Coping with *ex ante* Regulations and *ex post* Liability Rules for Planting Bt-maize – The Portuguese Experience

Skevas, T. [1], Fevereiro, P. [2] and Wesseler, J. [1]

[1] Social Science Department, Wageningen University, The Netherlands
[2] Instituto de Technologia Quimica e Biologica, Oeiras, Portugal

Abstract— **This study investigates the attitude and practices of GM and non-GM maize farmers in Portugal. Thirty seven GM maize farmers were interviewed representing 22.5% of the total number of GM maize notifications in the country. Additionally, 66 non-GM 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 (GM and non-GM) stated that the *ex ante* regulations are rigid and difficult to apply. On the contrary, the *ex post* tort liability rules are very clear and provide the appropriate security for the continuation of the GM maize cultivation.**

Keywords— **Coexistence, Bt-maize, Portugal.**

I. 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." (Recommendation 2003/556/EC, p. L189/36).

The importance of the coexistence regulations lies on the fact that they can play a crucial role in farmers' decision to cultivate GM crops. They induce extra costs on potential GM farmers and therefore lower the incentives for adopting GM crops (Beckmann et al, 2006b).

Soregaroli and Wesseler (2005) predict strict minimum distance requirements will increase the adoption threshold and discriminate against smaller farms. Demont et al. (2007) show 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 about 77% based on a GIS simulation model applied to Central France.

Less strict minimum distance requirements that allow for collaboration among neighbouring farms have the potential to partially off-set the negative effect of minimum distance requirements (Beckmann et al., 2006a).

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. (2006) 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 paper we present the results of a survey among GM and non GM maize farmers in Portugal. The aim is to identify to what extent the coexistence regulations affect the continuation of the GM maize cultivation. More specifically, we want to investigate the ease of application and costs of the ex ante regulations among GM maize farmers. Additionally, we want to clarify if the ex-post tort liability rules are clear and provide security to farmers. The second objective is to investigate if the non-GM maize producers are aware about the GM technology and the coexistence regulations, what led them to avoid planting GM maize and their intention for adoption in the short run.

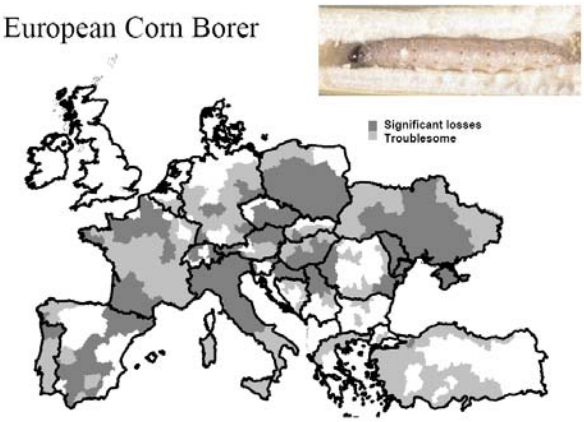
Interestingly, 43.7% of all the GM and non GM producers stated difficulties in applying the ex ante

regulations while the ex post liability rules were characterized as very clear and favourable and not seen as a constraint to adoption.

The paper is organized as follows: Section 2 provides an overview about Bt maize production in Portugal. Section 3 presents the Portuguese coexistence decree that regulates the coexistence of GM, conventional and organic crops and Section 4 outlines the survey approach. Section 5 presents the survey results and Section 6 concludes the paper.

II. BT MAIZE IN PORTUGAL

Portugal plants about 250.000 ha of grain and green maize every year (Fig.2). 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 (see. Fig. 1). The ECB can be controlled by insecticides, but also by using ECB resistant maize. 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.*). The maize line MON 810, Bt maize for short, has so far been the only GM trait that has passed the EU bio- and food safety assessment and being approved for planting in the EU.



Source: EuropaBio, 2007

Fig. 1 ECB pressure in the EU

Bt maize has been introduced in Portugal in 1999. About 1300 ha of Bt have been planted. Following the "quasi" moratorium of the EU planting of Bt maize stopped for five years. In 2005 about 770ha of Bt maize have been planted while in 2007 the area increased to about 4200 ha.

