ECONOMIC IMPACT OF NEW TECHNOLOGIES ON THE AGRI-FOOD PRODUCTION

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Abstract

The emergent population of the globe and the resulted augmented need for food require the identification of some innovative strategies in the agri-food production, able to elevate the degree of global food security. The biotechnologies and the use of genetically modified plants might be a resource in avoiding a global food crisis despite the fact that, with regard to using them, there are certain reticent areas of the world. The countries with developing economies have adopted these modern methods of agriculture which ensure superior yields in comparison with the conventional crops, supplementary benefits for farmers and resolve severe malnutrition problems of the population. The present paper proposes an analysis of the evolution of the global transgenic crops phenomenon, establishing the concentration degree of the cultivated areas and of the GM plants authorised in various areas of the world using the Gini Struck method. The conducted research revealed the absence of correlation between the size of the cultivated land and the authorization of GM plant. There is a low degree of concentration of authorized GM products and a high concentration of transgenic cultivated areas worldwide. The paper has both academic and business applications, proving that from an economical point of view the cultivation of the GM plants is profitable and Romania would be able to obtain substantial benefits from such an innovative agro-food production technology.

Keywords

Agriculture, food, production, new technologies, GMO, concentration, Gini Struck.

JEL Classification

E21, O13, Q16, Q18,

Introduction

The global agro-food production is confronting now with the challenge of providing the food resources for a population of over 7 billion people in 2015 and for an allegedly increase of the population over 9 billion in 2050, and over 11 billion in 2100, respectively

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(United Nations UN, 2015). Under these circumstances, the Food and Agriculture Organization of the United Nation FAO (2009) forecasts an increase with more than 70% of the global food demand caused both by the demographic evolution and by the income growth of people. According to FAO experts, by 2050, the demand of cereals (destined for food or for animals) will probably reach an approximate value of 3 milliards tons and the meat consumption will reach the value of 470 million tons, which will require increases in the production of more than 1 milliard tons of cereal and 200 million tons for meat. At the same time, agriculture might experience a supplementary tension from the international market with regard to the production of biofuels, in relation with the prices for energy and the administrative policies. Under the action of some restrictive factors represented by the limited, in terms of surface, agricultural areas, by the limited resources of water and energy, by the production cycles, which cannot be reduced under certain limits or by the global climatic changes, the global need of foods leads to the identification of new solutions for the vegetal agricultural and zoo-technical production (Alexandratos and Bruinsma, 2012). Despite the fact that it promises a good protection of the environment and healthy and safe products, the ecological production cannot represent a viable solution to the food problems of mankind. According to the studies performed by Stanciu et al (2015), the cancellation of the food wastage, estimated to represent 20-40% of the global agricultural production, might represent an alternative in the reduction of the worldwide food deficit.

Research methodology

The information regarding the authorised (for commercialisation or cultivation) genetically modified plants, cultivated areas, agricultural operators registered in the transgenic agriculture were collected from official documents of European Union, United Nations, Food and Agriculture Organization of the United Nation, Internal Service for the Acquisition of Agri-Biotech Applications, GMO Compass. The data were statistically worked, being graphically represented. The Gini-Struck method was used to determine the concentration degree of the analysed variables. The results were compared with the data in the technical literature.

New directions in the development of agri-food production

Ensuring a worldwide reasonable and sustainable food security imposes the identification of some global strategies based on the reconsidering/innovation of technologies, the increase of the agricultural productivity of fields or the expansion of aquaculture (Godfray et al, 2010). Together with the strategies based on the production optimisation and the well management of the available resources, innovation in the agri-food production make use of the progress registered in the border research sectors of research such as nanotechnology or genetic engineering.

Nanotechnology is a technique derived from the medical and pharmaceutic fields with quite recent applications in the field of agriculture. According to Sekhon (2014), nanotechnology application in the agricultural production includes nanoformulations of agrochemicals for applying pesticides and fertilizers for crop improvement; the application of nanosensors/ nanobiosensors in crop protection for the identification of diseases and residues of agrochemicals; nanodevices for the genetic manipulation of plants; plant disease diagnostics; animal health, animal breeding, poultry production; and postharvest management. Garcia, Forbe and Gonzales (2010) show that the research regarding the impact of these techniques on the environment must be continued but the techniques based on nanotechnology and applied in the agri-food field might have significant benefits in agriculture (by increasing the yield of the crops, with a minimum impact on the soil and on the water consumption, reducing the nitrogen loss, increasing the degree of the long term nutrient incorporation of the soil microorganisms) or in the field of food industry (through a better management of food processing and commercialisation).

