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Coping with Ex-ante Regulations for Planting Bt Maize: The Portuguese Experience

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This article investigates the attitude and practices of Bt and non-Bt maize farmers in Portugal. Thirty-seven Bt maize farmers were interviewed, representing 22.5% of the total number of Bt maize notifications in the country and 31.5% of the total area planted with Bt maize in 2007. Additionally, 66 non-Bt maize farmers were surveyed in an attempt to investigate their opinion on the Bt technology, its viability, and its future. The most interesting finding is that almost half of all the surveyed maize farmers stated that the ex-ante regulations are rigid and difficult to apply.

Key words: coexistence, Bt maize, Portugal.

Introduction

Ex-ante regulations and ex-post liability rules regulate the planting of GM crops in the European Union (EU). Those rules and regulations are in addition to the rules and regulations governing the planting of the equivalent non-GM crop. The legal basis imposing additional rules and regulations—the coexistence measures—is Directive 2001/18/EC on traceability and labelling of GMOs. The European Commission has published recommendations for coexistence measures (Recommendation 2003/556/EC) to support national approaches. Accordingly, "coexistence refers to the ability of farmers to make a practical choice between conventional, organic and GM crop production, in compliance with the legal obligations for labelling and/or purity standards." (Commission of the European Communities, 2003, pp. L189/36).

The importance of the coexistence regulations lies in the fact that they can play a crucial role in farmers' decisions to cultivate GM crops. They induce extra costs on potential GM farmers and therefore lower the incentives for adopting GM crops (Beckmann, Soregaroli, & Wesseler, 2006b). Soregaroli and Wesseler (2005) show that strict minimum-distance requirements will increase the adoption threshold and discriminate against smaller farms. Demont et al. (2007) demonstrate that a strict minimum-distance requirement of 50m for oilseed rape reduces adoption by about 66%, while a 100m minimum-distance requirement may reduce adoption by roughly 77% based on a GIS simulation model applied to Central France. Less strict minimum-distance requirements that allow for

collaboration among neighboring farms have the potential to partially off-set the negative effect of minimum-distance requirements (Beckmann & Wesseler, 2007).

In addition to minimum-distance requirements, potential growers of GM crops face a number of additional rules and regulations that further increase the costs of adoption. Beckmann et al. (2006b) provide an overview of the different ex-ante regulations and ex-post liability rules EU member states intend to implement or have implemented.

In this article we present the results of a survey among Bt and non-Bt maize farmers in Portugal. The aim is to identify to what extent the ex-ante coexistence regulations affect the continuation of Bt maize cultivation. More specifically, we want to investigate the ease of application of the ex-ante regulations among Bt maize farmers. The second objective is to investigate if the non-Bt maize producers are aware of the Bt technology and the coexistence regulations, what led them to avoid planting Bt maize, and their intention for adoption in the short run.

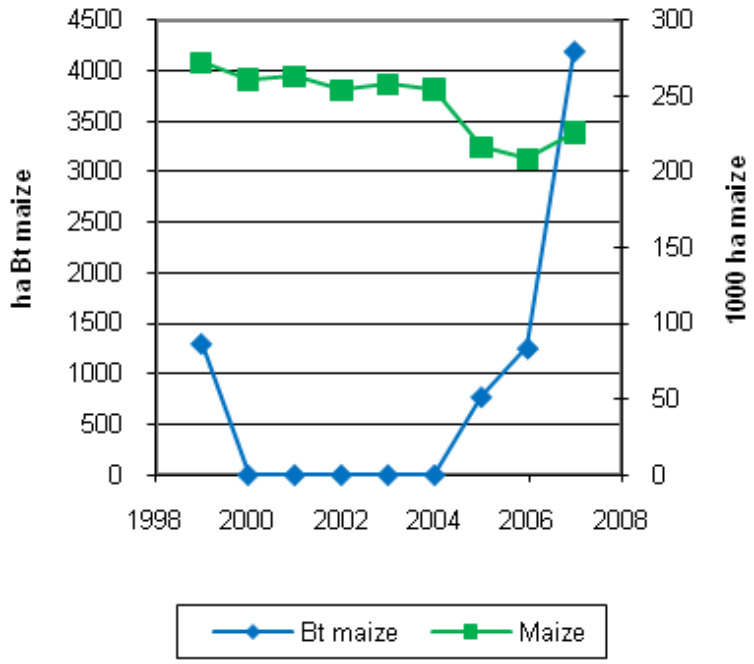
Interestingly, 43.7% of all the Bt and non-Bt maize producers stated difficulties in applying the ex-ante regulations. Therefore, it can be stated that, among other factors, the rigidity of ex-ante regulations seems to hamper Bt maize adoption in Portugal and in its current form *reduces* rather than *supports* coexistence.

The article is organized as follows: The next section provides an overview about Bt maize production in Portugal. Following that, we present the Portuguese coexistence decree that regulates the coexistence of GM, conventional, and organic crops, and then outline the survey approach. Finally, we present the survey results and conclude the article.

