Agris on-line Papers in Economics and Informatics

Volume IV Number 2, 2012

The Role of Transgenic Crops in the Future of Global Food and Feed

H. Řezbová, O. Škubna

Faculty of Economics and management, Czech University of Life Sciences in Prague, Czech Republic

Anotace

Tento příspěvek se zabývá problematikou geneticky modifikovaných (transgenních) plodin. Hlavním cílem příspěvku je analýza trendů nejdůležitějších skupin transgenních plodin s ohledem na jejich využití jako zdroje potravin a krmiv. Základními analyzovanými skupinami plodin jsou sojové boby, kukuřice, bavlník a řepka. Základními metodami, užitými v příspěvku, jsou řetězové a bazické indexy a regresní analýza časových řad. Na základě regresní analýzy je stanovena predikce vývoje ploch GM plodin na další čtyři období (2012-2015). Vymezením trendů je možné stanovit nezbytnost implementace GM plodin do zemědělských systémů ve všech zemích (včetně EU). Závislost světového agrárního trhu na geneticky modifikovaných (transgenních) plodinách je nesporná a predikce potvrzují další navýšení důležitosti tohoto sektoru.

Klíčová slova

Transgenní plodiny, GMO, trendy, produkce, potraviny, krmivo.

Abstract

The paper is aimed on the problematic of biotech crops planting (GM, transgenic crops). The main aim of this paper is to analyze the trends in the main biotech crops planting groups in the sense of their use for food and feed in the future. The selected groups of biotech crops analyzed in this article are soybeans, maize (corn), cotton and rapeseed (canola). The used methods are chain and basic indexes and regression analysis of times series/ trend data - for predicting on next four years (2012-2015). The trends are able to determine the necessity of implementation the biotech crops planting into the agricultural systems everywhere (also in EU) and it is without the questions if the impact are mainly positive or negative. The dependence of world agricultural commodity market on the biotech crops is undeniable and the prediction acknowledges that the importance is increasing. Pieces of knowledge introduced in this paper resulted from solution of an institutional research intention MSM 6046070906 „Economics of resources of Czech agriculture and their efficient use in frame of multifunctional agri-food systems".

Key words

Transgenic crops, biotech crops, GMO, trends, production, food, feed

Introduction

Global population reached a historical milestone of 7 billion on 31 October 2011. As the population of the world continues to increase, it will be accompanied by an increase in the demand for food. The global acreage under cultivation is no longer increasing because of global climate change or for environmental reasons, and so the only way to increase the food supply is to increase crop yields. GMO production technology may therefore be one way of increasing crop yields and food supply. In such circumstances, food prices will not need to be raised (Chen, Tseng, 2011).

The UK Foresight report 'The Future of Food and Farming' (Government Office for Science, 2011) analyses the predicted pressures on the global food system up to 2050.

More productive GM crops could actually lead to better coexistence between intensive agriculture and biodiversity (Dewar et al, 2003; National Research Council, 2010) and future biotechnologies could be more effective.

GM crops are already contributing to increased yields, greater ease and predictability of crop management, a reduction in pesticide use and fewer post-harvest crop losses (Trait, Barker, 2011).

Biotechnology has been the most rapidly adopted agricultural technology in history. In the United States, 94 percent of the soybean crop, 90 percent of cotton and 88 percent of field corn (maize) are now bio-engineered, known as genetically modified organisms, GMOs[1] . (NASS Report, 2011).

In 2011, biotech soybean occupied three-quarters of the 100 million hectares of soybean globally, biotech cotton almost 80% of the 30 million hectares of global cotton (64% in the year 2010), biotech maize over 30% of the 159 million hectares of global maize (29% in 2010) and biotech canola (also called rapeseed) more than one-quarter of the 31 million hectares of global canola - 23% in 2010 (ISAAA Releases, 2011). This information is significant argument for the propagators of biotechnologies. The results of the reports all around the world about the trends of biotechnology in agriculture are clear – the share of GMO (genetically modified organisms) is increasing in each indicator, in the amount of hectare, in the amount of volume and also in the amount of consumption and of the share on the foreign trade.

Across the globe, experts Galvão (2010) and Parente (2010) expect to see a marked increase in corn (maize) and canola GMO varieties in the next few years, which currently make up 30 and 23 percent of those crops, respectively. Developing nations, including China, India, Brazil, Argentina, South Africa and Mexico are now using GMO varieties in nearly 62 percent of their acreage. With further dramatic growth of GMO use predicted in these countries, the use of GMOs worldwide is projected to grow at a much faster rate in the next five to 10 years than in the United States. In China, for instance, hundreds of new biotech companies have recently emerged (Zhu et al., 2009). Adoption of plant biotechnology continues to grow worldwide as confirmed by the International Service for the Acquisition of Agri-Biotech Applications (James, 2010) announcement that 15.4 million farmers in 29 countries grew biotech crops on 148 million hectares in 2010. This is a 10 percent increase over 2009. This represents 9.4% of the world's arable land, an area equivalent to over five times the size of the UK. The majority of existing commercial genetically modified (GM) crops have been designed to express transgenic proteins with a limited spectrum of biological activity, e.g. insect resistance and herbicide tolerance (Codex, 2003), (Chassy et al., 2004) and (Chassy et al., 2008).

