PRESENT STAGE OF AGRICULTURAL BIOTECHNOLOGY IN ECONOMIST'S VIEW

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First, before starting to write this article I looked up the definition of biotechnologies available in the web. The FAO dictionary (www/fao/org), for instance, gives such explanation of this rapidly developing science of our millennium: biotechnologies are any technologies in which biological systems, living organisms or their derivatives are used in order to create or change final product.

In accordance with this definition biotechnology has been pursued for several thousands of years. Long ago Ancient Egyptians knew biochemical characteristics of yeast for bread-making. Cheese making, cultured dairy produce, brewing are all examples of biotechnologies. At the same time biotechnologies in a strict sense mean a whole number of molecular technologies such as manipulation and transference of genes (trans-genosis), DNA typing and cloning both plants and animals (www/fao/org). This scientific area dates back to the 1970s when geneticists learnt to operate DNA molecule and create man-made DNA molecules-recombinant DNA.

Unlike 1970s and 1980s there is no need to explain the meaning of biotechno-logical revolution at present. Today we wonder - how important its results are and what benefit mankind has got from it. There is an impressive list of biotechnological products in the world market including important fundamental discoveries which have commercial potential in medicine, pharmaceutical industry, agriculture, chemical industry and ecology as well. Thus, in 2005 alone common biotechnological market made a total 34 billions of dollars, sales of technologies related to pharmaceutical proteomics and bioinformatics reaching almost 17 billion dollars. (Commercial Biotechnology Review, 2005)

All this is happening against the background of very significant characteristics of the present stage agricultural development - its globalization and strained international competitive relations in agribusiness resulting in a limited number of widespread merchantable both crop varieties and breeds of farm animals.

Very often the process is accompanied by decreased adaptability of gene pools spread to new reproduction conditions, accumulation of genetic load, and by introduction of concomitant weeds, pests and infectious diseases into new environment as well.

Concerning current complication and worsening of ecological situation in the world the creating of conditions and gene pools which allow forecasting quantity and financial viability of final products despite the consequences of environmental factors has become a leading economic aspect in crop and animal farming. Absolute productivity characteristics of farm produce are of no practical importance any more. Due to the necessity of transition to the intensive development of agrosphere agricultural science is facing an acute problem that is to find a balance between productivity and resistance of crops and farm animal breeds to both biotic and abiotic environmental factors. Thereupon, analysing the present stage of agricultural biotechnology development I would like to emphasise the key dilemmas of this scientific branch.

First, genetically modified objects - GMO. This is a sore point which is being widely debated at present. Unfortunately, negative attitude towards GMO is unconsciously extended to all biotechnologies as a whole. It should be remembered that a tremendous breakthrough in both diagnostics of inherited diseases and curing such serious diseases pathologies as pancreatic diabetes, haemophilia and many others has been done due to achievements in biotechnologies. Whether we accept biotechnology or not, on the basis of recombinant DNA technologies in cells of microorganisms, animals and plants huge pharmaceutical industry produces antibiotics, interferon, hormones, ferments essential in therapy of people.

As to genetically modified foodstuffs, we can say that it is still an open question. But in 1998 under the pressure of public opinion the EU blocked the possibility for genetically modified foodstuffs enter the market. The veto was imposed without any scientific explanations of GMO hazard for people's health in accordance with the world sanitary agreement signed by the world trade organization. Though, as far as we know, 300 million of Americans have already been eating genetically modified soybeans and maize for some years, and there are no registered cases of people's health danger yet. In spite of the ban biotechnological research institutes in Europe haven't stopped working intensively in the field of bioengineering.

Due to the progress in genome dideoxy sequencing of some important crop varieties and creation a new technologies generation of genetic material transfer, cisgenic plants have been developed. (H.J. Schooten, F. A. Krens and E.Jacobsen. Cisgenic plants are similar to traditionally bred plants. EMBO, 2006, 7(8)753-755).

Cisgenic plants are genetically modified organisms too, but unlike transgenic plants they don't have foreign DNA either from microorganisms or from insects, they have a gene from a closely related plant which is able to cross with a recipient in nature, moreover, a regulatory part of an embedded gene being phytogenous. Per se, cisgenic plants are just like plants obtained by traditional interspecies-specific hybridization.