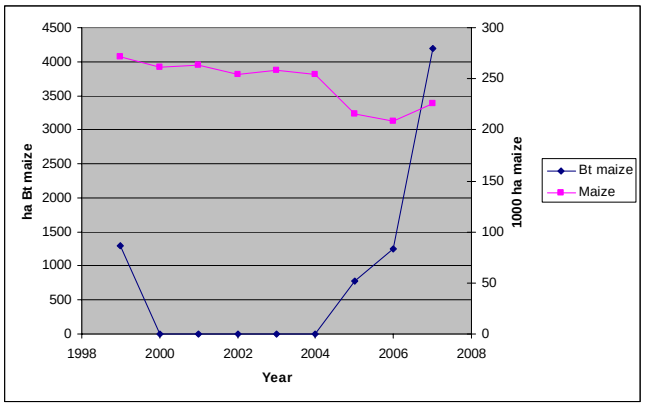


Fig. 2 Bt maize and maize cultivation in Portugal

The planting of Bt maize is distributed across the country (Fig. 3). Case study results for 2007 (Skevas) report incremental benefits of about 216€ per hectare. They are even above the average annual incremental benefits of 196€ per ha for Portugal as estimated by Wesseler et al. (2007) in their ex-ante assessment.

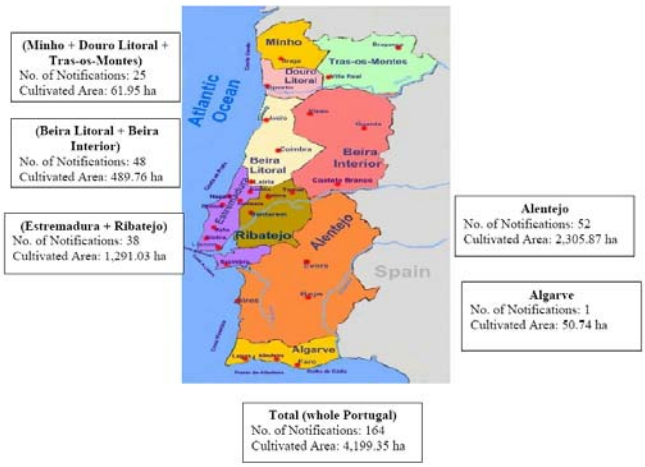


Fig. 3 Distribution of Bt maize planting in Portugal in 2007.

III. 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 genetically modified crops with conventional and organic crops.

According to the Commission Staff Working Document [COM (2006) 104], Portugal has established a mandatory national registration system. GM farmers have twenty days in advance provide notification of those fields cultivated with genetically modified 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.

Other farm measures include the national register or license and the authorization requirements for GM crop growers. In other words, this measures concern the type of information which has to be provided by GM crop growers to national or regional authorities. Thus, 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.

Additionally, it is obligatory for the GM farmers to inform by letter their neighbours 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).

Moreover the Decree has established technical segregation measures. This type of measures include 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 GM and conventional corn plots, and a 300-meter distance between biotech and organic corn plots. As an alternative to the aforementioned segregation distances 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 can be chosen by farmers.

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 for standard seed bags. Apart from this measure,

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 biotechnology-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 do include a number of fixed costs for growers which are independent of field size including 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 have to inform more neighbours.

The ex-post liability rules do not have a farm size effect except that on smaller fields it will be more difficult to use buffer zones.

Table 1 Ex ante regulations and ex post liability rules governing coexistence in Portugal (Decree-Law no. 160/2005)

Policy	Regulatory Status
Ex ante regulations	
Registration, information and training duties	
National registration system	M
Notification of the GM crop fields in public register (20 days in advance)	M
Training courses	M
Duty of grower to inform neighbours	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 staff working document [COM (2006) 104].

M: Mandatory, M/A: Mandatory/Can be amended locally by agreement.

It is important to note, Pioneer Company, the main seed provider, has agreed to pay 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 provides incentives for neighbours to collaborate, but also reduces the economic costs of vandalism, which is a non-negligible issue. The damage from the destruction of one hectare of Bt maize in 2007 have been estimated with about 4000€. The Portuguese government classified the destruction as a terrorist act (EUROPOL, 2008).

