10] and similar resulted in deep misinformation of public. In 2005 more than half of Europeans believed that "eating GMO fruit, my own heredity will be modified" and more than 40% believed that standard tomato has no genes, as these are present only in modified tomato[11].

Instead of mobilising effort to correct these shameful superstitions by broad information and explanation campaign, EU used it as an argument for implementing more and more tight regulation[12]. It requested labelling "made from GMO" even to products lacking any material traces of the transgene – e.g. to ethanol made from GM corn.

Recent GMO regulation reached the level much above that of toxic chemicals: there is not compulsory labelling of products resulting from a process where, e.g., acryloylchloride, cyanide, phosgene or other toxic chemicals are employed. More than that: In chemicals or drug registration the scientific assessment made by groups of experts invited by the Commission is the ultimate ground for decision. Not with GMO. The process is set in such a way that politics can wipe out any science: the conclusion of EFSA is subjected to voting by politicians who may overrule it.

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[8] Anonymous, US Regulation. Nature 356, 6364, 1992.

[9] David BYRNE European Commissioner for Health and Consumer Protection SPEECH/01/565 "Risk versus benefit" European Voice Conference "Farm to Fork" Brussels, 22 November 2001.

[10] DG III: Economic Inpacts of Genetically Modified Crops on Agri-Food Sector. A Synthesis. Working document, Directorate-General for Agriculture, Brusel 2000.

[11] Gaskell G., Allansdottir A., Allum N., CorcheroC., Fischler C., Hampel J., Jackson J., Kronberger N., Mejlgaard N., Revuelta G., Schreiner C., Stares S., Torgersen H. and Wagner:W.: Europeans and Biotechnology in 2005: Patterns and Trends. Eurobarometer 64.3 - A report to the European Commission's Directorate-General for Research, May 2006.

[12] The sequence of regulations: Regulation (EC) No 258/97 of the European Parliament and of the Council of 27 January 1997 concerning novel foods and novel food ingredients.
Council Regulation 1139/98/EC of 26 May 1998 concerning the compulsory indication of the labelling of certain foodstuffs produced from genetically modified organisms of particulars other than those provided for in Directive 79/112/EEC
Regulation (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed.

The only GM crop approved for planting in Europe is Bt corn carrying the protein toxic to Lepidoptera. Brookes 2007[13] (Table 2) summarized the benefit of its growing in European countries where Ostrinia nubilalis or Sesamia nonagrioides represent serious pests.

It was just a question of time when this battle of politics against science is lost. Many voices from scientists[14], economists[15], industry[16], Member States[17], European Parliament[18] and Commission[19] drew attention to the damage and losses resulting from this policy. Important politicians, e.g. German minister Horst Seehofer (CSU - Agriculture and Consumer Protection) as well as his French colleague Michel Barnier ask for clear-cut scientific process of GMO approval[20]. Naturally, WTO cannot be fooled by the excuse "our consumers do not love GMO." But highest chance for the comeback of science results from the fact that the EU fell in its own trap.

Due to the GMO legislation Europe becomes more and more a sort of museum of conservative agriculture. Existing policy of subsidies do not put science in the centre of interest in European agriculture. The approval process of new GM crops for import and processing has all characters of an alibi for WTO. First, the benefit of GM crops to consumers and environment comes from their planting rather from processing[21]. Thus their approval for processing does not contribute to the competitiveness of EU. Quite the opposite: the expensive controls, monitoring, traceability and accompanying bureaucracy increase the cost. Second, the red-tape approval process involving "democratic" voting about scientific references by EFSA takes in most smooth and flexible cases two and half year.

But the rest of the world does not wait. Big players in global agribusiness moved ahead: not just USA, but Argentina, Brazil and recently China and India. Main suppliers of soybeans proceed to introduce new more advantageous varieties. But EU legislation sets ban on non-approved GM crops. As long as the EU was the most important importer of soy meal

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[13] Brookes G. The benefits of adopting genetically modified, insect resistant (Bt) maize in the European Union (EU): first results from 1998-2006 plantings. PG Economics Ltd. March 2007, www.pgeconomics.co.uk

[14] Editorial, Nature Biotechnology - 24, 1178; Oct. 2006, a Shane H Morris, Nature Biotechnology, Jan. 2007, v. 25, p33. www.nature.com/nbt;
Kalaitzandonakes, N. (2007) Compliance costs for regulatory approval of new biotech crops. Nature Biotechnology 25, 509-511.
Montagu, M.van (2007), Innovations Report Feb. 26, 2007.

[15] Kalaitzandonakes, N. (2007) Compliance costs for regulatory approval of new biotech crops. Nature Biotechnology 25, 509-511.

[16] Garthoff B. (2007) The Green Biotechnology Manifesto, EuropaBio Press release, Lyon, France 13 March 2007. http://www.europabio.org/ne_Greenmanifesto130307.htm

[17] ACRE (2007) Wider Issues raised by the Farm-Scale Evaluations of Herbicide Tolerant GM Crops, Report of the ACRE Sub-Group Revised after public consultation, 3 May 2007.

[18] European Parliament, (2006) On Biotechnology: Prospects and Challenges for Agriculture in Europe, Draft Report by Committee on Agriculture and Rural Development, Provisional 2006/2059 (INI).

[19] Mandelson P. (2007) Speech at the European Biotechnology Info Day Bavarian Representation, Brussels, 14 June 2007.