Genetically modified crops – primarily canola, cotton, maize and soybeans modified for insect-resistance and herbicide-tolerance – presently widely used have earned the label of sustainable intensification in global agriculture through the vital role of science (Raven, 2010). Ruttan (1999) has developed a simple three-stage classification of the goals of agricultural biotechnology development starting with stage one where the goal is lifting the yield ceiling of cereals. The second stage focuses on enhancing the nutritive value of cereals such as golden rice, which increases the Vitamin A intake, and reduces child blindness. The third stage focuses on the development of plants as nutrient factories to supply food, feed and fiber. The critics of biotech crops include Altieri (2001), Greenpeace, Oxfam, Global Justice Ecology Project, Vandana Shiva, Zerbe (2004). Critics emphasize the potential health and environmental risks and the dominance of multi-national corporations in research and decision making in developing countries.

The European Union (EU) is one of the small group of countries standing against these trends. The European Commission is strictly for high level of control in this field of agricultural sector. The single steps in legal regulations are the clear proof. In the EU, seven countries (Spain, Czech Republic, Romania, Portugal, Germany, Poland and Slovakia) planted MON 810, a genetically modified maize variety from Monsanto, on a commercial basis in 2008. The total acreage for the seven countries increased from 88,673 hectares in 2007 to 107,719 hectares in 2008 (James, 2008), with Spain being by far the most important adopting country in Europe (Gomez-Barbero et al., 2008 a,b). However, in 2009, the EU acreage decreased by 9 % compared to 2008, partially due to a German ban on MON 810. According to James (2009) the decrease was associated with several factors, including the economic recession, decreased total plantings of hybrid maize and perceived disincentives due to onerous reporting of intended plantings of MON 810 (Kaphengst, 2011) In France and Germany, national cultivation bans for genetically modified Bt maize (MON810) were enacted in 2009. Both countries have suspended the approval issued according to EU law. In the meanwhile, stricter co-existence regulations apply in almost all EU member states (GMO Compass, 2009).

The main aim of this paper is to analyze the trends in the main biotech crops planting groups in the main producer countries. The partial aim is to analyze the impact on world agricultural commodity market in the possibility to operate without these crops. The selected groups of biotech crops analyzed in this article are soybeans, maize (corn), cotton and rapeseed (canola).

[1] in this contribution is term biotech crops equivalent GMO crops

Material and methods

Data used in this paper comes from the following sources: ISAAA Briefs No. 1-43: Global Status of Commercialized Biotech/GM Crops: 1996-2011 (author Clive James), National Agricultural Statistics Service (NASS, 2010-2011) - Agricultural Statistics Board, U.S. Department of Agriculture, FAOSTAT database (2011, direct access), CÉLERES AMBIENTAL (Brazil database) and FEFAC Statistical Yearbook 2009, 2010: Feed & Food.

The first used statistical methods are the Fixed Base Index Numbers and Chain Base Index Numbers. For Fixed Base Index Numbers (usually just called Index Numbers), the Base is given the value 100 and everything after that is given relative to the Base, going above 100 for higher values or below 100 for values which drop below the original. For Chain Base Index Numbers, each value is given an Index based on the previous value being used as the Base.

The second used statistical method is simple regression analysis of times series/ trend data, for predicting on next four years (2012-2015). Linear prediction is a mathematical operation where future values of a discrete-time signal are estimated as a linear function of previous samples. Linear regression can be used to fit a predictive model to an observed data set of y and x values. Simple linear regression predicted values of one variable.

The data are pairs of independent and dependent variables {(xi,yi): i=1,...,n}. The fitted equation is written y = ax + b, where y is the predicted value of the response obtained by using the equation. Regression coefficient represents the rate of change of one variable (y = million hectares) as a function of changes in the other (x = year); it is the slope of the regression line. The simple linear regression is counted by STATISTICA 10 Software.

The trends are able to determine the necessity of implementation the biotech crops planting into the agricultural systems everywhere (also in EU) and it is without the questions if the impact are mainly positive or negative.

