Chapter 19

Use of Biotechnology in the Control of Insects-Prague

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1. Introduction

Productivity gains in agriculture are satisfactory with the use of genetically modified plants and the dependency of application of insecticides on crops becomes smaller over the years. The consequences of the development and marketing of corn genetically modified (GM) have been profound, and in 2011 the area planted in the United States of America (USA) with at least one GM trait corresponded to more than 88% of was over acreage.

In addition, the efficiency gains in the production chains were only possible thanks to the entrepreneurship and management of rural producers, who adopted the most modern technologies available for science. Among these, stand: the tillage, fertilization and soil correction, the techniques of integrated management of invasive plants, diseases and insect pest and the growing adoption of improved seeds with high productive capacity. It is observed that the simple hybrids corn came to dominate the market of seeds embedded in technologies and seeds are more easily adopted by producers. This is the case of transgenic seeds, which in the culture of corn were widely adopted, including the major world producers of this cereal USA and Argentina.

In crops of corn, the losses caused by pests are limiting factor to achieve high productivity. The fall armyworm (*Spodopterafrugiperda*) is the main plague of corn in Brazil culture, causing severe damage. The attack on the plant occurs since its emergence to the booting and the silking.However, the critical period is flourishing. Losses due to Caterpillar attack may reduce production in up to 34%. Survey conducted among some 1,100 farmers who produce more than 8,000 kg ha-1 showed that, among the crops sampled, 15% received from 4 to 5 applications of insecticides and 6% received 6 to 8 applications for pest control.

Other recent surveys, conducted by Embrapa maize and sorghum, have shown that in some regions the number of applications of insecticides for the control of Caterpillar-cartridge can reach 10. In addition, there is no efficient method of chemical control for at least two other important species: or the control of the corn earworm (*Helicoverpazea*) and the Maize stalk borer (*Diatraeasaccharalis*).

The insects have been one of the biggest causes of damage in food production being these losses of the order of 20 to 30% of world production in [1]. It is estimated that approximately 67,000 species of insects cause damage to plantations and tropical regions, usually the poorest in the world, those who suffer most from the high incidence of insects-Prague in [2].

The attack of any pest depends on the development of culture, as well as the intensity of the attack, which can significantly affect the performance of the same. Chemical control is the primary measure used to prevent the immediate damage that reach the level of economic damage. Many times, the insecticides do not have the desired effectiveness and have a high cost, because are usually required multiple applications.

The insecticides used in pest control as an example in corn culture are often of low selectivity, therefore can affect the population of natural enemies, favoring the proliferation of pests and even resurgence of others. Due to these factors, the search for alternatives that can minimize or even replace the conventional insecticides was intensified and, currently, the new tactics comprise a series of alternatives: resistant plants, selective insecticides, parasitoids and entomopathogenic microorganisms. Among the entomopathogenic *Bacillus thuringiensis* (Bt), notable for its wide use in the control of pest insects of the order Lepidoptera, especially in corn culture.

Currently, transgenic production is widespread in almost all agricultural regions of the planet and with the adoption of biotechnology by greater productivity with the producers reaches lower use of insecticides. An example of this is the use of gene technology (Cry) of bacteria (Bt) in control of the main pests of maize culture. The Bt gene technology diffusion aims to make the environment more sustainable, decreasing the concentration of inert products in foods using insecticides rationally. However, many challenges must still be overcome, with that biotechnology has as a fundamental role, seek new research, sustainable in modern agriculture.

2. Importance of biotechnology in the control of insects-prague

Biotechnology is defined as a set of techniques for manipulation of living beings or part thereof for economic purposes. This broad concept includes techniques that are used on a large scale in agriculture since the early 20^{th} century, such as tissue culture, the biological fixation of nitrogen and organic pest control. But the concept includes also modern techni-

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ques of direct modification of the DNA of a plant or a living organism, in order to change precisely the characteristics of that organism in [3].

Agricultural biotechnology varieties are used as a tool for agricultural research characterized by gene transfer of agronomic interest (and, consequently, of desired characteristics) between a donor agency (which may be a plant, a bacterium, fungus, etc.) and plants, safely.