IV. Survey Approach

A detailed questionnaire that concerned the agricultural year 2007 was introduced to the Bt-maize and non-Bt maize farmers with the aim to get an insight into their attitude and practices towards Bt maize cultivation. The questionnaire included questions about farm status, the GM maize cultivation and the implementation of the Portuguese coexistence decree, the surrounding status, the agronomical results and the future of GMO's. The farm status questions concerned 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 surrounding status covered non-Bt maize neighbours and if their presence created problems and extra costs for Bt maize cultivation. Furthermore, the Bt maize producers had to reflect on their obtained economical results and compare them with the non-Bt ones. 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 GM farmers. The goal was to investigate their opinion about Bt maize production and the importance of the coexistence measures.

In total thirty seven 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.

V. SURVEY RESULTS

A. Bt maize farmers

The age of the surveyed producers ranged from 27 and 84 years while their level of education was from elementary to graduate. Therefore, the age and the

level of education can not provide the means to categorize the respective farmers in a homogeneous category with a specific characteristic.

Among the 37 surveyed farmers, 32 claimed full time farming while only five claimed part time farming. The total area planted with maize (Conventional and/or GM and/or Organic) ranged from 1.5 to 300 ha. Thirty one farmers reported problems in controlling the corn borer attack while only 6 stated they did not face any problems in controlling the European corn borer.

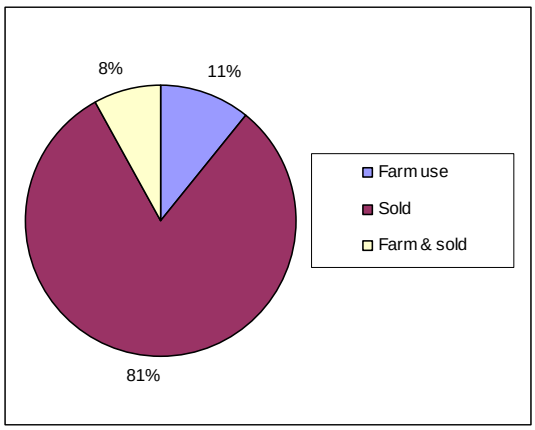


Fig. 4 Use of Bt maize

Twenty farmers planted GM maize for the first time while 17 had planted Bt maize in the past. The total area planted with GM maize ranged from one to 240 ha. 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 (see Fig. 4).

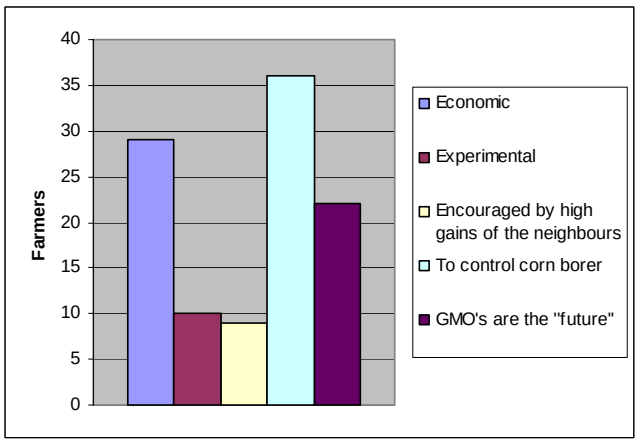


Fig. 5 Reasons for planting Bt maize in 2006

Almost all the surveyed farmers (36) stated that the main reason for planting GM maize was to control the corn borer. The main reason was the improved economic results followed by the opinion that the GMO's are the future, experimental reasons and high gains of the neighbors that had planted GM maize (see Fig. 5). Information about GM maize (Fig. 6) was obtained from companies that sell seeds, the internet, governmental institutions, TV-radio, neighbours, other (technical assessors) and cooperatives. 29 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.

