

GMO-BASED OR ORGANIC AGRICULTURE: WHAT CHOICE MIGHT BE BETTER FOR FOOD SECURITY IN THE LONG TERM PERSPECTIVE?

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Abstract

Taking into account emerging fundamental challenges to the food security such as climate change and population growth, a number of countries has started to implement into practice two alternative ways to the agricultural production, that are technologically opposed to each other, but jointly they are forming alternative approaches to the conventional agriculture. First of them is based on the genetic engineering and creation genetic modified organisms (GMO), and the second one – on organic production technologies.

The article considers international experiences of the implementation of these two approaches, their effects in socio-economic dimensions and impact on the food security and the food safety.

Basing on assessment of examples of the implementation of modern approaches in agriculture in international practice, the article provides suggestions on possible state-grade actions that can be considered for insuring the development of organic agriculture as an important prerequisite of the food security and the food safety in the future.

Keywords: *GMO, organic agriculture, agricultural policies, food security, food safety.*

JEL Classification: *Q12, Q13, Q16, Q17, Q18*

1 Introduction

Nowadays in finding appropriate alternatives to the conventional agriculture two relatively modern approaches such as GMO-based and organic-based models of

agriculture are still a subject for dispute and discussion among researchers, professionals and experts.

The emergence of both was conditioned by a need to find solutions that could mitigate negative effects associated with emerging challenges to the food security. Among them there are population growth and predicted scenario of growing hunger, climate change and disturbances in natural weather cycles, as well as a reduction of natural land and soil degradation.

According to expectation of the UN in near future humanity is going to find it increasingly difficult to meet growing demand for food. It is expected that by 2050 the world population will increase by 34% to 9.1 billion people from present 6.8 billion people [1]. It means that if population is keeping its current rate growth by 2050 the world food production should increase by 70% [2].

Climate change is going to seriously affect the decline in food production due to increased level of the average annual temperature, droughts and a reduction in water resources. Mainly it concerns the production capacity of primarily cereals, vegetables, fruits, livestock products and fisheries.

Due to the development of the urbanization, the fertile land of the planet is continuously reducing. According to a report, carried out under framework of the United Nations Environment Program (UNEP), about 849 million hectares of natural land of the world area is expected to degrade by 2050 [17].

Food safety is also important taking into consideration the abundant usage of chemical elements and additives in the food production. For example, to increase productivity and defend agricultural crops from damages caused by weeds and various pests, modern science has elaborated and equipped food producers and farmers with a variety of herbicides, pesticides, insecticides, fungicides, defoliants, phytohormones, growth stimulants and much more. It is also not rare the usage of additives and components, hormonal preparations, antibiotics, growth regulators, productivity stimulants, protein-vitamin concentrates of petroleum and other origin. A considerable part of these substances or products of their decomposition remaining in food gets into our organisms.

Handling growing demand for healthy food in necessary quantities requires to secure intensive and extensive expansion of production capacities in the agricultural and food sectors on the basis of the mobilization of modern scientific, engineering, industrial and marketing ideas.

Thus, the implementation of GMO-based and organic-based models in agricultural production should be viewed as objective answers to emerging challenges to food security. In other words, currently mankind is witnessing the rapid development of new approaches designed to achieve an optimal agriculture output and solve challenges that food security is facing.

By the present, many countries of the world have accumulated necessary knowledge, technology and experience to outline further directions of development of the agriculture and food industry in order to guaranty the four main components of food security in the future.

Before choosing an optimal model of agriculture each country should note that both GMO-based and organic-based models of agricultural production have their positive as well as negative sides. The choice in favor of one of them depends on many factors related to level of economic, scientific and technological development, conditions of trade, and environmental and climatic aspects.

Thus, the aim of the article is to analyze the international experience of the implementation of GMO-based and organic-based models in agricultural production, and to evaluate their impact in socio-economic dimensions in long run perspective. Basing on assessment of the usage of these approaches, the article provides a number of basic suggestions on possible state-grade actions that can be considered for insuring the development of organic agriculture.

2 Data and Methods

In attempt to provide proposals that can be used in the development of corresponding agricultural policies at the state level, authors summarized results of a comparative analysis of the world experiences of the implementation of GMO-based and organic-based agricultural production and related trade.

During the preparation of the article authors used statistical data provided by world renowned institutes and organizations that are dedicated to studies of GMO-based and organic-based agriculture and related issues, as well as publications and articles of authors that are focusing special attention on different aspects of food security and food safety.