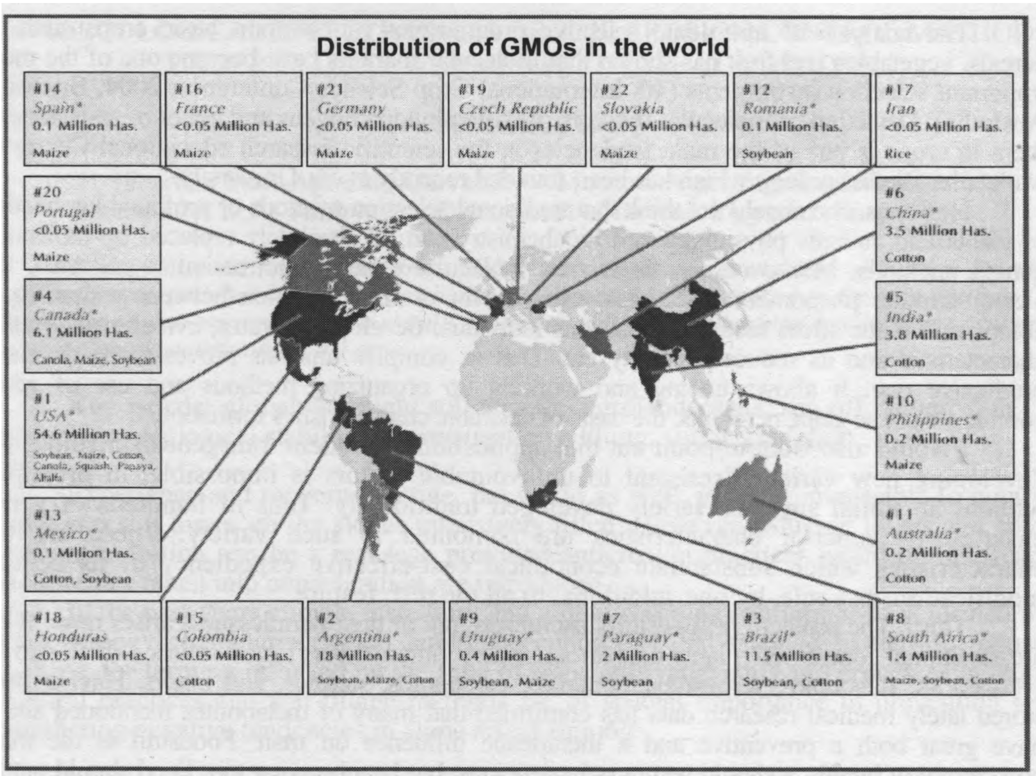
According to ISAAA total area of cultivated genetically modified crops will have increased from 89 to 200 million hectares by 2015.

China takes one of the most leading places in biotechnologies. It was the country where in 1997 a committee on bio-security assessment of genetically modified objects was set up.

Having been examined and approved by the committee twelve out of forty six GM varieties are widely grown by farmers now. From 1997 till 2002 the Chinese government allocated 25 billion yuans (302 million dollars) from the budget in biotechnology. 150 research laboratories working in the field of animals and plants biotechnologies had been opened in China by 2001. (Jikun Huang and Qinfang Wang. Agricultural Biotechnology Development and Policy in China, The Journal of agrobiotechnology management and economics, 2002, 5 (4), 122-135). Concluding the topic of genetically modified organisms and leaving it open for further discussions I would like to point out that both GMO production and their use are only a part of up-to-date biotechnologies. Considerable proportion of all biotechnological investigations and engineering is comprised of the research in molecular marking in animals and plants selection and in such scientific 'omics' branches, playing the principal role in development of so-called 'functional' foodstuffs and being able to meet the requirements of life quality improvement standards, as genomics, transcriptomics, proteomics, metabolomics.

Second, working out new, scientific intensive methods in selection is an important key moment for the intensive development of agriculture nowadays. Availability of genetically conditional variety of desirable characteristics in living organisms and their combinations is obviously the basis of selection.

The main trends of modem plant breeding are: development of methods in order to reveal genetic bases of variability, large-scale breeding of most economically sound optimal genotypes for specific conditions of their reproduction as well as increasing diversity in order to create new forms combining both high productivity and resistance to adverse effect of environment.



The beginning of this trend was formulated by N.I. Vavilov, in his theory about Origin Centres of Cultivated Plants. Due to his scientific studies, his collection of both cultivated and uncultivated higher plants of our planet the first step was taken towards a purposeful research into biosphere with the object of forming approaches to have power over its development. That is why, N.I. Vavilov remains a key person in a present-day world agrarian science, and his scientific works are still widely used in fundamental research into agrosphere state and methods of its sustained development.