Bt Maize in Portugal

Portugal plants about 250,000 ha of grain and green maize every year (Figure 1). The European corn borer (ECB) (Ostrinia nubilalis [Hübner]) is, in some areas of the country, an important pest, in particular in the northern part of the country (EuropaBio, 2007). The ECB can be controlled by insecticides, but also by using ECB-resistant maize. The ECB-resistant maize plants have been modified to produce a toxin by transferring, e.g., the protein Cry1Ab of the soil bacterium Bacillus thuringiensis subsp. kurstaki (B.t.k.).

Figure 1. Bt maize and maize cultivation in Portugal.



Note. Prepared by the authors based on data obtained from the surveys in Portugal (2007).

Bt maize was introduced in Portugal in 1999 and about 1,300 ha of Bt maize were planted that year. Following the *quasi*-moratorium of the EU, planting of Bt maize stopped for five years. In 2005 about 770 ha of Bt maize have been planted, while in 2007 the area increased to about 4200 ha.

The planting of Bt maize is distributed across the country (Figure 2). Case-study results for 2007 (Skevas, 2008) report incremental benefits of about 218€ per hectare. They are even above the average annual incremental benefits of 194€ per ha for Portugal, as estimated by Wesseler, Scatasta, and Nillesen (2007) in their ex-ante assessment. All the case study farmers had planted both conventional and Bt maize.

Figure 2. Distribution of Bt maize planting in Portugal in 2007.

Total in Portugal:
No. of Notifications: 164 / Cultivated Area: 4,199.35 ha

1) Beira Litoral + Biera Interior
No. of Notifications: 48
Cultivated Area: 489.76

2) Alentejo
No. of Notifications: 52
Cultivated Area: 2,305.87

3) Minho + Douro Litoral + Tras-os-Montes
No. of Notifications: 25
Cultivated Area: 61.95

4) Estremadura + Ribatejo
No. of Notifications: 38
Cultivated Area: 1,291.03

5) Algarve
No. of Notifications: 1
Cultivated Area: 50.74

Note. Prepared by the authors based on data obtained from the surveys in Portugal (2007).

Portuguese Coexistence Regulations for Maize (Decree-Law No. 160/2005)

In 2005 the Government of Portugal finalized a national coexistence decree that regulates biotechnology production. The Decree-Law no. 160/2005 of September

21, defines a set of agricultural practices that have to be followed in order to achieve a viable coexistence of GM crops with conventional and organic crops.

According to the Commission of the European Communities (2006, pp. 104), Portugal has established a mandatory national registration system. GM farmers have 20 days in advance to provide notification of those fields cultivated with GM varieties (Table 1). This procedure is mandatory and the notifications are being sent to the Regional Agricultural Directorates (DRA) and from there to the Directorate General for Crop Protection (DGPC) for evaluation and their public disclosure. Additionally, GM farmers have to provide the parcel ID, the size, and the location of the field, information that concerns the identification of the GMO and details of precautionary measures. Furthermore, farmers have to attend compulsory training courses in order to be informed about the coexistence of GM, conventional, and organic crops. The DGPC is responsible for the publication, evaluation, and approval of the program contents of proposed training courses. Responsible for the organization of the training courses are the seed companies or farmers' organizations, while the trainers must have at least a bachelor's degree in conjunction with a trainer's certificate in the field of coexistence. Also, it is obligatory for the GM farmers to inform by letter their neighbors and the farmers they are sharing agricultural equipment with about their intention to plant GM crops. They also have to keep records of their production process (Fevereiro, 2006).

Table 1. Ex-ante regulations and ex post liability rules governing coexistence in Portugal (Decree-Law n° 160/2005).

Policy	Regulatory status key
Ex-ante regulations	
Registration, information and training duties	
National registration system	M
Notification of the GM crop fields (20 days in advance)	M
Public access to register	M
Training courses	M
Parcel ID	M
Size & location	M
Identification of GMO	M
Details of precautionary measures	M
Duty of grower to inform neighbors	M
Record keeping	M
Technical segregation measures I	
Isolation distances to non-GM crop of the same species (or related)	M/A
Barriers/pollen traps	M/A
Buffer zones	M/A
Production planning	M/A
Seed handling and/or storage	M/A
Technical segregation measures II	
Segregation in transport and handling	M
Separate field and margin harvesting	M
Crop-specific segregation measures: Maize	
Separate distance—conventional: 200m (24 rows) or production planning	M/A

Separate distance—organic: 300m (24 rows) or production planning	M/A
Refuge zone (20% of the total Bt corn acreage)	M
Ex post liability rules	
Compensation fund	—
Penalties payable	—
Fines—administrative infringement: €250 individuals, €2,500 legal entity	—
Fines—aggravating circumstances: €3,700 individuals, €44,800 legal entity	—

Note. Data from Commission of the European Communities (2006, p. 104).
M = Mandatory
M/A = Mandatory/can be amended locally by agreement

Moreover, the Decree has established technical segregation measures. This type of measure includes isolation distances to non-GM crops of the same (or related) species, barriers/pollen traps, buffer zones, production planning, and seed handling and/or storage. As far as Bt maize is concerned, farmers should keep a minimum distance of 200 meters between Bt and conventional corn plots, and a 300-meter distance between Bt and organic maize plots. As an alternative to the aforementioned segregation distances, farmers can choose different times for seeding or the use of a 20% buffer zone, which at the same time can be part of the refuge zone for pest-resistance management.