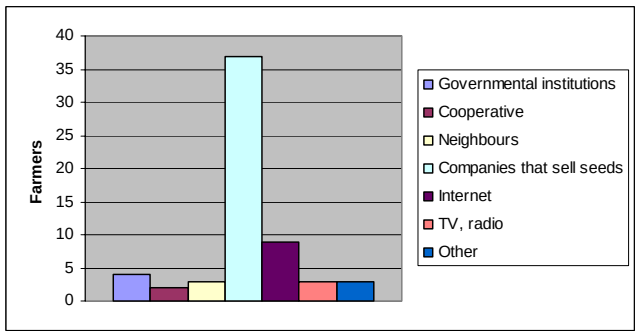


Fig. 6 Sources of information about Bt maize

All the farmers notified in advance the respective authorities for their intention to plant GM maize, provided their parcel ID, the size and location of their GM field and kept records of their agricultural practices. All of the farmers except one received at least one training course about the planting of GM

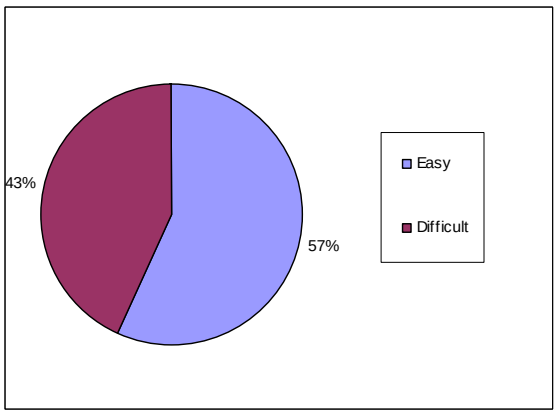


Fig. 7 Ease of complying with segregation measures

maize and the coexistence regulations. Fourteen of them characterized the quality of the respective courses "very good", while 22 of them stated that they were "good". Twenty one farmers reported that they did not have any problem in complying with the

segregation measures while 16 farmers faced various problems in applying the pre-mentioned measures (Fig. 7). Among them, were the small parcels and the increased number of conventional maize neighbours. All the producers reported to have 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.

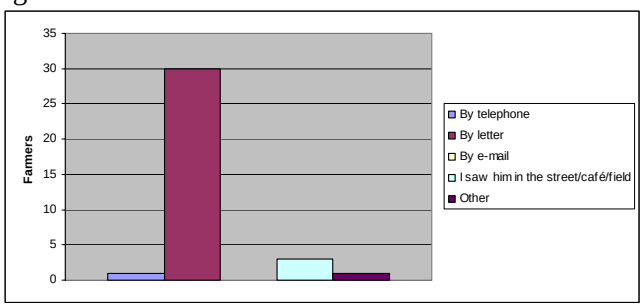


Fig. 8 Means of informing neighbours

From the surveyed farmers, 20 had one or more conventional and/or organic maize neighbours but only two of them followed the method of production planning. Almost all of the interviewed farmers (36) stated that they do not have any problem (concerning the planting of GM maize) with their neighbours. Thirty six out of the 37 surveyed producers informed their neighbours about their intention to plant GM maize. This was done mainly by sending them a letter (Fig. 8). From the 36 farmers that informed their neighbours about their intention to plant GM corn, 11 reported that it was easy to inform them while 24 stated that they find difficulties in informing all their neighbours. The difficulties were based on the increased number of conventional neighbours, 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 that they spend to inform their neighbours about their intention to plant GM maize. This time ranged from one minute to some days.

However the majority (26) of the interviewed farmers reported that the procedure of informing their neighbours was costless. Only nine farmers stated that the pre-mentioned procedure was costly valuing it from 12 to 100 Euros. Only five of the surveyed farmers claimed that they reached an agreement with their neighbours for planting GM maize. All the agreements were referring to the establishment of production zones. Finally, none of the 37 GM maize farmers caused damage to one or more neighbouring 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 fertilizers was at the same level with the conventional corn needs. Additionally, 33 farmers referred to increased quality of harvested product, two stated that the quality remained the same as in the conventional corn while only one said that the quality of the obtained product decreased.

Furthermore, 24 farmers reported that the cultivation of GM maize minimizes to a great extent ("very much") the cultivation risk related to the loss of earnings due to corn borer. 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 GM 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).