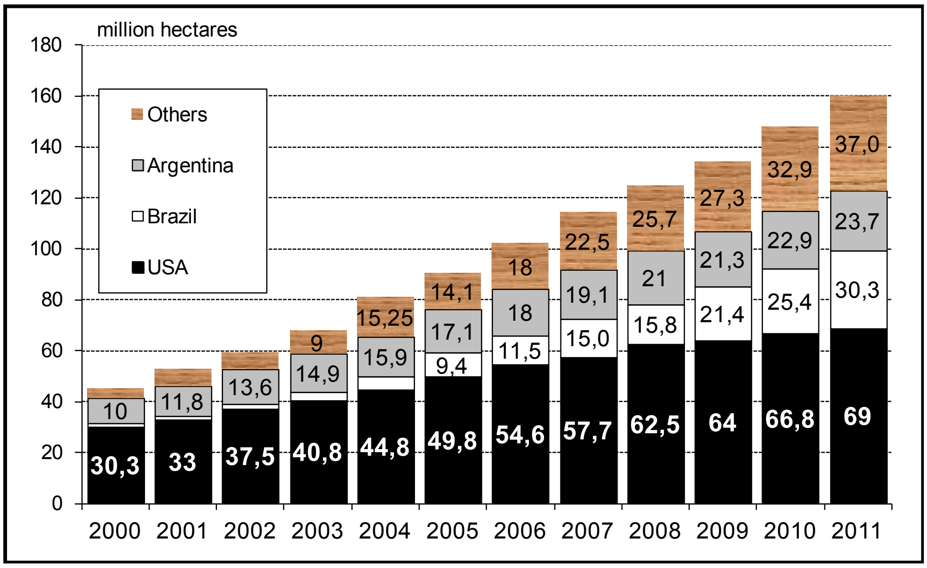
Results and discusion

1. Basic overview

The growth from 1.67 million hectares of biotech crops in 1996 to 160 million hectares in 2011 is an unprecedented 96-fold increase, making biotech crops the fastest adopted crop technology in the history of modern agriculture. Global acreage of biotech crops continued its strong growth in 2011 for the sixteenth consecutive year – a 8 %, or 12 million hectare increase, notably the third largest increase in 16 years, reaching 160 million hectares, – up significantly from a 10% growth or 14 million hectares increase and a total of 148 million hectares in 2010 (James, 2011). Of the 29 countries planting biotech crops, it is noteworthy that 19 were developing and 10 where industrial countries. The top nine countries each grew more than 2 million hectares - in decreasing order of acreage they were: USA (69.0 million hectares), Brazil (30.3), Argentina (23.7), India (10.6), Canada (10.4), China (3.9), Paraguay (2.8), Pakistan (2.6) and South Africa with 2.13 million hectares.

There is considerable potential for increasing the biotech adoption rate of the four current large acreage biotech crops (maize, soybean, cotton, and canola), which collectively represented almost 160 million hectares of biotech crops in 2011 from a total global potential of 320 million hectares; thus, there are approximately 160 million hectares for potential adoption (James, 2011). Developing countries grew close 50% (48,875%) of global biotech crops in 2011 and will exceed industrial countries acreage in 2012. In 2011, the growth rate for biotech crops was much faster in developing countries, 11% or 8.2 million hectares, versus 5% or 3.8 million hectares in industrial countries. The five lead developing countries in biotech crops are China and India in Asia, Brazil and Argentina in Latin America, and South Africa in Africa.

Total world area of GM crops is divided into main producing countries; it is illustrated in Graph 1. Till the 2009 were two states with the largest acreage USA and Argentina, from this year is on the second position Brazil. Brazil is perceived as the driving force for biotech crop investment in the future. From the view of share, in the year 2000 the USA produced nearly 67% of biotech crops, Argentina around 22% and Brazil was almost around zero % - all other countries around 11%. The share of the USA at the total biotech crops area is decreasing – in 2010 43,1%, the same situation is in Argentina – in 2010 14,8%, but other countries share grew to nearly 40% (from this group is important Brazil – more than 18,9%, Canada – around 6,5%, India – 6,5% and China – 2,4%; other countries – Paraguay, Pakistan, South Africa and Uruguay have each less than 2%). From the view of the growth rate the rapid increase in share can be seen only by Brazil and by some states from the group "Others" – for example India.



Source: Global status of commercialized biotech/GM crops: 2000-2011. ISAAA Briefs, ISAAA: Ithaca

Graph 1. Area (million hectares) GM crops in main producing countries.

	1996	2008	2009	2010	2011	Crops 2011: structure in %
Soybeans	0.4	65.8	69.2	73.3	75.4	47.1%
Maize	0.5	37.3	41.7	46.8	51.0	31.9%
Cotton	0.8	15.5	16.1	21.0	24.7	15.4%
Rapeseed	0.2	5.9	6.4	7.0	8.2	5.1%
Total	1.67	125	134	148	160	100%
Soybeans : Chain Index	x	12.3%	5.2%	5.9%	2.9%	x
Soybeans : Base Index	x	164.5	173	183.25	188.5	x
Maize : Chain Index	x	6%	12%	12%	9.0%	x
Maize : Base Index	x	74.6	83.4	93.6	102.0	x
Cotton : Chain Index	x	3.3%	3.9%	30.4%	17.6%	x
Rapeseed : Chain Index	x	7.3%	8.5%	9.4%	17.1%	x

Source: Global status of commercialized biotech/GM crops: 2010,2011. ISAAA Brief No.42,43, ISAAA: Ithaca, NY Fefac (2010). Based on USDA; IAAS; CÉLERES AMBIENTAL® Brazil, own calculation

Table 1. Distribution of Biotech Crops, by Crop, million hectares.

The distribution of the global biotech crop area for the four major crops is illustrated in Table 1 for the period 1996 to 2011. It clearly shows the continuing dominance of biotech soybean occupying 47.1% of the global area of biotech crops in 2011; the entire biotech soybean acreage is herbicide tolerant RR®soybean. Biotech soybean retained its position in 2011 as the biotech crop occupying the largest area globally, occupying 75.4 million hectares in 2011, 2.9% higher than 2010 and biotech maize had the second highest area at 51.0 million hectares and also had the third highest year-to-year growth rate for any biotech crop at 9%. Biotech cotton reached 24,7 million hectares in 2011 and grew at the highest of all biotech crops at a rate of 30.4% between 2009 and 2010 (17,6% between 2010 and 2011). Rapeseed reached 8.2 million hectares in 2011 with an 17.1% global growth rate and planted in Australia for the first time in 2009.