All the mentioned technical segregation measures are mandatory but can be amended according to local conditions. Other obligatory technical segregation measures include the segregation in transport and handling (e.g., cleaning of machinery) and the separate field and margin harvesting.

The decree also establishes liability provisions. A compensation fund, which covers accidental contamination due to pollen drift, will be financed by the DGPC. The money for this compensation fund comes from a 4€ tariff that DGPC has posed on the price of standard GM seed bags. Penalties have been established for farmers that do not comply with the coexistence rules. The fines for administrative infringements will be 250€ for individuals and 2,500€ for legal entities, while the fines for aggravating circumstances (non-compliance with segregation measures) will be 3,700€ and 44,800€, respectively.

DGPC is also responsible for the enforcement of the above-mentioned measures and it can have access to the fields, records, and samples. Additionally, DGPC, in cooperation with regional agricultural authorities, has to monitor the implementation of the national legislation on coexistence. Finally, the decree provides a framework for GM-crop-free regions. According to this, GM-free areas will be subject to regulation through a joint order of the Minister for Agriculture, Rural Development, and Fisheries and the Minister for the Environment, Land Management, and Regional Development.

The ex-ante regulations listed in Table 1 include a number of fixed costs for growers that are independent of field size, such as the registration costs, the training course, and the record keeping. The segregation measures, the minimum-distance requirements, and the information obligations do increase with field size. Also, a structural effect is present. Farmers in areas with smaller

filed sizes need to register more fields and have to inform more neighbors.

The ex-post liability rules do not have a *direct* farm size effect but an *indirect* effect in the sense that larger buffer zones reduce ex-post liability and buffer zones are more difficult to implement on smaller farms (Soregaroli & Wesseler, 2005). Pioneer Company, it is important to note, the main seed provider, has agreed to pay for any damage not only due to accidental cross pollination, but also due to vandalism and destruction of the crops from people that are against the Bt technology. This in particular reduces the economic costs of vandalism, which is a non-negligible issue.[1]

Survey Approach

A detailed questionnaire about the 2007 agricultural year was introduced to the Bt-maize and non-Bt maize farmers with the aim of getting an insight into their attitude and practices toward Bt maize cultivation. The questionnaire included questions about farm status, Bt maize cultivation, and the implementation of the Portuguese coexistence decree, the relationship with neighbors, the agronomical results, and the future of GMOs. The farm status questions addressed general farm information such as the location of the farm, the type of farmer, and the total area cultivated with crops. The second part of the questionnaire referred to the Bt maize cultivation and was about farmers' opinion on the coexistence decree, the extent of compliance with it, and the difficulties faced during its implementation. The relationship with neighbors covered non-Bt maize neighbors and if their presence created problems and extra costs for Bt maize cultivation. Furthermore, the Bt maize producers had been asked to reflect on their net revenues for Bt maize in comparison to non-Bt maize.

Finally, they were asked if, according to their opinion, the Bt maize technology is safe for the environment and human health and if they intend to replant Bt maize in the near future.

A similar questionnaire was used for the non-Bt maize farmers.

In total, 37 Bt maize farmers were interviewed, representing 22.5% of the total number of Bt maize notifications in the country and 66 non-Bt maize farmers, with 23 out of the 66 farmers neighboring Bt maize farmers.