The practice of biotechnologies in the agri-food production is a resource in the reduction of famine and poverty, in the adaptation to the climatic changes and in the maintaining of the natural resources basis (FAO, 2016). Biotechnology provides viable alternatives for the synthetic foods and an advancement of plant cultivation conventional technologies. Combined with other advanced agricultural technologies, they are an interesting and responsible method for the environment to satisfy the consumers' need of durable agriculture. Among the available biotechnologies and the practical methods they can be applied, the genetic modification (GM) of crops might be the answer to famine, according to the UN experts (2009). Biotechnology provides possibilities for the developing countries. The use of high yield and pests resistant crops might have a positive impact in the improvement of food security, poverty reduction and protection of the environment. In some cases the transgenic crops can contribute to the reduction of the nutritional deficiencies, the most known example being the Golden Rice, created by researchers in Germany and Switzerland, rich in pro-vitamin A which can help an estimated 250,000 to 500,000 vitamin A deficient children (World Health Organisation, WHO 2016).

Worldwide embracing of transgenic crops

Although in some areas the genetically modified organisms (GMO) are reticently approached due to the partially unknown effects on the environment and on the human race, the transgenic crops were enthusiastically embraced by many states throughout the world. According to the data provided by the International Service for the Acquisition of Agri-Biotech Applications ISAAA (2016) in 20 years of biotech crops cultivation the following aspects can be emphasised the spectacular emergence of the areas allocated to the genetically modified crops and of the farmers who cultivate them. Globally, there are registered 29 transgenic plants, legally approved for using in 40 states and regions of the world, including EU, and which are made and commercialised by 57 developers, mainly private companies. Cumulated, in 2015, there were issued globally 1903 authorisations for commercialisation or cultivation of genetically modified plants, the highest numbers being registered in Japan (214), USA (192) and Canada (169). The concentration degree of the authorisations globally issued can be calculated using the Gini-Struck formula (Savoiu, Craciuneanu și Țaicu, 2010), being represented in table no.1.

$$GS=\sqrt{\frac{n\sum gi^2-1}{n-1}} \qquad (1),$$

where - *n* represents the number of terms of the series under study

- g_i represents the weight factor of issued authorisations for the use of GM plants in the *i* state related to the total number of authorisations.

Table no. 1. The global concentration degree of the GM plant authorisations

Total number of states (n)	Total number of authorized GM	$\sum gi^2$	GS	Observations
40	1904	630.19	25.42	An average concentration degree

Source Authors, by using ISAAA data, 2016

In EU, there are authorised for commercialisation 86 transgenic plants, at present being admitted for cultivation only the genetically modified corn from Monsanto (European Commission EC, 2015). The main characteristics targeted by the mutations are the resistance to different agrotechnic treatments or pests, and the increase of the weight factor of some useful components. From 6 states to apply the transgenic cultures in 1996 (USA, Mexico, China, Canada, Australia, Argentina) it has come to 28 states in 2015, with over 17 million farmers to cultivate them, the areas dedicated summing more than 179.7 million ha. In total, throughout the 20 years of utilisation, there were cultivated approximately two billion hectares of Biotech crop. The state distribution of the cultivated surfaces with transgenic plants is uneven, USA, Brazil and Argentina having more than 75% from the total worldwide surface (figure no. 1).