[20] GMO Safety November 30, 2007 http://www.gmo-safety.eu/en/news/599.docu.html

[21] Gómez-Barbero M. and Rodríguez-Cerezo E. (2006) Economic impact of dominant GM crops worldwide: A Review, Institute for Prospective Technological Studies, JRC, EUR 22547.

from Argentina and Brazil[22] (Table 3), these suppliers were careful to keep new varieties away from international market as the export to EU represented about half of their harvest in 2006. Once China and India step in and agree to import soy products with those new varieties, EU becomes just a marginal party and will be confronted with a choice: either drastically reduce the animal production or drastically change the legislation. The majority of the Commission - except for Mr. Stavros Dimas - will seemingly prefer the latter move.

What is the role the Czech Republic may play in this game? The increase in Bt corn planting (5000 ha in 2007) indicates that farmers do not oppose GM crops. Except for bureaucracy imposed by EU requested rules the only problem consists in "GMO psychosis" mood of consumers. However, non-food use may be a solution. The field tests of the BASF potatoes with altered starch composition were successfully performed. The variety Amflora will be probably approved in the EU for planting and for feed and there is no reason why other potatoes varieties should be left behind. This opens an opportunity for revitalization of the traditional potatoes production in our country. The industrial starch manufacturing would be important contribution in several regions. The negotiation concerning starch quota should be started. Industrial starch should not be included in the food starch quota. As most of our neighbours oppose to GM crops our position in industrial starch from GM potatoes with altered starch composition should be better.

There is one more chance for Czech agriculture. The sugar regulation policy of EU was rather damaging for our agriculture and sugar industry. The solution chosen by TTD Dobrovice demonstrates, that the bioethanol production from sugar beet offers the efficiency way above that of cereals (6000 litre/ha) and brings it close to sugar cane[23]. The price of the product may drop when the herbicide tolerant sugar beet is used. Then it may compete with the bioethanol from Brazil. This is exactly in concert with the calculation by Demont et al.[24] They indicated that "with a global annual value of €668 million, herbicide tolerance in sugar beet cultivation is the EU's most promising 'first-generation' GM technology." The planting o herbicide tolerant sugar beet has been studied and found rather beneficial to the environment.[25]

What is the future of biotechnology in European agriculture? Global inflation entered agriculture. The price of wheat zoomed from 3 USD in 2005 to 5 USD in 2006 and over 10 USD/bushel last year. Biofuels and growing demand by China and India were main driving factors. We may hope that this will wake up EU policymakers and giving up the nostalgia of museum-type European agriculture they will adjust conditions for modern methods.

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[22] European Commission – Directorate-General for Agriculture and Rural Development, Economic Impact of Unapproved GMOs on EU Feed Imports and Livestock Production, Brussels, June 2007.

[23] FAO Global Energy Partnership Review: Bioenergy Developmen in G8 + 5 Counties, 2007. www.globalbioenergy.org

[24] Demont M., Dillen K, Mathijs E, and Tollens E (Katholieke University Leuven): GM Crops in Europe: How Much Value and for Whom? EuroChoices, Volume 6 Issue 3 Page 46-53, December 2007, http://www.blackwell-synergy.com:80/doi/abs/10.1111/j.1746-692X.2007.00075.x

[25] Dewar, A.M., Haylock, L.A., Bean, K.M., & May, M.J. (2000) Delayed control of weeds in glyphosate-tolerant sugar beet and the consequences on aphid infestation and yield. Pest Management Science, 56, 4, pp 345-350.

Elmegaard, N. & Pedersen, M.B. (2001) Flora and Fauna in Roundup Tolerant Fodder Beet Fields, NERI Technical Report, No. 349. No. 349 pp (Report).

Table 1

COMPARING POTENTIAL RISK SOURCES OF GMO AND RADIATION MUTANTS

Factor	GMO	Risk	Radiation mutant
New gene	Natural Product of natural selection	<	Artificial Product o DNA damage
New protein	Found in nature Very often part of food or feed	<	Non-existing in nature New for food or feed
Number of changes	Known 1 to 5	<	Not known Many
Knowledge	Good Many solid information	<	Zero Nature of changes not known
Changes detection	Possible Many method available	<	Poor No molecular methods
Monitoring	Easy PCR or RIA standard use	<	Difficult Only morphology changes
Health impact	Tested Allergy, toxicology, feeding	<	Seldom tested Only antinutrients level
Outcrossing	Possible Easy to monitor	<	Possible Limited monitoring

Table 2

Agronomic and economic benefits of Ostrinia and Sesamia-resistant BT corn 1998-2006 (From Brooks 2007)[11]

	Spain	France	Germany	Czech R.	Portugal	Poland	Slovakia
Bt corn area ha	53 667	5 200	950	1 290	1 240	30	30
Infestation 1000 ha	80	300 to 750	300 to 500	31 to 37	15	not available	50
Yield change Bt/nonBt %	+1 to +15	+5 to +24	+14 to +15	+9 to +10	+12	not available	not available
Bt seed price €/ha	35	40-45	39-42	31-38	35	45	35
NonBt gross margin €/ha	1146	559	683	444	515	178	361
Change in profitability €/ha	+141	+98 to +120	+83 to +93	+65	+112	not available	not available

Table 3
Import of soy beans to the EU (27) in million tunes
(From [22])

Year	2003	2004	2005	2006	Fraction export to EU
Argentina	11.1	11.1	12.0	14.4	42%
Brazil	17.7	17.2	17.4	15.4	51%
USA	4.7	2.8	2.6	2.5	9%
Paraguay	0.8	0.8	0.8	0.9	-
Other	0.7	0.8	0.9	0.8	-
TOTAL	**34.9**	**32.7**	**33.7**	**34.0**	-