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Biotechnology in agriculture: The perception of farmers on the inclusion of Genetically Modified Organisms (GMOs) in agricultural production

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The aim of this study was to determine the perceptions and attitudes towards biotechnology in the insertion of genetically modified (GM) crop production. The data analyzed in this article were obtained through qualitative research, via a semi-structured questionnaire administered in June 2014, with 20 associated cooperatives of farmers at Campos Gerais region. It was found, from the speech of farmers, there are advantages and disadvantages of biotechnology in agriculture, and all point to transgenic technology as a necessary and essential for increasing productivity and reducing the cost of production. On the other hand, the monopoly of seeds and inputs companies was identified as the main disadvantage of the insertion of biotechnology in agriculture. All farmers pointed insurance transgenic and research that prove the risks to human health are few and delayed.

Key words: Biotechnology, farmers, perception.

INTRODUCTION

Since the biotechnology term is recent, reports of its application have been appointed for six thousand years, where microorganisms were used in fermentation processes to produce beer and bread, among other products. Whereas the modern biotechnology has advanced, many development opportunities in various sectors of the economy were created, stands out in agriculture, which has the challenge to increase food production with sustainable use of the current biodiversity (Gomes and Borém, 2013).

Through the current biotechnology, it was possible to modernize agriculture with the new discoveries of plant breeding. Thus, traditional crops are being replaced by improved cultivars and transgenic plants to increase crop productivity to meet the demand for food (Leite and Munhoz, 2013).

According to Leite and Munhoz (2013), modern biotechnology is marked by attribution of characteristics from different species to another receptor without sexual reproduction and through human intervention.

Genetically Modified Organisms (GMOs) are those with genetic material altered by man through transferring a

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gene from one species to another. 1971 was the landmark of technological advancement, when the first GMO, mainly food was patented in the United States, and rapidly reached the world (Alves, 2004).

Among the applications of biotechnology applied to production, the insect resistance and herbicide tolerance stood out. Although commercial use of this seed started in USA in the 1980s; in Brazil, the authorization to plant genetically modified (GM) soybeans occurred after a long period of conflict and uncertainty involving an aggressive strategy of the companies, institutional uncertainties in the regulatory plan and resistances formed in the domestic market between producers and their organizations. In spite this fact, adoption of the new law on Biosafety, in March 2005, has opened the way for release of the planting and sale of GMO varieties of soybeans in Brazil (Vercesi et al., 2009; Schioschet and Paula, 2013).

In a bid to achieving higher productivity, lower production costs, reduce need for labor and ensure easy control of weeds by herbicide use, glyphosate resistant transgenic crops have being grown in larger areas. In fact, the creation of GM plants can be declared as a scientific breakthrough and a certainty of profit for major centers of biotechnology and for farmers. Since the growing of these plants by means of recombinant DNA technology, there have been present characteristics that would not have been acquired through conventional breeding (Andrioli, 2013; Ribeiro and Marin, 2012).

Biotechnology, including transgenic crop development, is contributing to alleviation of hunger; however, FAO commented that ‘there is still a need to step up investment in agriculture with the dual purpose of stimulating sustainable productivity increases to expand supply and of exploiting the potential of agriculture to contribute to economic development and poverty alleviation’ (Park et al., 2011).

The impact of biotechnology on agricultural productivity in developing countries, as well as national and international standards of biosafety and potential risks to the environment stood out as principal points of the incipient debate on GMO crops (Massarani et al., 2013).

In that sense, Brazil has been substantially growing its food production by means of biotechnological processes and will play a key part in supplying considerable portion of food that the world will demand.

In just eight years, the country already has the second largest area of GMO crops planted worldwide. And for the fifth consecutive year, Brazilian agriculture experienced the most boosted global growth in planted areas of GM varieties, with expansion of 12% compared to 2011, reaching a record of 36.6 million hectares, an increase of 4 million (James, 2012). According to the International Service for the Acquisition of Agri-Biotech Applications- ISAAA (2013) report, Brazil is emerging as a global leader in biotech crops, and is only behind the USA in planted area, with 36.6 million hectares. For four consecutive years, Brazil was the global growth agent, increasing its acreage of transgenic crops more than any other country in the world, growing 21% of the global area and is stabilizing its position consistently to reach the USA.