Survey Results

Bt Maize Farmers

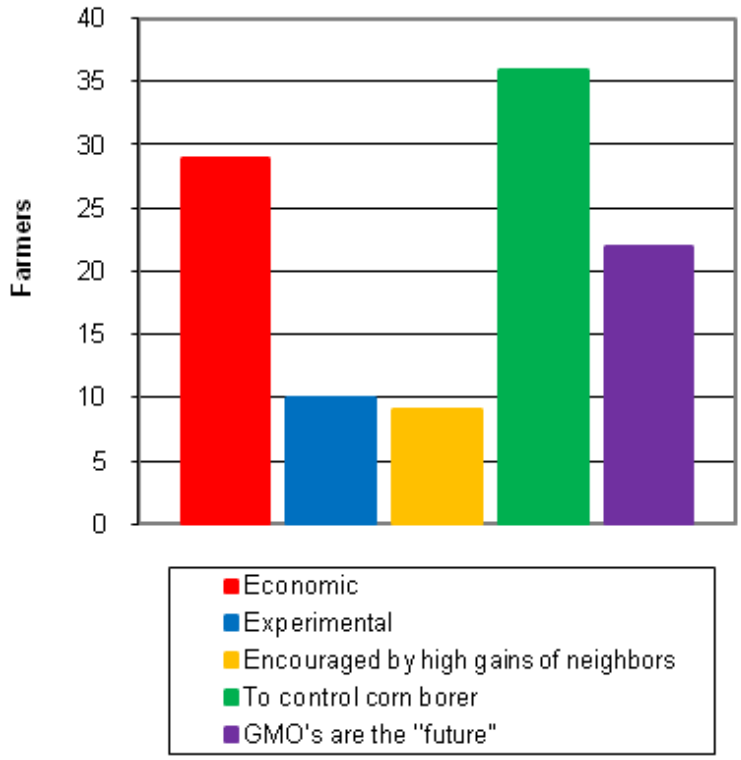
The age of the surveyed producers ranged from 27 to 84 years, while their level of education ranged from elementary to graduate. Given the large variation in age and education it was not possible to categorize farmers into homogeneous groups using these characteristics. Among the 37 surveyed farmers, 32 claimed full-time farming. The total area planted with maize (conventional and/or Bt and/or organic) ranged from 1.5 to 300 ha. A total of 31 farmers reported problems in controlling the ECB, while only six stated they did not face any problems.

A total of 20 farmers planted Bt maize for the first time, while 17 had planted Bt

maize in the past. The total area planted with Bt maize ranged from 1 to 240 ha. The total area planted with Bt maize of the sampled farmers was 1,324.26 ha or about 31.5% of the total Bt maize area in 2007. About 81% sold all their maize, while about 11% kept all their maize for feed and about 8% kept a part of their maize harvest as feed.

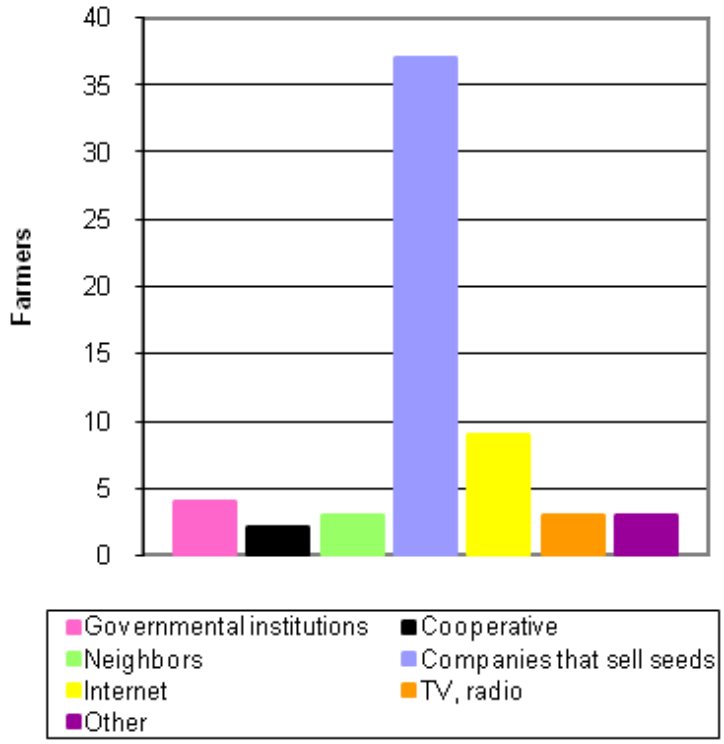
Almost all the surveyed farmers (36) stated that the main reason for planting Bt maize was to control the ECB. This result is in line with results from Spain that indicate the same reason as being the most important for Bt maize adoption (Gomez-Barbero, Berbel, & Rodriguez-Cerezo, 2008). The farmers planting Bt maize and starting to face no ECB-related control problems did adopt Bt maize due to environmental and health concerns (clean environment, worker's safety). The second main reason for planting Bt maize was the improved economic results, followed by the opinion that the GMOs are the future, experimental reasons and observed high gains by neighbors that had planted Bt maize previously (see Figure 3). Information about Bt maize (Figure 4) was obtained from seed companies, the internet, governmental institutions, TV-radio, neighbors, other (technical assessors), and cooperatives. Twenty-nine out of 37 farmers characterized the information attached to the seed packages as useful. Concerning the importance of the Decree-Law 160/2005, 21 farmers stated that it is important, 15 characterized it as of low importance, and one did not respond.

Figure 3. Reasons for planting Bt maize in 2006.



Note. Prepared by the authors based on data obtained from the surveys in Portugal (2007).

Figure 4. Sources of information about Bt maize.