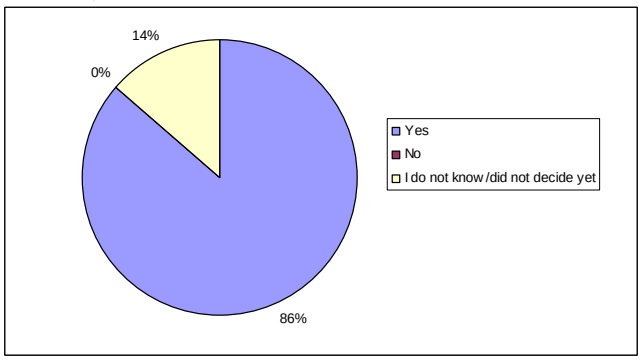


Fig. 9 Intention for re-planting Bt maize in 2007

Most of the interviewed farmers (86%) claimed that they are going to plant GM maize again, while only five reported that they had not yet decided (14%) (Fig. 9). Finally, almost all the farmers (36) believe that the cultivation and consumption of GM products do not pose a threat to the environment and to humans' health.

B. Non-Bt maize farmers

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

From the 66 producers 57 are full time farmers while only nine of them claimed part time farming. Furthermore, concerning the problems in controlling the corn borers, 24 of the surveyed farmers stated that they had faced problems with the insects' attack while 42 (63.6%) observed no problems.

As far as the use of the harvested maize is concerned (Fig. 10), 54 farmers (81%) sold, seven farmers (11%) sold a part of their harvest, while five producers (8%) used the total harvest within their farm.

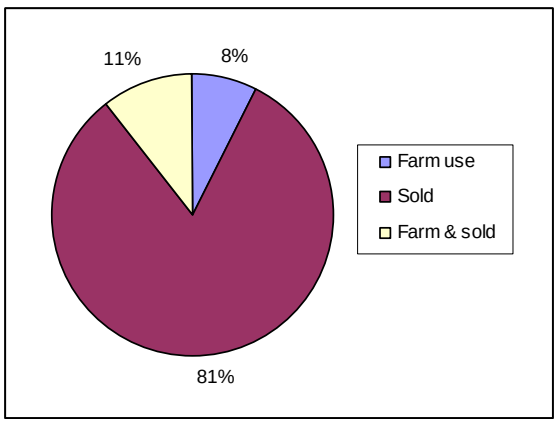


Fig. 10 Use of maize

Sixty out of all the surveyed farmers stated that they are informed about the existence of GM maize varieties as shown in Fig. 11.

As the respective question allowed the selection of more than one choice the total number of answers is bigger than the 66 surveyed producers. Thus, the majority of the producers (52) referred that their main source of information about the GM varieties was the different companies that sell seeds, followed by the TV and the radio, the internet, the cooperatives, the governmental institutions, the neighbours and other.

Concerning their neighbouring status, 23 farmers stated that their neighbours planted GM varieties, while 43 stated that they do not have any neighbour that planted GM corn last year. All the 23 farmers that had GM maize neighbours claimed that they did not have any problem with their neighbours planting GM maize.

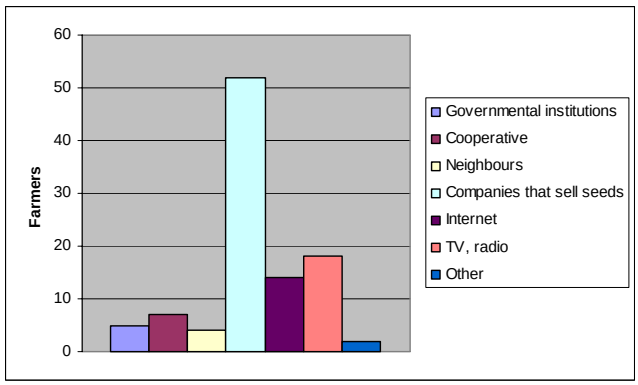


Fig. 11 Source of information for Bt maize

The coming question referred to the interest of the farmers to be informed by his/her neighbour/s about their intention to plant GM corn and to keep the segregation distances. Out of the 66 farmers, 35 respond that they would like to be informed and their neighbours to keep the appropriate distances, while 29 reported their indifference towards the practices of their neighbours.