Table 1 shows the Fixed Base Index Numbers and Chain Base Index Numbers of described GMO crops. The share is increasing for each commodity, but the important is the dynamic in last four analyzed years (2008 – 2011), because it shows the trend for next years. The Chain Base Index Numbers is higher for maize (9% between 2010 and 2011) than for soybeans (nearly 3% between 2010 and 2011). Soybeans are also single crop with falling dynamic in last four years. Other two crops are also increasing – rapeseed slowly (the main reason is given by approach to GMO rapeseed in the most of states where it is planting) and cotton with big jump in 2010 (30.4% against 2009). The limits which can determine the dynamic of growth is partially possible to see in the Graph 3.

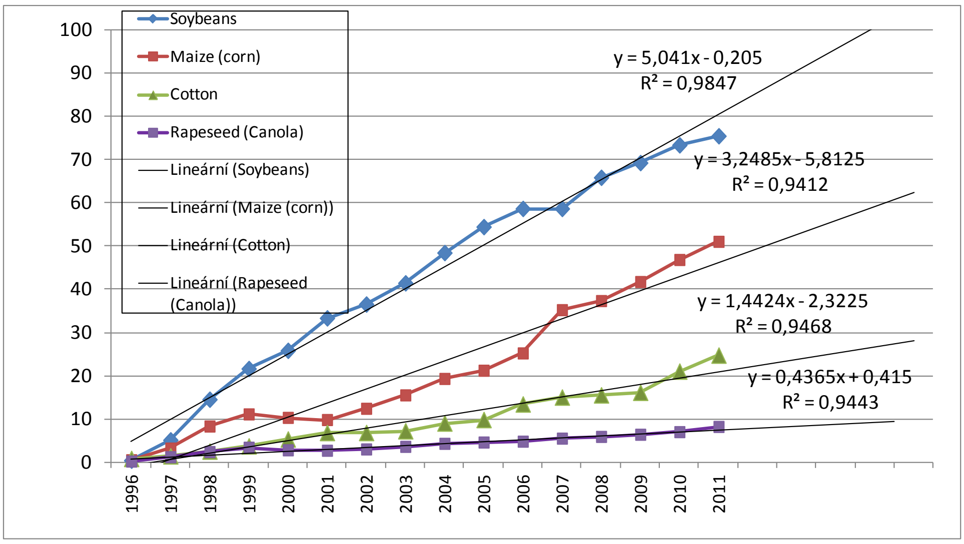
Roundap Ready sugarbeet is an important relatively new biotech crop first commercialized in the USA and Canada in 2007, and an increased adoption rate of 59% in 2008, and 95% in 2009 when acreage reached more than 1 million hectares (in 2011) – this makes it the fastest adopted biotech crop since the genesis of commercialization in 1996. Roundup Ready sugarbeet varieties have been planted in 10 U.S. states: Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, Washington and Wyoming. Canadian growers planted more than 37,000 acres in two provinces, Ontario and Alberta. (Monsanto, 2011).

RR alfalfa, first grown in 2006, occupied 102,000 hectares equivalent to approximately 5% of the 1.3 million hectare seeded in the USA in 2009, with no further planting taking place in 2009 until the restraining order on planting is rescinded in the USA. Small acreage of biotech virus-resistant squash and papaya continue to be grown in the USA and China also grows about 4,500 hectares of PRSV resistant papaya and 447 hectares of Bt poplar.

Regression line, calculate in the Graph 2 is linear (y = ax + b) and the regression coefficient is the constant (a or Beta). Regression coefficient represents the rate of change of one variable (y = million hectares) as a function of changes in the other (x = year); it is the slope of the regression line.

The highest value of regression coefficient includes soybeans line, Beta = 5.041, i.e. year-to-year prediction growth is 5.041 million hectares. In 2015 can be achieved 100.62 million hectares of biotech soybeans (see Table 2, paragraph: Year 2015 prediction).

The second highest value of regression coefficient includes maize line, Beta = 3.24853, i.e. year-to-year prediction growth is 3.24853 million hectares. In 2015 can be achieved 59.16 million hectares of biotech maize. The third highest value of regression coefficient includes cotton line, Beta = 1.44235, i.e. year-to-year prediction growth is 1.44235 million hectares. In 2015 can be achieved 26.52 million hectares of cotton. The lowest value of regression coefficient includes rapeseed (canola) line, Beta = 0.43647, i.e. year-to-year prediction growth is 0.43647 million hectares. In 2015 can be achieved 9.14 million hectares of rapeseed (canola).