Studies dating this year in India and China show that the Bt cotton production increased 10% to 50%, respectively, and the use of insecticides has reduced in both countries by 50%. In India, the producers have increased the income up to $ 250 or more per hectare, the farmer's income increasing national $ 840 million to $ 1.7 billion last year. Chinese farmers saw similar gains with increasing yields on average $ 220 per hectare, or more than $ 800 million nationwide. It is important to emphasize the trust farmer in technology, with 9 of 10 Indian farmers reseeding the biotech cotton 100% year after year and Chinese farmers using the technology.

It is important to recognize the need for scientific research that point on the General mode of action of Bt toxins and also that their toxicity is influenced by several factors. However, it is known that, in General, the toxicity of the Bt toxin on target organisms depends on factors such as certain pH, proteases, and the receivers in [4]. On the other hand, and more specifically, the extrinsic factors can also influence and co-factors in specific efficacy of Bt toxin on target organisms resistant and/or can also have an impact on the selectivity and toxicity to non-target organisms in [5].

Therefore, the emergence of modern biotechnology marks the beginning of a new stage for agriculture and reserves a starring role to molecular genetics. The advances in the field of plant genetics have the effect of reducing the excessive reliance on agriculture mechanical and chemical innovations, which were the pillars of the green revolution. In addition to increased productivity, modern biotechnology can contribute to the reduction of production costs, better quality foods and for the development of less aggressive to the environment in [3].

3. The *Bacillus thuringiensis* (Bt)

The *Bacillus thuringiensis*, was discovered in 1901, by the occurrence of an epidemic of mortality of larvae of the silkworm in Japan. Researchers found that it was caused by a previously unknown bacterium.

The bacterium entomopathogenic (Bt) stands out on the world stage since 1938, when the first product formulated with this pathogen was released in France.

In 1911, in Germany, the Berliner managed to isolate and characterize this bacterium, baptizing it *Bacillus* (by its cylindrical shape) *thuringiensis* (named after the German region of Turíngea). In 1938, France formulations containing right-handed bacteria colonies were sold as insecticides and, in 1954, its mode of action was discovered and its use today.

Since then more than 100 products were launched on the market and currently constitute more than 90% of gross revenues with biopesticides in [6, 7].

In some studies, this bacterium was considered inefficient in controlling *S. frugiperda*in [8, 9]. However, with the advances provided by new laboratory techniques and greater interest of researchers' positive results were obtained in [10]

The Bt a soil bacteria present in various continents, Gram-positive, aerobic and family Bacillaceae, when environmental conditions become adverse can sporulate to survive these conditions in [11]. Are found in every terrestrial environments and also in dead insects, plants and debris in [12, 13, 14, 15, 16, 17, 18, 19]. The methods to isolate this pathogen are powerful and usually easy to perform in [20, 21, 22, 23]. The number of cells obtained from Bt varied between 102 and 104 colony-forming units (CFU) per gram of soil, while in plants this number varies between 0 and ufc 100 cm^{-2} in [24].

Produces sporangia containing a endospore and crystalline inclusions of proteins that are responsible for their action entomopathogenic, among which stands out the protein CRY. This crystal is composed of a protein polypeptide called endotoxin in [25]. When larval forms of insects feed on such proteins, initiates a series of reactions that culminate with the death of the same.

4. Biotechnology vs insecticide

The insects have been one of the major causes of damage to food production in [1] and, in world terms, the losses caused by pests and diseases are quite high. The same causing losses of the order of 38% in [26]. Withdrawals in Brazil indicate that pests can be liable for loss of 2.2 billion dollars for the main Brazilian crops in [27].

Control of harmful insects is done, most of the time, by agrochemicals and, on a much smaller scale, by the employment of biological insecticides. The indiscriminate use of pesticides in combating the causal agents causes, despite its efficiency, environmental problems severe, human health, reduces number of natural enemies, and provides an accelerated selection of resistant insects in [28]. In contrast, biopesticides, Bt based, used for over a century, retainers of features less impactful on the environment and less harmful to humans ever occupied a prominent place on the market for the sale of pesticides in [29].