It is important to stress that selective methods are changing due to the necessity of a faster process, but the paradigm of selection work stays the same: creating initial genetic diversity in different ways, selection of desirable variants and their further reproduction.

You can see how biotechnologies are replacing traditional methods of selection. How much easier the task of desirable forms selection becomes when molecular markers closely linked genetically to valuable genes are used.

Molecular markers allow accelerating considerably a selection process, increasing its efficiency and decreasing costs of developing new varieties of plants and breeds of animals. Much faster, much cheaper and much more reliable way is sure to select forms not by desirable characteristics but by means of molecular markers of those characteristics. In other words, to select crop forms resistant to phytopathogens there’s no need to infect crops with viruses, fungi or other pathogens in order to find stable forms, one should just carry out a DNA analysis for marker occurrence. It takes only quite a few hours, whereas resistance biotesting takes several weeks and sometimes several months. Molecular markers of quantitative characters responsible for productivity - characteristics which phenotypic selection is rather difficult, have been widely used in recent times.

The analysis of up-to-date selective programmes of common basic crops such as cereals, vegetables and fruit has shown that molecular markers have become one of the most important selection instruments (4th International Crop Science Conference, 2004, Brisbane, Australia). Detection of molecular markers of basic phytopathogens and genes of resistance to them in crops is one of the main tendencies in the scientific-research educational Centre of Molecular Biotechnology which has been founded recently at our University.

However, one should not think that traditional selection methods or profound knowledge of plants and animals physiology and biochemistry can be absolutely replaced by molecular genetic methods. Moreover, the faster new molecular genetic information is collected, the clearer familiar phenomenon becomes, such as, for example, relation between resistance to abiotic and biotic stress factors and various individual development rates, evolutional "youth" characteristic and its reduced stability etc. That is, complex analysis proves to be the most productive one. It allows tracing and working up organizing methods and use of genic complexes per se genic networks, the basis of desirable characteristics formation.

I would also want to point out that application of modem transgenosis methods for developing new varieties resistant to unfavourable factors is impossible, in principle, without an initial superior variety developed traditionally. Tens of hundreds of genes ensuring its superior characteristics are combined in such variety. These are the characteristics which substantiate economical cost-effective expediency of its genetic modification, as a rule, by one, additional to all the rest, feature.

Third. The problem of foodstuffs usefulness, not of their harmlessness arises now. What are functional foodstuffs? Plants contain secondary (intermediaiy) metabolites, which can be grouped as: flavonoids, terpenoids, alkaloids, caratinoids, steroids, and others. Having been stored lately medical research data has confirmed that many of metabolites mentioned above have great both a preventive and a therapeutic influence on man. Foodstuff is the main component of health, it should be not only delicious, but health-giving too. Food should not be injurious to health. It make sense both for an individual and for a whole nation.

Economic side of this question is quite obvious: the healthier people are, the less medical care they need. Using up-to-date 'omics' approaches biotechnologies are able to recognize metabolic ways which lead to phytosubstances synthesis which, in its turn, preserve health. European scientific funds have started contributing to research programmes related with development and selection of cultivated plants rich in secondary metabolites thus, preserving health (e.g. tomatoes, potatoes, wheat, onion etc.) The European Union will finance the 7th framework programme of scientific research in 2007-2013 under the name of 'Foodstuff, agriculture and biotechnology'. The budget of the programme will be approximately 1.9 billion euros. The Russian Federation is one of the participants and our university has already been drawing up a project for the competition in the 7th EU framework programme.

And fourth. It's quite clear that the progress in biotechnology and its great importance in national economy require highly skilled specialists training. Four years ago the faculty of bioengineering and bioinformatics was opened at Moscow State University named after M.V. Lomonosov by initiative of the rector, academician V.A. Sadovnichyi. In the short run we are planning to introduce a speciality - Agricultural Biotechnology, for training specialists in animals and plants biotechnology. Training such highly skilled specialists is only possible if scientists who do research in biotechnologies are involved in the educational process of the University. That is why so much attention is focused on development of both traditional and up-to-date biotechnologies at Russian State Agrarian University - Moscow Agricultural Academy named after K.A. Timiryazev.

Results of scientific investigations into biotechnologies carried out at the University are provided in this issue of "Izvestiya of Moscow Timiryazev Agricultural Academy".