Paraná has a very particular history in relation to GMOs. The state government, in 2003, at the height of debate on the subject in Brazil, has always been opposed to GM crops. Even after the passage of the Biosafety Law, a series of legal impediments and structural obstacles was created to the cultivation of GMO crops in Paraná. In 2006, transgenic soybeans still represented less than half of the soybean production in the region. Monsanto's RR soya resistance to glyphosate had been released for commercial cultivation in the previous year; however, most farmers had not yet acceded to these seeds; most local cooperatives did not receive transgenic soybeans, and the state government continued to put pressure on farmers not to plant GM seeds (Almeida and Massarani, 2011).

Farmers had an active role in the introduction of this new technology. The objective of this research was to investigate the perceptions and attitudes toward biotechnology in the insertion of GMOs in agricultural production.

MATERIALS AND METHODS

The approach of this paper is based on the qualitative method in order to verify the perception of farmers about the cultivation of GM crops. Based on an exploratory research by Lakatos and Marconi (2003, p. 188), "exploratory research is understood as an empirical investigations of research which goal is the formulation of questions or a problem with triple aim: to develop hypotheses, increase the familiarity of the researcher about an environment, fact or phenomenon for conducting more precise future research and modify and clarify concepts."

From the definition of a qualitative methodological approach were chosen complementary procedures as an interview and also the choice of interviewees.

A semistructured interview script was followed to the interviews. The questionnaire was applied in the first half of 2014, with associated farmers from cooperatives in the region of Campos Gerais. There was no selection of people to be interviewed, because despite the region presents a significant number of producers of GMOs, part of them did not answer the questionnaire. There were a total of 20 interviewees in the region.

An explanation of the research was made, exposing the objectives to be achieved, clarifying that there would be guaranteed anonymity of 20 interviewees and then, the questionnaire was applied.

The questionnaire was based on the study of Lima (2005) and consisted of three sections:

Section I - General questions aiming to elicit information about the crop practices of the farmers;
Section II - Questions related to the knowledge of the farmers about GM;
Section III - Questions regarding of the advantages and disadvantages of growing GM crops and their health risks.

RESULTS AND DISCUSSION

Interviews were conducted with 20 GM producers in the

Table 1. The profile of interviewees and their properties.

Interviewees	Property type	Property size (hectares)	Area for GMOs cultivation (hectares)	Time of agricultural (years)	Time of GMOs agricultural (years)
Interviewee 1	Owned	142	80	2	2
Interviewee 2	Owned	36	36	9	5
Interviewee 3	Owned	224	120	20	10
Interviewee 4	Owned	80	80	25	20
Interviewee 5	Owned	100	100	5	5
Interviewee 6	Mixed	50	50	35	8
Interviewee 7	Owned	12	12	40	5
Interviewee 8	Mixed	10	10	8	8
Interviewee 9	Mixed	100	100	40	9
Interviewee 10	Owned	1100	1000	30	7
Interviewee 11	Owned	1500	1200	17	5
Interviewee 12	Mixed	135	135	1	1
Interviewee 13	Leased	60	40	25	4
Interviewee 14	Mixed	300	250	19	10
Interviewee 15	Mixed	156	90	3,5	3,5
Interviewee 16	Leased	50	50	3	3
Interviewee 17	Owned	900	900	40	7
Interviewee 18	Leased	77	77	26	2
Interviewee 19	Leased	40	30	20	12
Interviewee 20	Leased	50	50	10	8

region of Ponta Grossa, Castro and Palmeira. Regarding the level of education, one (1) respondent had incomplete elementary school; three (3) had complete elementary school; one (1) producer did not have complete high school, and four (4) of them has finished high school; eleven (11) present a college degree and one (1) holds a post-graduation, showing a diverse school level, which did not interfere in a general cultural level, since on the subject all producers showed similar level of knowledge.

Most (9) of the interviewees farmers own their land, five (5) produce in leased areas and six (6) cultivate GMOs in mixed areas (leased and owned). All interviewees use more than 50% or even 100% of farmland to GM production, which demonstrates the expansion of cultivation of GMOs in the region. Among farmers who do not cultivate GM crops on 100% of the cultivation area are those that produce oats, wheat and beans. Among the existing GM crops that the farmers cultivate stand out the soybeans and corn (Bt).

The areas of conventional crops, as well as GM crops found in this study, range from 10 acres to a maximum area of 1500 ha, demonstrating that the cultivation of GM crops occurs in all types of farms, whether small, medium or large.