From the Decade of 80, because of genetic advance, it became possible to develop a new pest control strategy, which consists of the genetically modified plants resistant to insects in [and with effectiveness similar to conventional insecticides in [31, 32].

The first experiments with genetically modified (GM) plants were made in 1986, in the United States and in France. The first variety marketed a vegetable species produced by genetic engineering was the "FlavrSavr Tomato ", developed by the American company Calgene and marketed from 1994.

Between 1987 and 2000 there were more than 11,000 field trials in 45 countries and cultures more frequently tested were corn, tomatoes, soybeans, canola, potatoes and cotton, and the genetic features introduced were herbicide tolerance, product quality, virus-resistance and resistance to insects in [33].

Rank	Country	Area (million hectares)	Biotech Crops
1	USA*	69.0	Maize, soybean, cotton, canola, sugarbeet, alfafa, papaya, squash
2	Brazil*	30.3	Soybean, cotton, maize
3	Argentina*	23.7	Soybean, cotton, maize
4	India*	10.6	Cotton
5	Canada*	10.4	Canola, maize, soybean, sugarbeet
6	China*	3.9	Cottton, papaya, poplar, tomato, sweet paper
7	Paraguay*	2.8	Soybean
8	Pakistan*	2.6	Cotton
9	South América*	2.3	Maize, soybean, cotton
10	Uruguay*	1.3	Soybean, maize
11	Bolivia*	0.9	Soybean
12	Australia*	0.7	Canola, cotton
13	Philippines*	0.6	Maize
14	Myanmar*	0.3	Cotton
15	Burkina Faso*	0.3	Cotton
16	Mexico*	0.2	Cotton, soybean
17	Spain*	0.1	Maize
18	Colombia	<0.1	Cotton
19	Chile	<0.1	Maize, soybean, canola
20	Honduras	<0.1	Maize
21	Portugal	<0.1	Maize
22	Czech Republic	<0.1	Maize
23	Poland	<0.1	Maize
24	Egypt	<0.1	Maize
25	Slovakia	<0.1	Maize
26	Romania	<0.1	Maize
27	Sweden	<0.1	Potato
28	Costa Rica	<0.1	Cotton, soybean
29	Germany	<0.1	Potato
Total		**160.0**	

* 17 biotech mega-countries growing 50,000 hectares, or more, of biotech crops.

** Rounded off to the nearest hundred thousand

Source: in [34].

Table 1. Global Area of Biotech Crops in 2011: by Country (Million Crops)**.

These days, according to the annual report of 2011 on the use of transgenic crops, the non-profit organization International Service for the acquisition of AgriBiotech Applications (ISAAA) observed an increase of 94 times in planted area of 1.7 million hectares in 1996 to 160 million hectares in 2011 (Table 1), allowing biotech crops become more agricultural technology adopted in the history of modern agriculture.

The endless search for alternative methods of insect control-Prague has been held strongly by several research groups worldwide, due to the need of a more sustainable agriculture and more committed to environmental preservation in [35].

In this way, farmers have adopted this technology Bt targeting an increasing effective production to sustainable agriculture in [36]. The benefits of this technology are: reduction of environmental effects on toxins, safety in use, efficiency, conservation of natural enemies and reduction of fungal diseases.