In some cases, while providing examples of implementation of GMO and organic approaches in agriculture, authors consciously did not indicate names of specific companies and states, intending to not provide unwilling disturbances in the general society perception of these two modern concepts of agriculture production.

3 Results and Discussion

This section provides summarized results of the assessment of international experiences of the development of the GMO-based and organic-based production and related trade. In particular, the assessment contains main features of both models, including their role in the world agricultural market, the importance of these two models for national agricultural sectors, positive and negative examples

of the implementation of these two approaches in agriculture and their impact on the food security, food safety and “environment” safety.

Based on the analysis of the best practices of the implementation of the organic model of agriculture, the potential for the development of organic farming can be strengthened through the introduction of supportive measures at the state level.

3.1 Assessment of the development of agriculture based on GMO technologies

Agricultural production based on GMO technologies involves methods of genetic correction of structural properties of living and plant organisms. This correction is being achieved with help of genetic engineering and creation of genetically modified organisms. In other words, GMOs are organisms whose genetic material has been artificially altered. These changes would not be possible to achieve in nature by means of the reproduction or the natural recombination. Agriculture production based on GMO technologies are used to improve the qualitative properties of plant varieties and to increase the animal population in order to reduce production costs and increase the consumer properties of final products.

Main characteristics that are introduced at the present time in plants are resistance to herbicides and insect pests. Technologies of this type are used in commercial agricultural and food production, especially in those countries whose territories are prone to frequent droughts, floods and other natural disasters, including tornadoes, hurricanes, etc. Accordingly, these territories can be referred as zones of unsustainable farming.

In the period 1996 - 2016 the total world area allocated for commercial production of GMO-based agricultural products was expanded to 185.1 million hectares. The production of agriculture GMO products for commercial purposes is carried out by 26 countries of the world, including 19 developing and 7 developed countries. In 2016 about 90% of the world's GMO cultivation area was situated in five countries of the world, including the United States (39%), Brazil (27%), Argentina (13%), India (6%) and Canada (6%). In terms of geographical division, in 2016 88% of this area was situated in North and South America, 10% in Asia, 2% in Africa and less than 1% in Europe [14].

The implementation of GMO technologies in agriculture and the food industry is considered among important factors of making a profit in the agricultural sector. The scale of cultivated plant crops based on these technologies in some countries of the world now exceeds the population of "paternal" (original) plants. For example, in the United States 90% of all corn, soy and cotton now contain GMOs [16].

In 2016, the share of certain GMO-based products in the global agriculture production achieved respectively: soybeans - 78%, cotton - 64%, maize - 33%, rapeseed - 24% [15].

Opponents of GMOs commercial agriculture point out that the consequences of using of such technologies are still poorly understood and learned. There are some arguments and facts that prove threat to human health, animals, and the environment, including through the violation of natural biodiversity of nature.

Basing on studies and experience of the implementation of GMO technologies in agricultural systems of individual countries, it is possible to point out several negative effects that affect the sustainable development of agricultural complexes and farms, especially in developing and least developed countries.

In some cases, farmers have a hypothetical possibility of losing access to large markets for their products, i.e. to the markets of countries that restrict or even ban the importation of GMO products. At the same time, losing the access to these markets can be fatal for producing countries because the implementation of GMO-based agriculture has ability to affect all parental plants so that plants of certain types can lose their original, inherent natural qualities and properties forever.

Another controversial aspect of the application of GMOs from market point of view is the monopolization of the world production of seeds and related trade. Only a few companies of the world currently are main producers of genetically modified (GM) seeds. Seed producers patent their inventions and prohibit the use of seeds in other manner than it is envisaged by terms of a contract concluded between a farmer and a company. Often seeds cannot be postponed for sowing in the next year. Inappropriate usage of seeds can be considered as a violation of contract conditions and subsequently followed by penalty consecutives. Thus, for each sowing campaign farmers need to purchase new lots of seeds. In this way, producers of GM seeds using intellectual property rights separate farmers from one of the main means of production – seed grain.

The monopolistic position of GM-seed producers represents some risks for farmers. Having some unseen internal problems in production processes or intercorporate logistics, seed producers can be unable to supply seeds in required volumes. In turn, it creates risks for accuracy of functioning of seed supplies that may lead to the disruption of sowing campaigns at the state scale. Thus, shortages of seed grain have a certain potential to undermine the stability of food markets as a whole, and to restrain ability of farmers to manage properly their production and financial plans as well as accomplishment of agreements.

There are examples when the use of GM herbicides led to an increase in production costs for farmers (e.g. Brazil) that used them to control weeds in soybeans'

growing. In several cases weeds adapted to GM herbicides. That entailed additional costs for purchasing more herbicides of this type or other varieties of herbicides [10].