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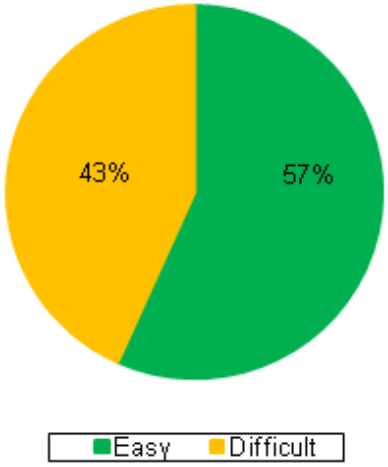
All 37 farmers notified in advance the respective authorities about their intention to plant Bt maize, provided their parcel ID, the size and location of their Bt maize field, and kept records of their agricultural practices. All of the farmers except one received at least one training course about the planting of Bt maize and the coexistence regulations. A total of 14 producers characterized the quality of the respective courses as "very good," while 22 of them stated that they were "good." Twenty-one farmers reported that they did not have any problems complying with the segregation measures, while 16 farmers faced various problems in applying the previously-mentioned measures (Figure 5). The most important problem that these 16 farmers faced was the small size of their parcels in conjunction with the number of conventional maize neighbors. All the producers reported that they kept the appropriate segregation distances from conventional and/or organic maize, and 25 of them harvested separately their margins from the rest of the field. Finally, 20 out of the 37 surveyed farmers had rented an agricultural machine (mainly harvesters and seeders). From those 20 farmers, 19 claimed that the respective machine was properly cleaned by its owner or its previous user. However, 14 out of the 20 farmers that rented an agricultural machine in addition cleaned it before use, which is a standard procedure and not the result of planting Bt maize.

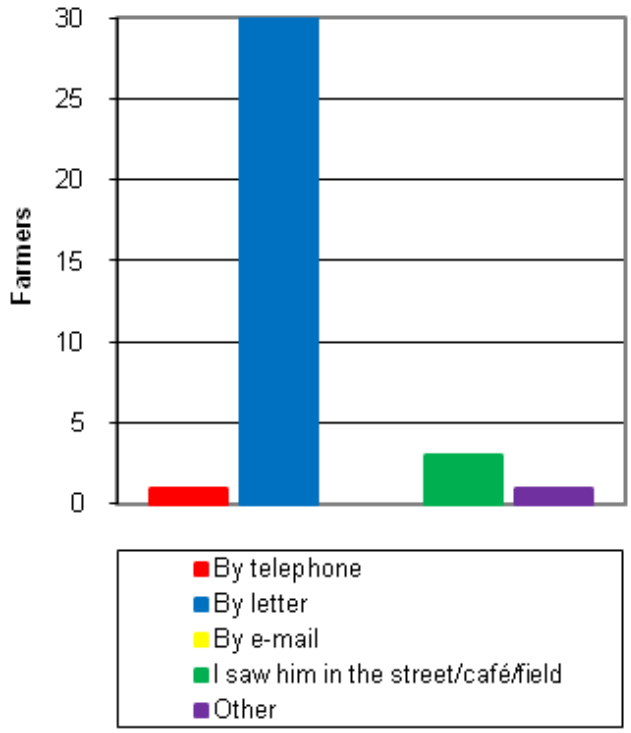
Figure 5. Ease of complying with segregation measures.



Note. Prepared by the authors based on data obtained from the surveys in Portugal (2007).

From the surveyed farmers, 20 had one or more conventional and/or organic maize neighbors but only two of them followed the method of production planning. Furthermore, three large farmers that had one or more conventional maize neighbors reported that they had planted around their Bt maize other non-Bt maize crops in order to avoid possible ex-ante costs. Almost all of the interviewed farmers (36) stated that they do not have any problem (concerning the planting of Bt maize) with their neighbors. A total of 36 out of the 37 surveyed producers informed their neighbors about their intention to plant GM maize. This was done mainly by sending a letter (Figure 6). Out of the 36 farmers that informed their neighbors about their intention to plant Bt maize, 11 reported that it was easy to inform the neighbors, while 24 stated that they had difficulties informing all their neighbors. The reported difficulties increased with the number of conventional neighbors and included the lack of contact/relationship with them and the difficulty in identifying them. The above mentioned difficulties are depicted in the answers that the farmers provided about the time they spend to inform their neighbors about their intention to plant Bt maize. This time ranged from one minute to some days.

Figure 6. Means of informing neighbors.



Note. Prepared by the authors based on data obtained from the surveys in Portugal (2007).