The first advantage is the production of protein *Cry*, by plants-Bt, which is not affected by environmental factors such as atmospheric fallout, light incidence, and high temperatures in [37]. In addition, the homogeneity of the protein, in plant tissues, allows a more efficient use of insecticide effect than the application (spraying) of biopesticides, Bt, based on plants. The second advantage is the possibility of a higher level of security in relation to insecticide formulated because the proteins and does not accumulate in fatty tissues, are not toxic to humans and pets. Tied to these characteristics, the protein Cry, has no activity by contact, being necessary, the ingestion of the toxin by the insect, to have the effect of insecticide. The third advantage is the *Heliothisvirescens*control significant and *Pectinophoragossypiella*, for example, in Bt cotton culture, between 95 and 99% efficiency in [38]. The fourth advantage is the preservation of natural enemies, therefore, secondary pests can become a problem if the population of beneficial insects is reduced by the use of chemical insecticides of low selectivity. The fifth benefit, no less important, is the reduction of fungal diseases. The lesions caused by insects, in the organs of plants, fungi infection, create opportunities mainly in the genus *Fusarium e Aspergillus*in [39]. The primary importance of these fungi is the presence of micotoxins, particularly fumosinsandaflatoxins produced by them. The fumosins can be fatal to horses and pigs in [40]. And aflatoxinis extremely toxic to animals and humans in [39]. The dramatic reduction of insect attack, leads to reduction of insect attack, and consequently, decreases the production of micotoxins.

5. Mode of action of protein Cry

Currently the insect resistant transgenic plants expressing genes, inductors, an insecticidal protein called Cry, derived from the bacterium *Bacillus thuringiensis*(Bt). The mechanisms by which proteins exert their effect are *Cry* elucidated by pore formation model discussed below:

The mode of action of Cry proteins, produced by the plant, it is accomplished, orally, by susceptible insect. The process begins by solubilization of crystals in alkaline pH

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around 9.5, in the gut of insects, releasing protoxin of 130 kDa to Cry1 and Cry2 to 79kDa.. After this breakdown, the protoxinare activated by digestive enzymes, forming toxic fragments of 60-65 kDa. These monomers bind to receptors specific primary, located in the apical membrane of the microvillus membranes of the columnar cells of the intestine of the larva. It is in this step that the affinity between the toxin and the receiver, for example, Cry1ae protein, lepdopteros is recognized as an important factor in determining the spectrum insecticidal Cry proteins. Later, the monomers bind to secondary receivers, which are proteins ancoradorasglicosil-phosphatidyl-inisitol (API), as phosphates and alkaline, to the lepidoptero*Heliothisvirences*. After this binding, the now oligômerose inserts into the membrane, where there are receptors for API, and leads to the formation of pores in the cell membrane of the intestinal epithelium and therefore destruction of microvilli membranes, hypertrophy of epithelial cells, vacuolization of cytoplasm, cell lyses and intestinal paralysis/death of the insect in [11, 41].

6. The safety of the use of Btplants

In relation to the safety of the use of Bt corn plants as an example, several tests are conducted to certify the safety of its use in the environment and in food and feed. Initially, the protein *Cry* is tested in animal models, such as rats and mice, for the verification of the toxic potential. One of these tests, called acute toxicity consists in forced ingestion of a pure animal protein by solution and on the observation of effects of this. The product only goes to the next steps of assessment if no effect is observed and diagnosed.

We can cite as an example the test performed with Safety, this protein in maize Herculex®. This protein was tested on mice to the level of 576 mg per kilogram of live weight and no side effect was observed. To be exhibited at similar level, a person weighing 70 kg would take almost 5 tons of raw corn grains. This without taking into consideration the aspect that the human digestive tract, not to have alkaline pH, would not be able to downgrade this protein crystal.

Other reviews include the potential to cause allergies as well as the corn grain consumption by other animals such as chicken and fish, and what is called substantial equivalence, which is comparing the nutritional profile of the genetically modified maize with conventional maize. The corn will only be released commercially and, therefore, will go to the market when, in these analyses, the nutritional content between the conventional and transgenic corn were exactly the same, except, of course, the presence of protein inserted.

In the analysis of environmental safety, non-target organisms, how insects from another order, class or species, natural enemies and beneficial insects like bees, for example, are exposed to proteins inserted or the pollen grains that express and are evaluated its effects.

If all tests present results within expected ranges and be proven that there is no risk of harm or damage to health and the environment, these damages are compiled and submitted to the competent authorities of the country where you intend to market the product for analysis and approval of use and consumption. In Brazil these analyses are made by the national technical Commission on Biosafety (CTNBio) and the approval of a product in one country does not guarantee that the same is approved in another. For example, the event MON810 (Yield Gard®) was approved in 1996 in the United States, in 1998 in Argentina and only in 2007 in Brazil.