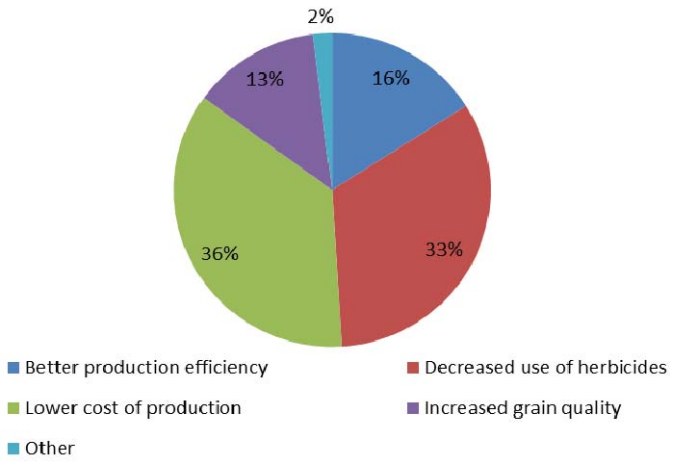
Of twenty (20) farmers interviewed, five (5) have worked in this business for 30 years or more, five (4) between 20 and 30 years, three (3) between 10 and 20 years and eight (8) have been working between 1 and 10 years. This last group, though has little time of individual farming, come from family farmers, and their knowledge and perceptions comes from when they accompanied their family on the field activities (Table 1).

The questionnaires aimed to verify the perceptions and attitudes toward biotechnology in the insertion of GM in agricultural production.

Producers most often had told what a GM is at least generally. All of them provided a clear definition regarding GMO crops, explained in their own words the general characteristics and type of resistance obtained and, in some cases, used basic scientific concepts. Among the words mentioned in most settings were the terms "technology", "modification" and "gene".

When they talk about GMOs, farmers have based their knowledge on different means; 37% of interviewees indicated the cooperative meetings as a primary means of information, followed by the media, such as television, radio and newspaper; 26% indicated the advertisements of companies. Almeida and Massarani (2011) also defined as important information about GMOs, interaction of farmers with other farmers, with agricultural experts and representatives of agricultural products.

Among the farmers interviewed, answers about the main benefits were highlighted when they choose to plant GM crops; there was ease of cultivation and crop management, higher productivity, greater weed control, reduction of the use of herbicides resulting in an economy of the use of pesticides and increased strength and durability of storage. Similar result to these was



Graph 1. Advantage of the cultivation of GM.

found by Mewius (2011). Among reasons for planting GM seeds are increase of productivity, reduced pesticide use against caterpillars and other plagues, obtaining a higher quality product and achieving better financial results.

In a study that focused on farmers in South Africa, Kruger et al. (2012) indicated the two greatest advantages associated with Bt maize to be convenient management (65%) and increased productivity (64%). Although Bt maize seed is more expensive than conventional maize seed, more than 84% of farmers interviewed still considered it economically worthwhile to plant Bt maize.

The insertion of GM seed in the production aroused intense controversy regarding the positive and negative issues related to them.

From an economic point of view, GM became a strong ally of the agricultural sphere, especially for farmers and providers of technology companies.

The benefits associated with its introduction were closely related to the promise of huge profits from transformative biotechnology (Massarani et al., 2013). Among the farmers interviewed, the views are linked to different experiences of each one with applications of GM crops. In this group, the benefits were set up as possible solutions to problems and difficulties in daily activities, in which this technology is seen as a tool to help growers improve the quality of their products. The production cost was highlighted among the main advantage of the cultivation of GM as shown in Graph 1.

The cultivation of GMOs aims to increase food production because in organic agriculture, which is when plants are grown without the aid of science, the process becomes more expensive and limited due to the immense difficulty with pests, as such the agriculture production was necessary to create a method that would improve the "strength" of the plants, so that an overproduction becomes possible (Leite and Monhoz, 2013).

In a research with farmers in Argentina, Massarani et al. (2013) obtained as response the benefits of the inclusion of GMOs in production that GM soy is a dividing line, because prior to its application, a large quantity of pesticides was required to eliminate as many weeds and it was not possible to achieve total elimination. Now with only glyphosate, all of these weeds are being eliminated. Production is simplified compared to before which results in a difference in the cost of farm work.

In a study developed by Céleres Consulting at the request of the Brazilian Association of Seeds and Seedlings, it was revealed that the economic benefits of using biotechnology in Brazilian agriculture reached $18.8 billion in 16 years and 81% of this amount remained with farmers, leaving 19% for the industry. As examples of approximate real values, the return on corn was at R$3 and in soya R$2.1 for every R$ 1 invested by the producer. This cost reduction with little loss in agriculture is about 30 and 51% of the $18.8 billion, respectively (Gomes and Borém, 2013).