Source: Global status of commercialized biotech/GM crops: 1996-2011. ISAAA Briefs, ISAAA: Ithaca, NY, own calculation, comment:term “lineární“ means linear

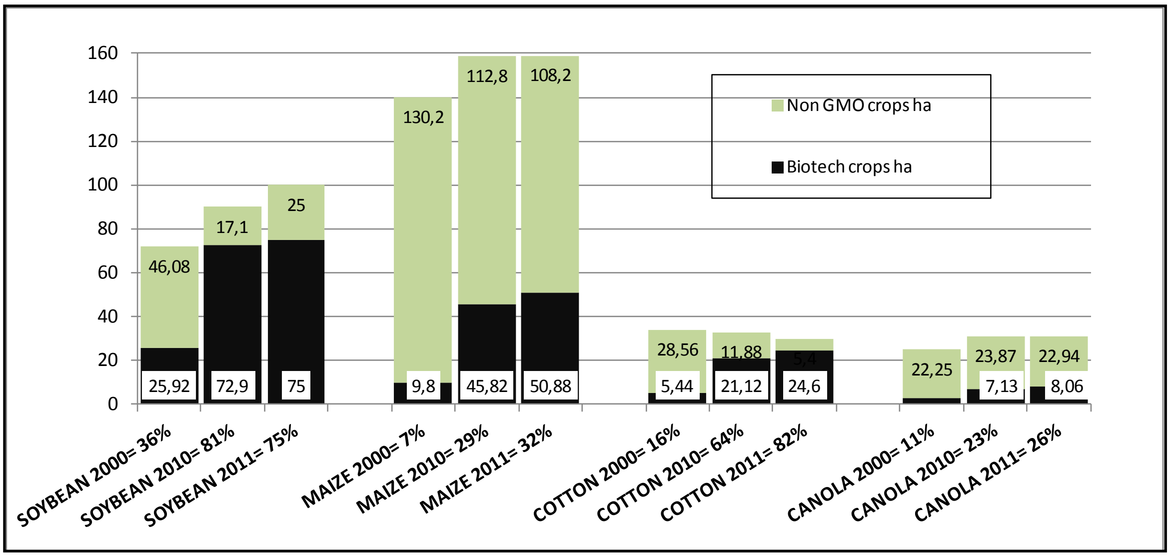
Graph 2. Distribution of Biotech Crops, by Crop, million hectares, regression analysis of times series.

	Absolute term	Beta coefficient	p-value (Beta coef.)	F (1,14)	Year 2015 prediction	-95% prediction	-95% prediction
Soybeans	-0.20500	5.04103	0.00000	902.78	100.62	96.16	105.07
Maize	-5.81250	3.24853	0.00000	223.93	59.16	53.39	64.93
Cotton	-2.32250	1.44235	0.00000	249.39	26.52	24.10	28.95
Canola	0.41500	0.43647	0.00000	237.52	9.14	8.39	9.90

Source: STATISTICA 10 Software, Data :Global status of commercialized biotech/GM crops: 1996-2011. ISAAA Briefs, ISAAA: Ithaca, NY

Note: In statistical significance testing, the p-value is under 0.015 by all Biotech Crops. The results are statistical significant.

Table 2. Main statistical characteristic of Biotech Crops distribution.



Source : Global status of commercialized biotech/GM crops: 2011. ISAAA Brief No.42, ISAAA: Ithaca, NY, own calculation

Graph 3. Global Adoption Rates (%) of Main Biotech Crops (million hectares), 2000 and 2011

The conclusions made from simple linear regression are statistically significant and correct, but there is necessary to compare the linear trends to real world situation. How it is written bellow, the important is the total acreage and the share of biotech crops. For example to achieve the 100 million hectare of biotech soybeans in 2015 means to exceed the total present acreage. But it is relatively possible (see Graph 3) and there is also second significant reason for exceed acreage of biotech soybeans – the positive approach to GMO in the main world producing countries. Growth of soybean is thus determined by fulfilled capacity in USA, Argentina and Brazil. From these reasons the realistic is prediction by corn and cotton. Growth in biotech rapeseed is determined by EU politics, EU is main world producer of rapeseed.

According to database FAOSTAT, in the 2010 total area harvested of soybeans reached 99.5 million hectares. Main producer were USA (30.9 million hectares, 31 percent of soybeans world area), Brazil (21.75 million hectares, 22 percent), Argentina (16.77 million hectares, 17 percent), India (9.8 million hectares, 10 percent) and China (9.19 million hectares, 9 percent of soybeans area. In the 2010 total area harvested of maize reached 158.6 million hectares. Main producer were USA (32.2 million hectares, 20 percent of maize world area), China (31.2 million hectares, 10 percent), Brazil (13.8 million hectares, 9 percent), India (8.3 million hectares, 5 percent) and Mexico (6.2 million hectares, 4 percent of maize world area). In the 2010 total world area harvested of cotton reached 33.1 million hectares and total area harvested of rapeseed reached 30.9 million hectares (Fefac, 2009).

	2002	2007	2008	2009	2010	2011
USA: Soybeans	74	92	92	91	93	94
USA: Maize	32	60	80	85	86	88
USA: Cotton	71	87	86	88	92	90
Argentina : Soybeans	95	99.5	99.5	99.5	99.5	99.5
Argentina : Maize	30	65	83	85	85	88
Brazil : Soybeans	60	64	65	71	76	79
Brazil : Maize	n.a	n.a	12	43	74	78

Source : Fefac (2009, 2010). Based on USDA; IAAS; CÉLERES AMBIENTAL® Brazil

Table 3. Plantings of GMOs in major countries as % of total acreage.