Concerning the impact of the agriculture based GMO technologies on the environment and human health some evidences show that GM products pollute natural sources of food at a significant pace, with serious consequences. Additionally, pollination by GM plants with traditional "neighbors" leads to mutations of the latter and the loss of their traditional characteristics.

3.2 Assessment of the development of organic agricultural production

The development of organic farming can be considered as another alternative model to conventional type of agriculture. In accordance with the definition of the UN, organic agriculture is a holistic production management system which promotes and enhances agro-system health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system [8].

Organic farming can be defined as an approach to agriculture that considers in production processes the socio-economic and environmental aspects of food security by prohibiting GMO and minimizing usage of external resources in the production, maximizing the use of local renewable resources, managing agro ecosystems and using the market to cut production costs.

Currently, the organic agriculture and related trade are dynamically developing segments of the world market of agricultural and food products. According to the organic market statistics issued by The Research Institute of Organic Agriculture (FiBL), in 2015 the world area allocated for certified organic production achieved 50.9 million hectares [11]. Growth was noted in all spheres of organic production: territory, producers, and retail sales. The regions of the world with largest shares in the total world area designated for organic agriculture are Oceania (45%), Europe (25%) and Latin America (15%). The main countries – owners of biggest areas for organic cultivation are Australia (22.7 million hectares), Argentina (3.1 million hectares) and the United States (2.0 million hectares). In 2015, the number of organics producers in the world, including small farmers, achieved approximately 2.4 million [11].

According to some estimates, in 2016 the world market of organic food and beverages amounted to about 90 billion US dollars [13]. Some international

experts are expecting that the world market of organic food by 2025 can reach 320.5 million US dollars [5].

Positive examples of the development of organic production, as well as its socio-economic importance, create good economic bases for further development of organic farming and agriculture, including export-oriented production. The use of organic farming creates positive effects in the field of improving the food safety. According to the Association of Organic Producers of the United States, if every farmer in the United States produces products in accordance with the requirements for organic production, it will allow to remove from food products about 102 million kilograms of persistent and harmful pesticides [4].

Experience of using the organic agriculture shows that it has great importance in the social dimension, significantly contributing to the development of rural and remote regions. In particular, it stimulates the development of entrepreneurship in rural areas by reducing the scale of migration from rural areas to cities. Various groups of society are given the opportunity to participate in profitable agricultural production. In addition, organic farming, by recognizing the value of local population and traditional knowledge, provides a basis for building organic production in conjunction with modern technologies that strengthen the socio-economic potential of farmers, cooperative farms or local communities. Aggregating all these factors, it is necessary to draw a conclusion about the high potential of organics directly contribute to the increase of food security.

Due attention to the development of farms and agricultural cooperatives is highly important while developing a national strategy required for enhancing of the food security. According to FAO, there are about 570 million farms in the world. More than 500 million of them are attributed to family-type of farms, which together account for about 56% of world food production. Of these 500 million farms, 475 million own agricultural lands with size less than 2 hectares. 74% of the total number of farms is located in the Asia-Pacific region, with China that accounts for 35% of farms and India - 24% [7].

One of the driving forces behind the development of the global organics market is the growing demand for "clean" food products, which, for example, currently is demonstrated by the EU. There are examples according to which the population is increasingly seeking to consume safer food even in countries that are producers of GM products for commercial use (Brazil, India), or in countries that in the recent past have had rather low requirements for the quality of food products (China).

For instance, the demand for organic food in China is rising year to year, as incomes of the middle class are growing. Chinese citizens express fears that they eat unhealthy food that harms health. Nowadays, China is actively importing raw materials

and semi-finished products for the production and exporting organic products. China imports food products that are either not produced by domestic producers, or produced only in small quantities. After a series of scandals in past that were related to the identification of poor quality of Chinese organics abroad, most of the exported products currently are sold in foreign markets under the guise of products of conventional agriculture. With the aim of reviving the trust of both foreign and domestic consumers to products of the national agriculture, for recent years the Chinese government has been tightening regulation in the sphere of organic production.

Assessing benefits and limitations of organic agriculture in the context of food security is complex. The impact of the transition to the organic agriculture depends not only on the farmer and agriculture, on their skills and available resources, but also on relevant support from the state. In many developing countries, organic production is still encountered with a healthy dose of skepticism, since organic products are in most cases more expensive than similar products obtained from the conventional or GMO models of agricultural production.