For the use of Bt corn, just the producer, in addition to using the seeds of biotech corn, fulfill two rules: the coexistence, required by law, and the rule of Insect Resistance management (MRI), recommended by (CTNBio).

The coexistence rule requires the use of a 100 m isolating surround of transgenic maize plantations of corn to retain without transgenic contamination. Alternatively, you can use a surround of 20 m, provided they are sown maize transgenic not 10 ranks (equal-sized and transgenic maize cycle) isolating the area of transgenic maize.

The CTNBiorecommendation for Insect Resistance management is the use of the area of refuge. This recommendation is the result of consensus that the cultivation of Bt corn in large areas will result in the selection of biotypes of target pests resistant to Bt toxins. Obviously, the monitoring of the infestation of plants is also important because, depending on the used hybrid and intensity of infestation, the producer may need to adopt additional control measures.

The biggest concern with the use of Bt corn is on transgenic crops and coexistence of transgenic crops do not. Coexistence is the set of agricultural practices allowing farmers grain production from conventional transgenic and organic crops, according to standards of purity and to meet legal requirements for labeling. The adoption of the rules of coexistence is essential to preserve the freedom of choice of producers and consumers. Coexistence is also a topic particularly relevant when there is market incentive for the provision of non-transgenic maize. Evidence of their practical viability is the coexistence of a considerable number of different varieties of open pollination still in use.

Showed that companies in possession of this technology must guide growers on the rules of coexistence. The producer also held technical information, stick to them properly and conscious.

Information on packages of seed of Bt corn, there is a contract in which the producer, to open it, assumes the responsibility of following the rules of coexistence and the resistance management. Therefore, it is incumbent upon the producer responsibility of use of these rules. It is important to remember that the incorrect use of technology can take it to ineffectiveness in little time. If the producer is interested in paying more for Bt corn seed, is because he believes in the benefits that this technology is bringing to your production system. Therefore, it must be motivated to use this technology in a responsible way (using the area of refuge), to take ownership of this benefit for much longer.

In relation to Bt cotton to China is the leader in this technology. In 2006 6.3 million farmers, or more than 60% of the number of farmers who have sown transgenic in the world in [42].

China is one of the only exceptions in the world to require shelters, although this may be changing. Even though the refuges were a way to reduce the accumulation of resistance to Bt toxin, the large number of small properties makes this strategy is difficult to apply.

The use of refuge in a developing country such as China becomes a challenging activity. Studies on policies of refuge on a large scale, in extensive agricultural systems of the United States of America, show that monitoring and implementation costs are negligible. Although this practice is reasonable in extensive production systems and with a small number of farms, they may not be suitable in developing countries. In developing countries like China, the agriculture sector is fragmented into millions of smallholdings, where each family has a diverse set of cultures in [43].

As a result, it is likely that the implementation of the strategy of refuge to the style (IE, all farmers planting Bt cotton are forced to grow cotton non-Bt with refuge) would require a large implementation effort, making these types of strategies of refuge becomes unviable unless farmers received individual incentives to implement refuges based on self-interest. This is unlikely, since the build-up of resistance to Bt technology is a collective evil (compared to the more common public as well) that is unlikely to be accounted for by individuals in [43].

The area of refuge is the sowing of 10% of the area planted with Bt corn hybrids using Btnot equal size and cycle, preferably their isogenic hosts. The area of refuge should not be more than 800 m away from the transgenic plants. This is the average distance by dispersion of adults of LCM in the field in [44].

All these recommendations are in order to synchronize the intersections of potential adults surviving in area of Bt corn with which emergency in the area of refuge. The structured refuge must be drawn according to the acreage with the Bt corn to plots dimensions above 800 m in the shortest side (or Ray), cultured with Bt corn refuge will be needed in their tracks internal plots. Yet, according to the recommendation, in the area of refuge CTNBiois allowed the use of other methods of control, provided that they are not used Btbased bioinsecticide.