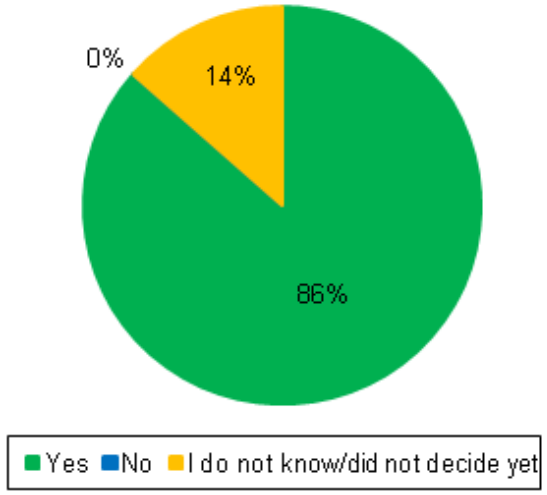
However, the majority (26) of the interviewed farmers reported that the procedure of informing their neighbors was costless. Only nine farmers stated that the previously-mentioned procedure was costly, valuing it from 12 to 100€. Only five of the surveyed farmers claimed that they reached an agreement with their neighbors for planting GM maize. All the agreements were referring to the establishment of production zones. Finally, none of the 37 GM maize farmers caused any damage to neighboring fields.

Moving to the agronomical conclusions, as far as the ease of planting is concerned, the majority of the farmers (34) responded that the planting of GM maize was as easy as the planting of conventional maize. Two farmers stated that it was easier than the planting of conventional maize, while only one said that the planting procedure was more difficult. Concerning the application of insecticides, 36 farmers claimed that it was lower in comparison to the conventional corn, while the application of fertilizer was at the same level as with the conventional maize. Additionally, 32 farmers referred to increased quality of the harvested product, three stated that the quality remained the same as for the conventional maize, one said that the quality of the obtained product decreased, and one did not answer.

Furthermore, 14 farmers reported that the cultivation of Bt maize minimizes to a great extent (“very much”) the cultivation risk related to the loss of earnings due to ECB infestation. Twenty-one farmers selected the option “much,” while the last two farmers chose the options “little” and “I do not know,” respectively. Among the augmented costs related to the cultivation of Bt maize, 33 stated the cost of seeds, two the cost of agrochemicals, and two the cost of drying. The costs that decreased with the planting of GM maize were agrochemicals (23 answers), cost of harvesting (12 answers), and drying cost (two answers).

Most of the interviewed farmers (86%) claimed that they are going to plant Bt maize again, while only five reported that they had not yet decided (14%) (Figure 7). Finally, almost all the farmers (36) are convinced that the cultivation and consumption of Bt products does not pose a threat to the environment nor human health.

Figure 7. Intention for re-planting Bt maize in 2007.



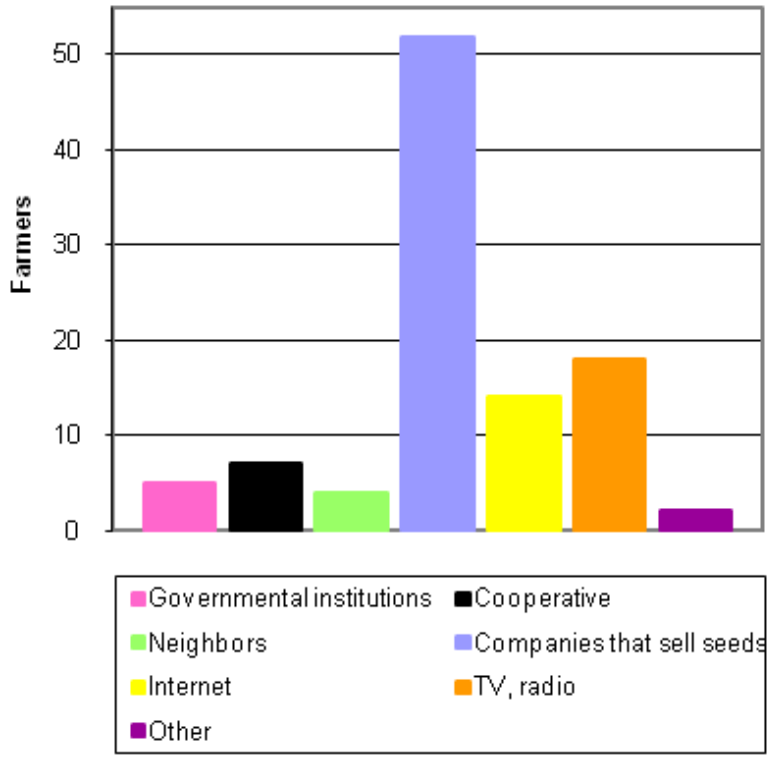
Note. Prepared by the authors based on data obtained from the surveys in Portugal (2007).

Non-Bt Maize Farmers

The surveyed farmers were between 22 and 84 years old and their educational level ranged from elementary to graduate. Thus, as before, no specific characteristic can be applied to this group of farmers regarding the two previously-mentioned points.