2.Biotech crops for food and feed

In the world, 29 % of soybean production is used as food and industry, 71 % is used for livestock feed. The increased volume of imported soy entering Europe primary comes from Argentina and Brazil. In 2007, Argentina and Brazil supplied nearly four-fifths (79.3 percent) of the 32.3 million metric tones of imported feed going to the EU. While these two countries are the key exporters, a large share of the exported soybeans grown in Paraguay and Uruguay are shipped through the soybean export terminals.[2] Average EU consumers, who eat 41 kilos of pork, 22 kilos of poultry and 9 kilos of beef annually, consume almost 56 kilograms of hidden biotech soy.

Soybeans, soymeal, maize, wheat, rapeseed and rapeseed meal are used in livestock feed. Yet not all the ingredients for livestock feed used in the EU, either prepared by commercial firms or on-farm, are solely sourced within the EU market (Nowicki, P. et al. 2010). Among the imported ingredients are maize and soy as well as the products derived from them (e.g. maize gluten feed and soy meal). The import of protein feed is a particularly sensitive issue where countries (including EU Member States) do not have the capacity to meet domestic needs of either soy or/and maize, and therefore depend on the capacity of a few key suppliers.[3] Aminy those countries/regions are the EU but also China, which together represent over half of world demand for imported livestock feedstuffs.

During the last three marketing years (2007/08 to 2009/10), the EU imported on average 34.1 million metric tons of soymeal equivalents[3], which accounted for 30% of the total tradable amount in the world market. As regards maize, the EU imported on average 7.9 million metric tons per year and over the same period - 9% of the total tradable amount (USDA-FAS, 2010a and 2010b)[4]. The global demand of crop protein, however, is being amplified around the world by the rapid economic growth of developing countries, which are catching up to the more mature economies (e.g. China imports of soybean increased by 43% during the last three marketing years; see USDA-FAS, 2010a and 2010b). It is in this context that the prospect for EU demand is to be considered.

European feed imports surged since the WTO went into effect. Since 1995, soy meal imports from outside the European Union to the 15 member states prior to 2004 (EU-15) grew 57.1 percent to 20.2 million metric tonnes in 2007. Total maize imports nearly doubled to 21.6 million metric tonnes. Soy exports from Latin America fueled deforestation. Four-fifths of EU soymeal imports came from Brazil and Argentina. The demand for more soybeans has been a key catalyst for clearing 44.5 million acres of forests in these two countries.

3. Biotech crops for fuel and fiber

Cotton is the main biotech crop produced for fiber. Leaders in this regard are the USA, India and China. In India, field area rose from 7.6 to 8.4 million hectares. In 2009, 87 per cent of Indian cotton production was based on GM cotton. (GMO Compass, 2009)

The USA were for a long time the main world producer of GM cotton, around the year 2004 the other world production was exceeded USA and from this time till now is great increase in biotech cotton worldwide – for example in 2000 was USA

[2] Eurostat. "Food: From Farm to Fork Statistics." 2008 at 13.

[3] Argentina, Brazil, Paraguay, Serbia, Ukraine and the USA are the primary EU sources for soy and/or maize.

[4] USDA-FAS (2010a). Grain: World Markets and Trade. Circular Series FOP 9–10, September 2010.
USDA-FAS (2010b). Oilseeds: World Markets and Trade. Circular Series FOP 9–10, September 2010.

share 72%, in 2008 17%. In 2010 the share of cotton on the whole area of GMO crops was around 14.2% - area of 21 mil ha. (ISAAA Brief, 2008)

Brazil is good example of fast adoption of biotech cotton in the agricultural production. Generally is the total area in time decreasing, but the yield is growing up (nearly 2 million ha in 1990 and now less than 1 million ha, but total production from around 0.7 million MT in 1990 – the lowest was in the middle of nineties (around 0.3 mil MT) – to nearly 1.5 million MT presently. There is no possible to make the result that the total production is increasing on the ground of increasing the share of biotech Cotton. How is in Kaphengst report (2010) in each of five analyzed countries is the yield of biotech cotton higher than in conventional cotton, but the differences are significant – less than 1% in USA till 50% in India. The Bt cotton is in Brazil used from 2004 and today it is on the area of around 0.2 mil ha.

This crop is also the object of one of the first studies about the influence of planting GMO on soil quality. The Navdanya study (2009) is the first that has looked at the long term impact of Bt cotton on soil organisms is a wake up to regulators worldwide. It also shows that the claims of the Biotechnology industry about the safety of GM crops are false. The soil, its fertility, and the organisms which maintain the fertility of soil are a vital aspect of the environment, especially in the context of food and agricultural production. A recent scientific study carried out by Navdanya (2009), compared the soil of fields where Bt-cotton had been planted for 3 years with adjoining fields with non GMO cotton or other crops. At this rate of described soil degradation, in a decade of planting with GM cotton, or any GM crop with Bt genes in it, could lead to total destruction of soil organisms, leaving dead soil unable to produce food.