7. Future trends for the Bt technology

The worst drought in more than half a century in corn-producing region of the United States should reduce the crop in that country at the lowest level in five years, where their stocks will be reduced to the lowest level in 17 years. The initial productivity is bad in the few fields harvested in areas of the Midwest, which represents 75 percent of the area with corn and soybeans in the United States. With this the world, returned his eyes to the Brazilian corn crop this year had one of the largest capacities of the whole story.

Brazilian agriculture won in the early 1980, an important milestone and helped the country to assume the rank among the major food producers in the world. Called when the off-season summer pós-safra was used by the producers for the planting of corn seeds uncultivated, and subsequently became part of the farmer's strategy to increase your productivity.

In more than 30 years of history, the off-season if expanded, gained strength and hit record. According to the 9th Brazilian harvest survey of grain (2011/2012), released by the national supply company (Conab) in June, the area planted with corn in the off-season is estimated at 7.188 million hectares, number 22% higher than last year's off-season.

According to Conab, the number is explained by good price prospects for climate advantage provided with the anticipation of rains for planting, and by the good harvest of soybeans, which encouraged producers to extend their crops.

Most producers that have soy as flagship summer crop production, bet on corn cultivation off-season, with attractive price and the advent of biotechnology has been the increase of productivity and safety in pest management and, in addition, there were the intangible gain with the decrease of insecticide applied in the environment.

The good news for the cultivation of corn in Brazil, according to Conab, are linked to the main corn producing States off-season: MatoGrosso, Paraná and MatoGrosso do Sul, which added to the total cultivated in the past year, the areas of 732.7 thousand, 283.4 billion and 193.2 thousand hectares, respectively.

With the data of the survey, the company foresees a production of about 32.9 million tones for corn second crop, or 53.1% to 21.5 million achieved last season. The Brazilian farmer realizes, each year, the off-season is a good deal, that is, it is an opportunity to increase the profitability of farming, maximizing the use of resources already invested.

Logically that this increased production, requires a quick response companies to address the needs of new hybrids of corn, which led to the increase of releases in this area, where the market turned to the specific needs of each region. With this, the producers have the opportunity to plant the best genetic, associated with the best biotechnology.

According to the Brazilian Association of producers of corn (Abramilho), the winter harvest has been growing a lot for two reasons: first, because soy has open space for the cultivation of this crop and, second, because of the technology. The conventional corn planting and with few seeds has become the past, and today, the use of increasingly technology for these cycles has achieved nearly the same results of the summer harvest.

Between farmers, the assessment is that the off-season will consolidate its position as an important complement in income and must, year after year, to expand to areas that do not yet have this established planting. There is a very strong demand for producer hybrids with more technology. Therefore, in recent years, companies have expanded investment in research in Brazil to bring to market the best product for the features of each region.

With the events of biotechnology of the culture of corn producers expect to achieve greater productivity per area, plants tolerant to various events and reduce production costs, primarily related to less use of pesticides.

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In the case of Bt crops (which produce a toxin in their cells), their adoption allowed a reduction of 56 million kg of insecticides between 1996 and 2011. In General, the transgenic seed calculation led to decrease of 183 million tonnes in the use of pesticides. In Brazil, the Bt seed companies are also newly tolerant to herbicides, thereby opening a new path of efficiency in the management of pests and weeds, factors that interfere with productivity and steal the producer's profit.

Due to various factors the area planted with genetically modified seeds should reach 36, 6milhões hectares in the next harvest, second 1° monitoring of adoption of agricultural crop 2012/13. The forecast points to a 12.3% higher adoption in comparison to the previous year and means 4 million new acres with transgenic varieties.

The leadership in adopting biotechnology continues with soybeans, which must have 88.1% of crops with genetically Modified seeds, an area estimated at 23.9 million hectares. And corn, which begins to cultivate the fourth crop with transgenic hybrids, already approaching that level. The winter crop represents the second highest rate of adoption, with 87.8%, or 6.9 million hectares of transgenic seeds. In the case of the summer harvest, the adoption must represent 62.6% of the total area or 5, 2 million hectares.