From the 66 producers, 57 are full-time farmers, while nine of them claimed to be part-time farmers. The total area planted with maize was about 5,377 ha, or about 81 ha on average per farm. Concerning the problems of controlling the ECB, 24 of the surveyed farmers stated that they faced problems, while 42 (63.6%) observed no problems. As far as the use of the harvested maize is concerned, the proportions were almost the same among Bt maize and non-Bt maize producers. A total of 60 farmers stated that they are informed about the existence of Bt maize varieties as shown in Figure 8. The majority of the producers (52) mentioned as their main source of information about the Bt maize varieties the different seed companies, followed by the TV and the radio, the internet, the cooperatives, governmental organizations, neighbors, and other sources. Twenty-three farmers stated that their neighbors planted Bt maize, and all the 23 farmers stated having no problem with their neighbors planting Bt maize.

Figure 8. Source of information for Bt maize.

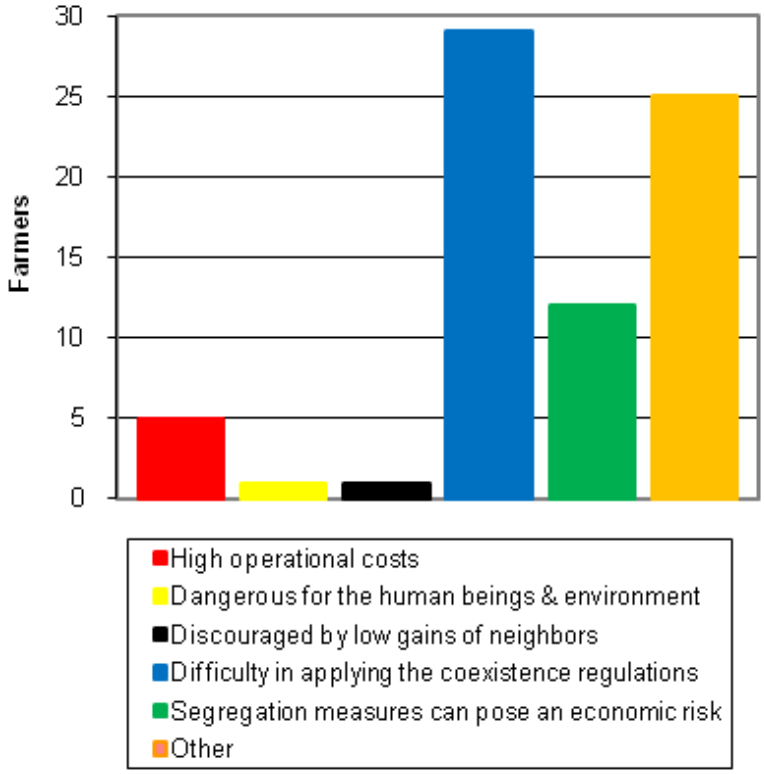


Note. Prepared by the authors based on data obtained from the surveys in Portugal (2007).

Out of the 66 farmers, 35 responded that they would like to be informed about their neighbors' intention to plant Bt maize as well as keeping the appropriate distances, while 29 reported being indifferent about the information practice and distance compliance of their neighbors.

Among the reasons for not planting Bt maize (Figure 9), 29 farmers stated that they faced difficulties in applying the coexistence regulations, 25 farmers referred to other reasons, 12 farmers stated that the segregation measures can pose an economical risk to their enterprises' viability, five farmers reported augmented operational costs, one farmer claimed that Bt maize can have adverse effects on human health and the environment, and one farmer stated the bad economical results of his neighbor planting Bt maize. Obviously, respondents could select more than one answer. Two farmers cited that the main reasons for not cultivating Bt maize were both the low level of ECB infestation and the rigid coexistence regulations, while 27 farmers reported just the difficulty in complying with the coexistence regulations without citing the low ECB pressure. Another important point is that although 18 farmers stated that they were facing ECB problems and they wanted to adopt the Bt technology, they did not do so because of the difficulties in applying the coexistence regulations.

Figure 9. Reasons for not planting Bt maize in 2006.

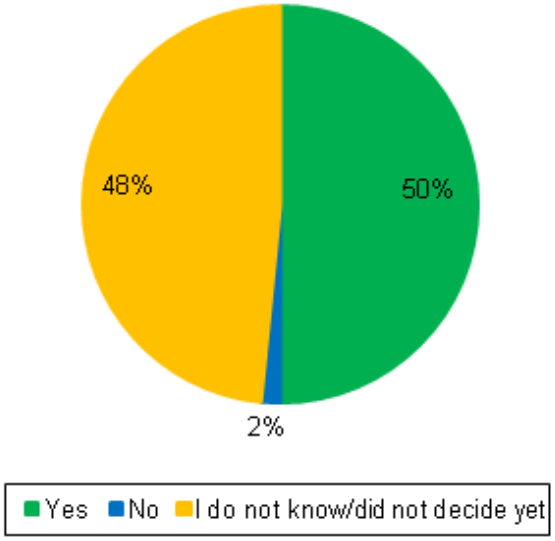


Note. Prepared by the authors based on data obtained from the surveys in Portugal (2007).