According to FAO, the productivity of organic agriculture depends on the type of agricultural production used earlier in farm territories [9]. A comparative analysis of productivity while transferring cultivated areas from conventional agricultural model to organic model, according to FAO, has the following correlation:

- In industrialized countries, the use of organic systems may reduce yields. The level of yield reduction depends on the intensity of the external inputs made for enhancing soil fertility in the past;
- In new areas, for example, obtained by irrigation, the conversion to organic agriculture gives almost the same productivity as it has conventional agriculture;
- Agriculture territories that uses traditional rain watering in agricultural production (external inputs for enhancing the quality of soil is minimal), after conversion to organic agricultural model will have a certain potential to increase yields.

The study, that has been conducted for 10 years by the Swiss branch of The Research Institute of Organic Agriculture (FiBL) in Kenya on the efficiency of crop cultivation using both organic and conventional farming models, has showed certain economic advantages in favor of organic farming production [12].

In particular, the results of the research disproved the proposition that organic farming requires a larger territorial space to achieve the same level of profit as conventional model of agriculture. Taking into account the reduction in the cost of purchasing a variety of chemicals used to increase the efficiency of agricultural production, incomes of "organic" farmers start to increase in five years. The use of the organic model in agricultural production proved its profitability not only for ecosystems, including increasing soil fertility, but also human health.

Similar studies on the profitability of using the organic farming model for different types of products, conducted in India and Bolivia, showed also positive results.

Taking into account above mentioned, it should be noted that the development of organic agriculture, organic farms and cooperatives in many countries of the world demonstrate a big potential to be an important component of food security in the national context as well as in international food supply chains.

3.3 State measures for support of the development of organic agriculture

The potential for the development of organic farming can be strengthened through the introduction of the following supportive measures at the state level.

In particular, to ensure the greatest positive economic effects in the organic production, government measures should include the development of advanced agro-technologies, engineering solutions and appropriate economic incentives for the innovative agricultural production.

One of the areas of state support should be dedicated to increasing productivity of organic agriculture. In this regard, it is necessary to envisage greater allocation of financial resources for conducting relevant researches in the field of organic agriculture.

According to the FAO, organic farming helps the soil to preserve nutrients and water in the process of launching so-called nutritional and energy cycles, achieved on the basis of organic technologies. They imply the development and application of such organic farming practices as crop rotation, crop cropping, symbiotic associations, inter-cropping, minimum tillage and the use of organic fertilizers. These methods contribute to the preservation of soil life and improve the structure and stability of soil fertility.

The development of organic farming requires the adoption of new rules and regulations, as well as the introduction of programs to train farmers in approaches and rules of organic production. In many developing countries, organic standards for processing crops and livestock products have not yet been adopted. In this regard, efforts should be made to promote the certification of organic farming and livestock.

Under conditions of free competition, it is necessary to inform consumers about different types of products in order to allow them to make an informed choice in favor of purchasing conventional, organic or "combined" types food products. It is also important to develop appropriate labeling.

From the point of view of supporting organic farming, it is also important to provide the same conditions of support at the state level as the traditional type of agriculture uses. Thus, the prices for products obtained within the framework of

the traditional model of agriculture are being reduced artificially through government subsidies aimed at supporting the development of conventional agriculture. Subsidies provided within the framework of the development of the traditional model of the agro-industry neutralize the impact of external factors on the profitability of conventional agricultural production, and, accordingly, restrain the growth of prices for final consumers of food.

Among the directions of economic policy in the field of organic support, it is necessary to note the need to support "direct" supply chains by reducing the number of intermediaries in order to ensure fair prices for farm products and an equitable distribution of profit margins throughout food supply chains. For example, in recent years, supermarkets in many countries around the world are increasing spaces allocated for the sale of organic products, including their sales on the street.

4 Conclusion

While GMO-based agriculture has a certain potential to guaranty a vast supply of food, under terms of social expectations it needs to meet a balance between effective production, food safety and "environmental" safety that in the future will increase their importance for sustainable food agriculture development. Organic agriculture and farming, based on best practices and experiences, makes it possible to meet the mentioned balance and to solve a number of important socio-economic issues in the long-term run.

In the same time, it would be wrong to consider organic farming and agricultural production as an antagonistic model to the GMO-based agricultural production. At the present stage it is not a panacea for solving food problems such as hunger and malnutrition. However, currently the organic model of agricultural management is demonstrating sustainable development, offering a wide range of economic and social benefits.

The development of organic agriculture has positive effects not only on human health. It also has numerous positive effects in the field of environmental protection and ecology. Thus, providing support for the development of organic agriculture can be considered as an important investment in the economic and healthy development of a country.

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