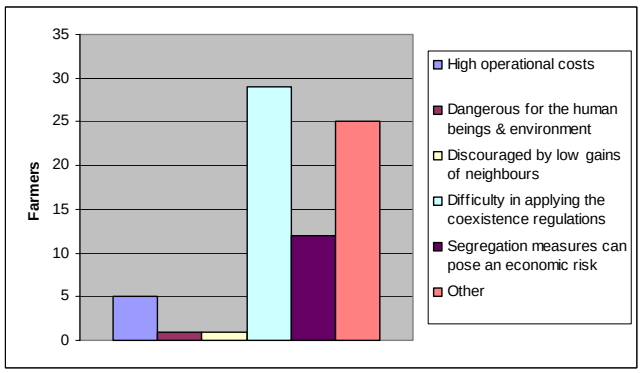


Fig 12 Reasons for not planting Bt maize in 2006

Among the reasons for not planting GM maize (Fig. 12), 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 said that GM maize can have adverse effects on humans' health and the environment and one farmer stated the bad economical results of his neighbour planting GM maize. Obviously, respondents could select more than one answer.

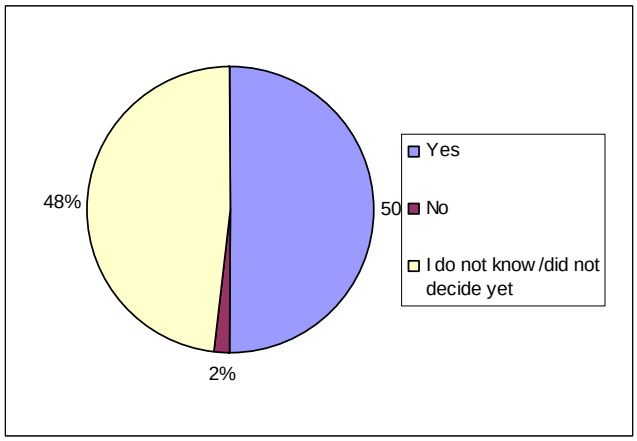


Fig. 13 Intention of planting Bt maize in the future

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

Finally, concerning the question for planting GM maize in the future, 32 farmers (50%) expressed their intention to plant GM corn, 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 GM varieties in the future (Fig. 13).

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 the GMO's 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 it herbicide resistant GM varieties will be approved.

The 31 farmers that were not sure if they are 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 insect attack and satisfaction with their economical results.

VI. CONCLUSIONS

The results of the survey clearly indicate that ex-post liability costs are not a concern of maize farmers in Portugal. The insurance scheme provided by the government in combination with the insurance provided by the seed industry reduces those costs to almost zero as perceived by farmers. This is in contrast with results reported from Germany where one of the major reasons for not adopting Bt maize was the uncertainty about ex-post liability (Nischwitz et al., 2005).

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 GM maize in the future. Soregaroli and Wesseler (2005) show minimum distance requirements reduce the adoption of GM crops. Beckmann et al. (2006a,b) extend the model by including transaction action costs. Demont et al. (2008) 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. We find empirical support for their results that ex ante regulations indeed reduce adoption.

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 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. Interestingly, the first group either was able to reduce the ex ante regulatory costs through cooperation or through internal organisation.

The majority of the non GM maize farmers were aware about 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. For them, one key factor in ensuring viable crop coexistence in Europe is the establishment of flexible ex ante regulations in conjunction with clear ex post tort liability rules.

As far as the intention of planting GM maize in the future is concerned, only one of the surveyed maize farmers responded that he is not going to plant GM maize while 62.1% of all the farmers were positive about planting GM 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 GM maize in the future was also due to the fact that a great percentage of them had difficulties in applying the coexistence regulations. As explained before, these difficulties concern the ex ante rules as the liability rules are very clear and provide a strong incentive for the adoption of the GM technology. Therefore, it can be stated that the ex ante rules are delaying the short-term adoption of the Bt technology. Beckman 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.

ACKNOWLEDGMENT

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Address of the corresponding author:

- Author: Justus Wesseler
- Institute: Environmental Economics and Natural Resources Group, Wageningen University
- Street: Hollandseweg 1
- City: 6706KN Wageningen
- Country: The Netherlands
- Email: justus.wesseler@wur.nl