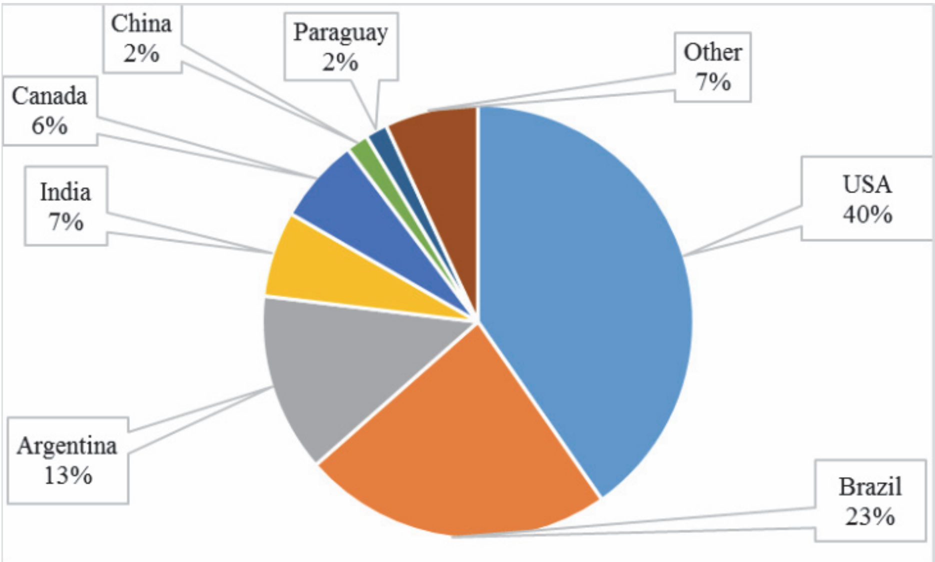

Figure no.1. The distribution of Biotech Crops, by Country
Source Authors, by using James data, 2015

The global concentration degree of the surfaces cultivated with GM plants is displayed in table no. 2. The analysis performed based on the Gini Struck coefficient shows a high degree of concentration of the agricultural surfaces distributed to GM, a normal aspect if taken into consideration the fact that 3 states cover more than 75% of the total globally assigned areas.
The list of the plants approved and of the countries that approve their utilisation is constantly updated on the ISAAA site. Spectacular progresses were registered in the cultivation of cotton, corn or transgenic soy.

Table no. 2. The concentration degree of the global authorizations for the GM plants

Total number of states (n)	Global area of Biotech crops (ha)	$\sum gi^2$	GS	Observations
28	181.5 mil. ha	2440,95	51,60	High concentration degree

Source Authors, by using ISAAA data, 2016

Globally, in 2016, there are registered 291 GM event from 29 plants (figure no. 2), unevenly distributed between the states of the world. As trends, stacked traits continued to be an important and growing feature of biotech crops. About 51 million hectares were stacked in 2014 and the steady and growing trend of more stacked traits continued last year, too.

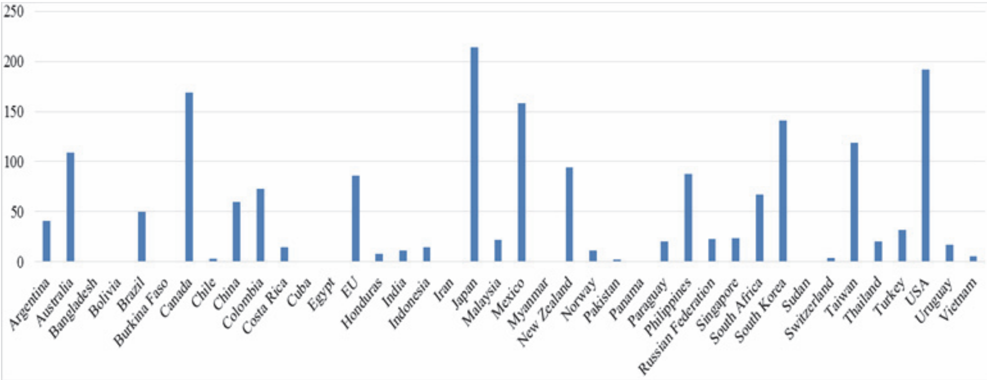

Figure no.2 Distribution of GM events by country

Source Authors, by using ISAAA data, 2016

Economic Data

In the 28 states, where there were cultivated GM plants in the year 2015, live almost 4 milliard people, which means more than half of the world population. With regard to their level, 20 states were developing (including the new biotech crop country Bangladesh) and only 8 were industrial countries, the areas cultivated being highly superior in the developing countries. With an average yearly growth medium of the sector of minimum 3-4%, the first 10 states in the hierarchy of the transgenic growers had an expansion of the cultivated areas in the last 20 years of at least one million hectares. A first calculation reveals that the transgenic crops provide important financial benefits to farmers (table no. 3). According to EC (2000) analysis, the profitability of GM crops should be analysed within a long-term timeframe, keeping in mind the annual fluctuations of crops and prices and the opinions of the request (inclined towards a more careful analysis of the transgenic production) and of the offer, respectively (continually growing as more and more farmers from the exporting countries access this type of production). At the same time, it must be mentioned that the developed countries that do no cultivate GM crops, especially in EU, are importers of cereals and soybean meal to feed animals or for biofuels. According to Stanciu and Sârbu (2015), the ceasing of soy GM production as a result of Romania's adherence to EU, led to annual losses for the Romanian farmers between 150-300 million euros, despite

the existence of a high potential for intern production and of the favourable notice from Romanian Academy.
EU is still careful and prudent with regard to GM plant as there are being applied strict rules regarding their authorization and commercialisation and the adequate labelling to fully inform citizens.