Generally for fuel can be used all described crops in this article. The principles of biofuels are based on liquid extracts from the crops – the oil for biodiesel and the ethanol for bioethanol. Nowadays there is no GM crop planting especially for burning. The use of GM crops is thus for combustion motors. The main share of planted biotech crops processed on fuel is in the USA. The biofuels are widely supported in developed countries (the natural conditions only in the same type of country as for example is Brazil let get enough energy from the crops (sugar cane) for successful competition of biofuels with fossil fuels) and thus the consumption is mainly in these countries. From this reason is relevant example of using biotech crops for fuel the USA. The highest share used for biofuel has maize (and 86% of maize acreage is GMO), around 21% in domestic market, but more than 17% is exported and there is also potential for fuel production. From the total domestic soy consumption (soybean oil is the main feedstock for biodiesel production in the USA) only 3% are used for biodiesel, but from the domestic soybean oil consumption is the share of 14% (and 93% of maize acreage is GMO). (Food&Fuel, 2008)

Conclusion

In the context of the main trends in world production of analyzed crops, the question of EU ability to protect the consumption of food, feed, fiber and fuel against the biotech crops is important. For example: the EU is depending on soya import, mainly for feed – it is the result of agrarian policy without the signals of any change of this situation in the near future – so, EU has to import soybeans and soybean meal, and if they will probably be worldwide in next few years nearly from 100% GMO, there will not be any other possibility for EU than to accept biotech crops as the standard part of agricultural production. Now, around 75% of soy import to EU is from Brazil and Argentina. In the field of crops for feed, the dependence of EU on the import from GMO acceptable country is significant. The second important part of agrarian commodity import is for fuel – the import from Brazil is the most fundamental (sugar cane for bioethanol, but it is not GMO yet), as well as the import of soybeans and other oils, but the segment of biodiesel is based on rapeseed produced in EU (about 65%), the share of soya oil is about 14% and palm, sunflower and other oils (each less than 10%) (Gelder at al., 2008). The question of biotech crops for fiber is the question about cotton – this part in the relation of import to EU is not solved in this contribution, but the presumption is that it is imported in the processed form as textiles and clothes. The impact of world biotech crops production in the field of food in EU seems to be not significant presently, because of strict EU policy against GMO, but in this field is valid also the presumption from the beginning of this conclusion.

Worldwide, in the near future the development in biotech crops is expected mainly in Africa (South Africa, Egypt) and in some states in Asia (Pakistan) and Latin America (Brazil, potential in Mexico) – it relates to the share of biotech crops on total acreage in these countries. ISAAA predicts the doubling of acreage of biotech crops (more than 300 mil. ha) and the share in arable land in the world of about

20%. The amount of GM crops has also been increasing – new types of rice, sugar cane, sugar beet, potatoes, etc.

Acknowledgements

Pieces of knowledge introduced in this paper resulted from solution of an institutional research intention MSM 6046070906 „Economics of resources of Czech agriculture and their efficient use in frame of multifunctional agri-food systems“.

Corresponding author:
Ing. Helena Řezbová, Ph.D.
Department of Economics, Faculty of Economics and Management
Czech University of Life Sciences Prague
Kamýcká 129, 165 21 Prague 6, Czech Republic
Phone: +420 2 2438 2087
E-mail: rezbova@pef.czu.cz

References

[1] Altieri, M.A. (2001). Genetic Engineering in Agriculture: The Myths, Environmental Risks and Alternatives, Food First. Oakland, CA., ISBN 0-935028-93-5.

[2] CÉLERES AMBIENTAL® , Brazil database, [Online], Available : http://www.celeres.com.br/1/index.html [20.1. 2012- 5.5. 2012].

[3] Codex (2003) Alinorm 03/34: Joint FAO/WHO Food Standard Programme, Codex Alimentarius Commission, Appendix III, Guideline for the conduct of food safety assessment of foods derived from recombinant-DNA plants (CAC/GL 45-2003), 25th Session, Rome, Italy, June 30–July 5, 2003, pp. 47–60. [Online], Available: http://www.codexalimentarius.net/download/standards/10021/CXG_045e.pdf> [20.1.2012].

[4] Chassy et al., Chassy, B., Hlywka, J.J., Kleter, G.A., Kok, E.J., Kuiper, H.A., McGloughlin, M., Munro, I.C., Phipps, R.H., Reid, J.E. (2004). Nutritional and safety assessments of foods and feeds nutritionally improved through biotechnology (prepared by Task Force of the ILSI International Food Biotechnology Committee). Comp. Rev. Food Sci. Food Safety 3, 38–104. [Online], Available: <http://members.ift.org/NR/rdonlyres/27BE106D-B616-4348-AE3A-091D0E536F40/0/crfsfsv3n2p00350104ms20040106.pdf> [15.4.2012].

[5] Chassy et al., (2008). Recent developments in the safety and nutritional assessment of nutritionally improved foods and feeds. Comp. Rev. Food Sci. Food Safety 7 (2008), pp. 50–113.

[6] Chen, Ch.Ch., Tseng, W.Ch. (2011). Do Humans Need GMOs? A View from a Global Trade Market, Journal of American Academy of Business, Cambridge, AgBioWorld Vol. 8 (1), p.147 [Online], Available: http://www.agbioworld.org/biotech-info/articles/biotech-art/need-GMOs.html [11.4.2012].

[7] Gelder, J. W., Kammeraat, K., Kroes, H. (2008). Soya consumption for feed and fuel in the European Union, Profundo, economic research. [Online], Available: http://www.foeeurope.org/agrofuels/FFE/Profundo%20report%20final.pdf, [18.3.2012].

