Final Report

Comparison of Bt and Non-Bt maize cultivation gross margin: a case study of maize producers from Italy, Spain and Germany

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Executive summary

In this research five Spanish, five Italian and ten German farms were chosen to conduct case studies and examine economic effects of Bt maize cultivation. Spain is the only country of these three, where Bt maize had been planted in 2010. In Italy Bt maize planting has never been allowed and in Germany it had been allowed until 2009. Therefore data from Bt maize in Spain and conventional maize in Italy and Germany from the year 2010 were gathered. The regions chosen for conducting the case studies are spread over a wide area in Germany; farms are placed in Brandenburg, Saxony, Thuringia and Bavaria. Spanish farms are all from the region of Aragon and Italian farms from Lombardy, Veneto and Friuli Venezia Giulia.

Famers who were interviewed are all proponents of Bt maize cultivation, as they all expect benefits or received benefits when planted. Only two farmers in Germany were not sure if they would plant Bt maize, since they were threatened by anti-GMO activists.

The Utilized Agricultural Area (UAA) of all surveyed farms is higher than the average UAA in those regions. The five Spanish farms present an average UAA of 279 ha with 34 % grain maize, the five Italian farms present an average of 218 ha with 36 % grain maize and two of them with 17 % silage maize of their UAA. All ten German farms present 1,126 ha on average and cultivate 16 % silage maize where only half of them cultivated 5 % grain maize.

All surveyed Spanish farms cultivated Bt maize and did not use insecticides for ECB. Four Italian farms and only three of the German farms used insecticide treatments for ECB. Insecticides are either applied with own machinery or by contractors. The average spraying cost are 77 € per ha for the Italian and 57 € per ha for the German farms. The farmers who did not spray insecticides valued the costs for spraying higher than the benefit. Insecticide costs for case study farms to increase yields by 1 % are 11 € compared to Bt maize, which costs 4 € per 1 %.

Costs of Bt maize cultivation are the additional seed costs. These were assumed to be 23 € per 50.000 grains multiplied with the amount of seed used per ha. Average additional costs were calculated to be about 35 € to 38 € per ha for Spanish and Italian farms and up to 44 € per ha for German farms due to a higher amount of grains used per ha.

Grain maize benefit from planting Bt maize are higher yields which have to cover the additional costs. In this research, yield increases were assumed to be 8.7 %. This yield increase covers the additional costs from Bt maize planting for all farms and results in a gross margin increase. The profit for Spanish farms is the highest with an average gross margin surplus of 185 € per ha, followed by the Italian farms with 132 € per ha and German farms with 66 € per ha. The breakeven point for adopting Bt maize is a yield increase of 1.5 % in Spain, 2.8 % in Italy and 3.3 % in Germany.

Silage maize benefit for farmers is mainly the healthier crop due to lower mycotoxin contamination. This quality aspect is also of high importance for grain maize. However, the study shows the breakeven points for silage maize are reached at a yield increase levels of 2.9 % for Italy and 3.6 % for Germany on average among the case study farms.

Coexistence measures can also cause costs to the farms. These costs have to be at least covered by the profit resulting from Bt maize planting. The reported results suggest this to be possible.

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1. Introduction

1.1. Problem definition

The cultivation and harvest of biotech crops hit a record high globally in 2010 (ISAAA, 2010). In the EU, not all Member States were able to contribute to this development and follow the trend of increasing genetically modified organism (GMO) cultivation of Europe. In principle, there is a common regulation (EU Regulation 2001/18/EG) which applies to all 27 member states of the EU. Before a GMO variety can be adopted by the European market for cultivation, it has to be approved by the European Commission (EC) in a process explaining that it poses no risk to the environment or human health. The approval procedure and requirements are laid down in the Regulation (EC) 1830/2003.

One of the genetically modified plants whose area increased globally over the last years was Bt maize. This variety is resistant to the European Corn Borer (ECB). The only Bt maize event that is approved for planting in the EU is MON810. Since Bt maize is only allowed in some countries in Europe many farmers having problems controlling the ECB felt themselves at a disadvantage vis-à-vis their competitors from countries allowing the cultivation of Bt maize. The competitive disadvantage some farmers argue comes from the economical damage that the ECB causes hence some farmers even sued the federal government due to economic losses (Transgen, 2011).