Małyska et al. (2014) notes that farmers expressed some concerns about GMOs, such as: long-term effects of consuming GMOs, monopolistic practices of international concerns, potential risks to human health and the environment. Once again, the biggest concern was the lack of trust of public institutions and scientific research; however, in this case the only reliable source of information would be other farmer – producer of GMOs.

When asked about the disadvantages caused by the cultivation of GM crops, the increased resistance of weeds to herbicides was noted in 34% of responses. There is a growing concern about the resistance of weeds to glyphosate. This herbicide was already used before the introduction of GM crops to clear the plant area, and in some locations, the recommended doses of glyphosate were no longer sufficient to kill the weeds. With the introduction of GM crops and increased use of glyphosate, producers fear that this resistance increases, killing weeds infeasible with glyphosate (Almeida and Massarani, 2011).

Another disadvantage that was noted is the monopoly on producing industry technology which appears at 29% of the interviewees responses. The cultivation of GM reinforces the dependency with the producers of inputs, allowing the threat of a growing monopoly of multinational producers of technology on the seed market. Monsanto in Brazil obtained a monopoly on seed sold. In spite the company does not retain the right to patent its genes in Brazil, it has a monopoly over trade agreements. Worldwide, Monsanto is the largest seed company and the fifth largest of pesticides (Leite and Munhoz, 2013; Lima, 2005).

Some farmers in the study of Almeida and Massarani (2011), proved to be concerned with the possibility of greater control of agricultural production by multinationals that supply GM seeds combined with herbicide, resulting in greater reliance on producers in these companies. Although this is a social discussion, some producers

demonstrate a concern with the fact that the same company was providing the seed and the herbicide and does not allow the farmers replant the seeds in subsequent years, that is, the producer must purchase certified seed and pay their royalties during each harvest.

The resistance of the consumer market was identified in only 16% of the farmers' responses. Propagation of a new product is not sufficient to just lower production costs or higher yields, it is also necessary that the product be accepted by the consumer market. In the case of GM crops, market acceptance is related not only to the preference of the consumer, but also with existing regulations in the buyer countries (Silveira et al., 2005). Although there are still doubts and disputes about the criteria used to define the quality, consumer interest in the origin of the agricultural product is no longer treated with contempt by farmers. According to the study by Lima (2005), the population is against the cultivation of GM crops, which is of serious concern and do not allow a differentiated market.

Aspects involving consumers are increasingly gaining importance. Consumer behavior becomes crucial when it comes to food safety in relation to both human health as the environment, in production control, quality certification, traceability, labeling, among others.

When asked about the risks of GM insertion in food, all farmers surveyed (20) regarded this technology as safe, noting the lack of research demonstrating the health consequences and citing the reduction of cases of poisoned employees by excessive use of pesticides in conventional culture. In their study, Massarani et al. (2013) found that majority of the sample demonstrated a pragmatic approach: they are profitable and require less work, thus, in general, there is not a dilemma as far as cultivating them. The generally favorable attitude is consistent with other attitudes related to GMOs, like human consumption of genetically modified foods or the use of GM technology for research in medicine, provided they were expanded control procedures and access to clear information.

Conclusion

The present study aims to verify the perceptions and attitudes towards biotechnology in the insertion of GM crop production.

It was found, from the speech of farmers, that there are advantages and disadvantages of biotechnology in agriculture, and all point out transgenic technology as necessary and essential to increasing productivity, production cost, including expenses for machinery, labor and herbicides. On the other hand, monopoly of seeds and supplies by a company was cited as the main disadvantage of the inclusion of biotechnology in agriculture.

It is important to notice that all farmers pointed GMOs As safe and researches that prove the risks to human health are few and late.

For ecological and social advocates, the biggest problem in risk analysis of GMOs is that their effects cannot be predicted in its entirety. The human health risks include those unexpected, like allergies, toxicity and intolerance. At the environment, the anticipated consequences are lateral or horizontal gene transfer, genetic pollution and harmful effects on non-target organisms (Nodari and Guerra, 2003).

There was a resulting controversy between speeches of social agents and farmers, probably because each one of them defends their interests, as for farmers GMOs bring benefits and their goal is to sell their product.

Conflict of Interest

The author(s) have not declared any conflict of interest.

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