[8] Dewar, A.M..(2003), May M.J., Woiwod, I.P., Haylock, L.A., Champion, G.T., Garner, B.H., Sands, RJN, Qi A, Pidgin, J.D. ‘A novel approach to the use of genetically modified herbicide tolerant crops for environmental benefit’ Proceedings of The Royal Society of London Series B-Biological Sciences, Vol.270, Issue 1513, p.335-340, London, ISSN: 0962-8452.

[9] FAOSTAT database (2011). [Online], Available: http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor [20.1. 2012-5.5. 2012].

[10] FEFAC Statistical Yearbook 2009. Feed & Food, European Feed Manufacturers' Federation, 2010, Bruxelles, Arnaud Bouxin, [Online], Available: http://www.fefac.org/file.pdf?FileID=32696 [20.1. 2011- 5.5. 2012].

[11] Food&Fuel (2008). Working Paper. United Soybean Board, [Online], Available:http://www.soyconnection.com/soybean_oil/pdf/foodvsfuel_soy_biofuels.pdf [25.3.2012].

[12] Galvão, A. (2010). The impact of decisions related to the use of products of biotechnology in agriculture. Environmental and Economic Benefits of Biotechnology in the Brazilian Agriculture, Proceedings of the Conference, September 28th, 2010, US Embassy, London, [Online],Available :http://photos.state.gov/libraries/unitedkingdom/164203/conference_28sept2010/Anderson_Galvao-Celeres-AgBiotech_in_Brazil.pdf [27.3.2012].

[13] GMO Compass. Website supported by the European Union within the European Commission's, part Agri-Biotechnology, [Online], Available: http://www.gmo-compass.org/eng/agri_biotechnology/gmo_planting/257.global_gm_planting_2009.html [27.3.2012].

[14] ISAAA Brief 39 – 2008. Executive Summary, [Online], Available: http://www.isaaa.org/resources/publications/briefs/39/executivesummary/default.html [06.03.2012].

[15] ISAAA Releases 2009. Report about the Global Status of Biotech Crops, [Online], Available: http://www.whybiotech.com/?p=1801 [06.03.2012].

[16] Kaphengst,T., Nadja, B., Evans, C., Finger, R., Herbert, R., Morse, S., Stupak, N. (2010). Assessment of the economic performance of GM crops worldwide. Report to the European Commission, March 2011. [Online], Available: http://ec.europa.eu/environment/funding/pdf/calls2009/specifications_en09010.pdf, [26.03.2012].

[17] Navdanya (2009). Monsanto's Bt Cotton Kills the Soil as Well as Farmers, study', [Online], Available: http://www.globalresearch.ca/index.php?context=va&aid=12432 [06.03.2012].

[18] NASS (2010), National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture, June 30, 2010, [Online], Available: http://usda.mannlib.cornell.edu/usda/current/Acre/Acre-06-30-2010.pdf [05.03.2012].

[19] NASS Report (2011), Ackerage, National Agricultural Statistics Service, Agricultural Statistics Board, United States Department of Agriculture (USDA), ISSN 1949-1522 [Online], Available : http://usda01.library.cornell.edu/usda/current/Acre/Acre-06-30-2011.pdf [20.3.2012].

[20] Nowicki, P. et al. (2010). Study on the Implications of Asynchronous GMO Approvals for EU Imports of Animal Feed Products, Final Report (Contract N° 30-CE-0317175/00-74), [Online], Available: http://ec.europa.eu/agriculture/analysis/external/asynchronous-gmo-approvals/summary_en.pdf [27.03.2012].

[21] James, C. (2011). Global status of commercialized biotech/GM crops: 2011, ISAAA Brief No.42, ISAAA: Ithaca, NY., ISBN 978-1-892456-49-4, [Online], Available: http://www.isaaa.org/resources/publications/briefs/42/executivesummary/default.asp [07.03.2012].

[22] Parente, P. (2010). Bunge Brazil. Proceedings of the Bunge Investor Day, September 23th, 2010, Paranaguá, [Online], Available: http://www.bunge.com/public/pdfs/PedroParente.pdf [22.04.2012]

[23] Raven, P. (2010). Does the Use of Transgenic Plants Diminish or Promote Biodiversity? New Biotechnology 27, pp. 601–606.

[24] Ruttan, V.W. (1999). Biotechnology and agriculture: a skeptical perspective. AgBioForum 2 (1), pp.54–60.

[25] Tait, J. and G. Barker, G. (2011). Global food security and the governance of modern biotechnologies. EMBO reports, Vol.12., p.763-768, [Online], Available: http://www.nature.com/embor/journal/v12/n8/full/embor2011135a.html [22.4.2012].

[26] Zerbe, N. (2004). Feeding the famine? American food aid and the GMO debate in Southern Africa, Food Policy 29, pp. 593–608.

[27] Zhu Hong-de, XIE Fu-ti, FEI Zhi-hong et al. (2009). Breeding of New Soybean Variety Kenjiandou 41 with Early Maturing and High Oil Content and It's Cultivation Techniques for High Yield, Journal of Heilongjiang, August First Land Reclamation University; 2009-02.