The ECB is an insect that damages the maize by chewing tunnels into the stalks. Some of the affected maize does not only fall over but also decreases in quality through an increasing amount of plants that are infested with fusarium, or contaminated by mycotoxins (Schorling, 2005). There is not only the possibility of controlling the maize borer with Bt maize but also with insecticides and Trichogramma[1] species, although these have often proven less efficient than Bt maize (Degenhardt et al., 2003).

As farmers suffer financial damages from the maize borer in many regions of Europe (Transgen, 2011) it is important to know, if it is worth to adopt precautions. Financial damage may occur due to a lower yield and sometimes lower prices caused by lower product quality. On the one hand, farmers can increase their yield and quality of maize by using Bt maize, on the other hand they face higher seed costs. Also, if the farmer uses insecticides or Trichogramma, they may be replaced by Bt maize.

1.2. Objectives of this Research

The main objective of this study is to show the potential economic impact of Bt maize cultivation among selected farmers in Europe. Therefore, the research deals with an economic comparison among genetically modified maize and conventional maize production based on three national case studies, which were chosen and structured to be comparable with each other. Since the study ought to reflect the current situation of farmers, the collected data arises from the harvest year 2010. In order to evaluate differences within Europe, the case studies took place in EU member states with different farming and GM policies. There are many experiments and field trials that show the economic effects of cultivating Bt maize on different farming situations. But this study combines the results from field trials and other Bt maize farming countries and the current situation (year 2010) of selected European Bt and non-Bt maize farmers. The study shows how farmers' economic situation is affected by planting Bt maize. The comparison of the results will verify whether data collected in the case studies shows evidence of economic advantage for planting genetically modified maize.

[1] Wasps that can be released in fields suffering from ECB

After a short introduction, the second section provides an overview about the economic and political background for maize and Bt maize cultivation. Section three explains the methodology which was used to collect and calculate the necessary data from farmers, whereas the results of the national case studies are represented in section four (Spain), five (Italy) and six (Germany). Section seven deals with a cross-country evaluation calculating the impact of planting Bt maize for every case study by focusing on differences in the results of the case study. Finally, the study discusses the results and provides recommendations and guidance for further research.

2. Background: GMO Policy and Coexistence in Europe

Only eight European countries planted GM crops in 2010. Within the EU the legislation associated with GMO applies for all 27 EU Member States. In 2001 the directive 2001/18/EC was adopted to regulate the deliberate release of GMOs into the environment (CEC, 2009) and it had to be transferred into national policy in every EU Member State. Principally, the approval of GM crops following this regulation is mandatory for all Member States but article 23 contains the safeguard clause which allows every single state to limit or permit the application or the disposal of a GMO. This limitation or permission can only be used "where a Member State, as a result of new or additional information made available […] has detailed grounds for considering that a GMO […] contributes a risk to human health or the environment" (2001/18/EC). How this directive was transferred within the countries covered by the case study is described in section 4.1 for Spain, section 5.1 for Italy and section 6.1 for Germany. The EU determined (Article 26a of Directive 2001/18/EC) that it has to be ensured that the production of conventional and organic crops is still possible when GM crops are planted (COM, 2009). On the one hand, every farmer must have the possibility to choose between one of the given production types and on the other hand the consumer must also have the choice between GM products, conventional and organic products (Große et al., 2007). To guarantee this freedom of choice the EU adopted Recommendation 2003/556/EC on guidelines for coexistence. This guideline helps the countries to draw their own coexistence regulations (Skevas et al., 2010).

There are additional regulations, which apply directly to all Member States and need not be implemented into national law: The EU regulation 1829/2003 on GM food and feed and the regulation 1830/2003 on traceability and labelling of GMOs and the traceability of food and feed products produced from GMOs (COM, 2009)

3. Applied Methods

In every country, the same methods had to be used to allow a comparison of the results in section 7. Section 3.1 explains the methods used to calculate the gross margins and how to calculate the potential impact of Bt maize cultivation among the case study farms. Section 3.3 explains the process of collecting data from farmers.