A total of 25 farmers reported other reasons for not planting Bt maize. Most of them stated the low level of insect attacks as the main reason for avoiding the cultivation of GM maize. Other reasons were the lack of information about Bt maize varieties and their economical and environmental benefits, the uninteresting Bt maize market, personal agreements for selling only conventional corn, and problems with the harvester and the transportation of the Bt maize.

Finally, concerning the question for planting GM maize in the future, 32 farmers (50%) expressed their intention to plant Bt maize, 31 (48%) responded that either they do not know or they did not decide yet, while only one farmer was sure that he will *not* plant Bt maize in the future (Figure 10).

Figure 10. Intention of planting Bt maize in the future.



Note. Prepared by the authors based on data obtained from the surveys in Portugal (2007).

Among the reasons of the 32 farmers that are intending to plant GM maize in the future were, the higher economical results, the reduced use of insecticides, the protection of the environment and health of farm personnel, reduced crop loss, the trustfulness in the GM varieties, and that GMOs are the future. However, 12 out of the 32 farmers that were positive about planting GM maize in the future stated that they definitely are going to plant GM maize if herbicide-resistant GM varieties will be approved.

The 31 farmers that were not sure if they were going to plant GM maize reported that their decision is depending on the market (approval of herbicide-resistant varieties, increasing demand for GM maize, guarantee for their production choice), lack of information on this topic, difficulty in applying the coexistence measures, dependence on the decisions of their cooperatives, low level of pest pressure, and satisfaction with their current economic results.

Conclusions

The ex-ante measures evaluated 43.7% of all the respondents as rigid and difficult to apply. Therefore, many of them were not sure if they were going to plant Bt maize in the future. Soregaroli and Wesseler (2005) show that minimum-distance requirements reduce the adoption of GM crops. Beckmann et al. (2006a, 2006b) extend the model by including transaction costs. Our results show that transaction costs are relevant, as 24 out of 36 farmers encountered difficulties in informing their neighbors about their intention to plant Bt maize. Beckmann and Wesseler (2007), in the development of a theoretical coexistence framework, have shown that high transaction costs minimize the possibility for negotiation between GM and non-GM farmers. Furthermore, Breustedt, Müller-Scheeßel, and Latacz-Lohmann (2008) state that neighborhood relationships play a major role in a farmer's choice to adopt or not a GM crop. Demont et al. (2007) in their case study on the impact of minimum-distance requirements for GM oilseed rape demonstrate this may result in a reduced adoption between 66% and 77% depending on the minimum-distance requirement. Devos, Demont, and Sanvido (2008a) argue that ex-ante regulations—like wide isolation distances—may jeopardize GM adoption in EU. When maize fields are small and scattered throughout the cultivated area, wide isolation distances may discourage farmers to cultivate GM maize (Devos et al., 2008b; Sanvido et al., 2008). Sanvido et al.'s (2008) meta-analysis showed that isolation distances of 50m would be sufficient to keep admixture below the EU labelling threshold, while in Europe isolation distances range between 15m and 800m. In Portugal, where the isolation distances are much higher than Sanvido et al.'s (2008) finding and the majority of maize fields are small, quite many farmers reported difficulties in complying with the segregation distances, as the generated opportunity cost can forego potential GM gains. Therefore, the previously-mentioned empirical results support the statement that ex-ante regulations indeed reduce adoption and discriminate against smaller farms.

Most of the farmers that adopted GM maize did not report ex-ante regulations being an obstacle. Logically, those farmers not seeing ex-ante regulations as a problem are more likely to adopt the technology in comparison to those who

assess them as being a problem. Two groups of farmers seem to emerge: one group that assesses the ex-ante costs as being low and adopts and the other group that assesses the ex-ante costs as being high and does not adopt.

The majority of the non-GM maize farmers were aware of the GM technology. Although many of them would have liked to adopt GM maize, they avoided it as they found difficulties in applying the coexistence regulations.

As far as the intention of planting Bt maize in the future is concerned, only one of the surveyed maize farmers responded that he is *not* going to plant Bt maize, while 62.1% of all the farmers were positive about planting Bt maize in the future and 34.9% did not yet decide. However, many of the producers of the two last categories stated that they are going to cultivate GM maize if herbicide-resistant varieties will become available.

The uncertainty in the farmers' intention to plant Bt maize in the future was also due to the fact that a great percentage of them had difficulties in applying the coexistence regulations. Therefore, it can be stated that the ex-ante rules are delaying the short-term adoption of the Bt technology. Beckmann et al. (2006a) report the same results with the difference that responsible for the low rate of immediate adoption is not only the design of the ex-ante regulations, but also the formulation of the ex-post tort liability rules. Clearly, the Portuguese ex-ante regulations do discriminate against smaller farms, work against the adoption of Bt maize, and, in its current form, reduce the coexistence of Bt and non-Bt maize growers.

Endnotes

[1] The damage from the destruction of one hectare of Bt maize in 2007 has been estimated at roughly 4,000€. The Portuguese government classified the destruction as a terrorist act (EUROPOL, 2008).

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