Table no. 3. Cost and yield comparison of GM vs conventional crops

Profitability criteria	**GM Crop**	**Difference GM versus conventional**		Source
		Min	**Max**	
Costs Seeds (Euro/ha)	HT Soybeans Bt Corn HT Canola	13.5 3 11	15 35 25	Various, convergent Alexander, Goodhue Various,
Costs Weed control (Euro/ha)	HT Soybeans Bt Corn HT Canola	-33 6 -8	-36 6 -54	Furman, Selz Duffy Fulton, Keyowski
Yields (%)	HT Soybeans Bt Corn HT Canola	12% 3% 11%	4% 9% 79%	Benbrook Gianessi, Carpenter

Source EC, 2000

Only Monsanto corn is now authorized on a European level, but there still can be noticed a gradual reduction of the areas allocated to this type of crop as a response to public opinion request. The European consumer is constantly against Biotech crops and their direct human intake, and part of the state members have voluntarily given up cultivating transgenic plants. However, in order to cover the consumption needs, there are imported significant quantities of cereals/leguminous GM to feed animals. Thus, the annual average soy consumption on a European level, ranges between 30 and 36 million tons out of which 1 million tons is produced by the state members, the rest being imported mostly from South America (where GM production is dominant), and there are no perspectives of covering the demand with the help of internal production (GMO Compass, 2014). High imports are realized in the case of corn, too, the European market having an annual demand of supplementary quantities of 7-16 tons over the internal production, out of which a third comes from USA, Canada, Brazil or Argentine, traditional producers of GM Maize (EC, 2015b).

Environmental impact

The arguments of the GM seeds producers are based on the reduction with more than 500 million kilograms of the quantity of pesticides used in the last 17 years, a reduced environmental footprint associated with pesticide use by 18.7% or the significant drop of the greenhouse emissions (ISAAA, 2016). In addition, together with the diminishing of the pesticide use there were reduced the cases of farmer illnesses. Furthermore, the studies conducted in Philippines or Romania did not emphasise a significant impact on the environment in the cultivation of Maize or Soy GM. The research performed by the employees of the companies producing transgenic material show that, throughout the 20 years cultivation period, there were not found cases of illness or death in the case of the animals fed with genetically modified feed (ISAAA, 2016).

The researchers' reticence regarding the use of GM plants is mainly associated with the inconclusive relatively short testing period concerning the potential risks of translocation phenomena and modified DNA combination with the human one, animals or plants in the farms, the reduction of biodiversity or the development of some allergic responses of human consumers. Moreover, the elimination of a natural pest might lead to perturbations in the natural trophic chains. The studies performed in US revealed that there is possible for the pests to develop a high resistance to antibiotics or to specific treatments for the GM crops. Additionally, there were situations when there were created certain plants which were not economically profitable, with registered losses of more than 500 million USD (University of New Mexico, 2014).

Conclusions

The new agri-food production technologies are globally required despite the reticence of some areas or countries. The production of GM plants has been the most dynamic sector of agri-food production in the last years, the growing prognosis still being optimistic. The developing countries embrace frenetically the transgenic crops, which are perceived as a solution to stop famine, reduce farmers' poverty or resolve some nutritional problems of the poor population Although EU remains prudent with regard to the cultivation of GM crops, the community market is dependent of the feed required in the zoo-technic sector which are mainly imported from the traditional producing GM food countries. Annually, Europe losses significant money because of feed imports but prefers to do so to increase the food security.

From an economic point of view, the transgenic crops bring important benefits to farmers via the reduced chemical treatments for pests and the use of some resistant plants to environmental conditions, characterised by high productivity which unfortunately lead to their dependence on big GM seeds-producing companies.

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