The cotton must have 50.1%, or 546 thousand hectares of the total area with transgenic seeds. The continuous growth of adoption of biotechnology should be attributed to the increase of new varieties available in the market and that, today, are adapted to the different agricultural areas of the country. The direct and indirect benefits arising from the use of these seeds have been singled out by farmers as one of the biggest reasons for choice. In relation to States, MatoGrosso follows in the lead, with 9, 6milhões hectares, followed by Paraná with 6.6 million hectares. Herbicide tolerance technology follows in the lead with 25, 3milhões hectares, followed by seeds with resistance to insects, with 5.7 million hectares, and the gene technology, combined with 5.6 million hectares.

All these good news coming from the field are a major impasse regarding the prices of maize, companies that buy corn in Brazil must face an even more difficult year in terms of price in 2013, compared with 2012, and projected smaller cereal availability in 2012/13.

In the first half of 2012 prices were behaved and there was even falling prices to the extent that it was becoming clear that we would have a great off-season.

Cereal prices in the international market began to rise and reached record levels in recent weeks on the Chicago Stock Exchange in function from the perspective of large us crop failure caused by the worst drought in more than 50 years. Prices in Brazil are now strongly tied to international prices due to a large demand from international buyers. Certainly we have a Brazilian corn buyer pressure by international customers, as strong or stronger than this year. Because the major supplier of the world's corn, which are the United States, will have less exportable surplus in history.

Corn futures in Chicago (CBOT) reached the highest value of all time before disclosure of the report of the United States Department of agriculture (USDA), which should cut forecasts for USA crops this year.

The contract of the new crop, basis December reached the peak of 8.2975 dollars a bushel, the highest ever recorded in the Chicago Stock Exchange and above the previous record of 8.2875 dollars per busheltested three weeks ago by September.

As we saw in this chapter to biotechnology is a very important tool for the development of Brazil as world agricultural power, but we must emphasize the importance of research. And to get an idea of its importance, the increase in productivity in the various cultures saved 60 million hectares to Brazil, but still in some cultures our average productivity is low. In corn, for example, our productivity is half of U.S.A productivity. Search is a technology and factor income generator to the field, but Brazil has employed little recourse in the area. In 2011 employed 1.3% of GDP in science and technology, and in 2012 must employ only 0.9%, which is a setback and lack of objectivity.

8. Perspectives and final considerations

The biggest challenge of this century is to feed the whole world's population; poverty and hunger are inextricably linked and are about 1 billion people, mainly rentals. So what we will do to overcome this in a sustainable way? What are the threats to the production, distribution and safety of these foods? And, mainly, what we will do to allow people to have access to them?

In 2011, approximately half of the world's poor were small resource-poor farmers, whilst another 20% were the rural landless who are completely dependent on agriculture for their livelihoods. Thus, 70% of the world's poor are dependent on agriculture – some view this as a problem, however it should be viewed as an opportunity, given the enormous potential of both conventional and the new biotechnology applications to make a significant contribution to the alleviation of poverty and hunger and to doubling food, feed and fiber production by 2050.

In the next fifty years will be nine billion people and the world will consume twice as much food as the world has consumed since the beginning of agriculture 10.000 years ago. The challenge of feeding the world and interest to increase the potential of biotechnology are intimacies trailers and, as biotech crops already occupy about 160 million hectares or 10% of the world's arable land, is significant and visible the ancestry of this market in today's society.

According to some international institutes, the world until 2020 will grow 20% in food production and Brazil will have a 40% growth in production with an increase of just 16% of the area. To see the responsibility, since the increment of production in traditional countries like the USA will be 15%, China 15%, and in the whole of Europe, 4%.

With all this challenge, it should be noted that the transgenic plants are not panacea to solve all the problems of agriculture. Transgenic agriculture is only a complement to conventional agriculture, organic and other modalities. However the endless search for improvement of this tool will provide future generations, guarantees of more sustainable living conditions and higher quality food.

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