3.1. Development of GMO and Bt maize cultivation in Europe

The GMO-cultivated area has increased every year since the commercialization of biotech crops 15 years ago and hit a record in 2010 with 148 Mio ha (IASSS, 2010). This area was cropped by 15.4 Mio farmers in 29 countries. Table 1 shows the area of the major biotech crops from 2006 to 2010 in million hectares. One notices a steady increase in all major biotech crops, i.e. soybeans, maize, canola and cotton.

Table 1: World areas sown with GMO by crop (Mio ha)

	2006	2007	2008	2009	2010
Soybeans	58.6	58.6	65.8	69.0	73.3
Maize	25.2	35.2	37.3	42.0	46.8
Canola	4.8	5.5	5.9	6.4	7.4
Cotton	13.4	15.0	15.5	16.0	21.0

Source: EC, ISAAA, USDA, FAO

Approximately 50 % of the global biotech area is occupied by herbicide tolerant soybeans which make up 81 % of the global soybean fields. Soybeans are followed by maize with 73.3 million ha i.e. 64 % of the 158 million ha maize fields worldwide, cotton with 21.0 million ha i.e. 29 % of cotton fields and canola with 7.4 million ha, i.e. 23 % of total canola fields (IASSS, 2010).

The GM crop cultivation in Europe does not reflect the global situation, because only Bt maize, i.e. maize resistant to the ECB, and a GM starch potato for industrial use have been cultivated so far. The GM potato has been approved for cultivation in the EU since 2010. Table 2 shows the area cultivated with Bt maize until 2009, while in 2010, there was also the GM potato planted, which is not included in the table. 91,193 ha in six countries were planted with Bt maize and 245 ha with the starch potato in three countries in 2010.

Table 2: Areas cultivated with Bt maize in Europe (ha)

	2005	2006	2007	2008	2009	2010
Spain	53,225	53,667	75,148	79,269	76,057	76,575
Portugal	750	1.250	4,500	4,851	5,094	4,868
Czech Republic	150	1.290	5,000	8,380	6,480	4,680
Poland	-	100	320	3,000	3,000	3,000[a]
Slovakia	-	30	900	1,900	875	1,248
France	492	5,000	21,147	-	-	-
Germany	342	947	2,685	3,171	-	-
Romania	-	-	350	7,146	3,244	822
Total	54.959	62,284	109,847	107,717	94,750	91,193

a = estimation of ISAAA
Source: Europabio, ISAAA

The countries cultivating Bt maize in 2010 were Spain, Portugal, Czech Republic, Slovakia, Romania and Poland. Spain planted almost 84 % of Europe’s Bt maize. There were two more countries - France and Germany - growing Bt maize in previous years until these crops were banned at the beginning of 2008 and 2009, respectively (Park et al., 2011). The starch potato was planted in Czech Republic, Sweden and Germany. Although the Bt maize area increased from 2007 to 2008 in Europe, it has decreased over the last three years. The European Association for Bioindustries states that “this can be associated with several factors including the economic recession, decreased total plantings of hybrid maize and disincentives for farmers due to onerous reporting of intended plantings of Bt maize.” (Europabio, 2010)

Table 3: Area of Maize in the EU among six largest producers (1000 ha)

	2006	2007	2008	2009
Romania	2,425	2,525	2,417	2,373
France	1,504	1,531	1,760	1,680
Hungary	1,215	1,079	1,200	1,179
Italy	1,108	1,053	990	916
Germany	401	403	521	464
Spain	344	361	362	345
EU-27	8,512	8,287	8,854	8,117

Source: EC, ISAAA, USDA, FAO

The whole area planted with maize in the EU in the last years covered between eight and nine million ha. In Table 3 it can be noticed that the biggest areas planted with maize in Europe over the last four years were Romania, France and Hungary. Also Italy, Germany and Spain are important maize producers, since they are among the six biggest maize producing countries in Europe.

3.2. Methodology: Gross margin calculation and cross-country evaluation

One of the main objectives of the study is to determine the economic consequences farmers would face if they had planted Bt maize in 2010. The task was less challenging for Spain as there Bt maize was planted in 2010. Before compiling the applied methods used to calculate the economic outcome of Bt maize production we have to distinguish three different cases: (Case 1) The farmer planted Bt maize in 2010 which was only the case in Spain. In this case it was possible to calculate with real data, whereas in Italy and Germany we had to make some assumptions to calculate potential impacts of Bt maize production based on yields, prices and costs of conventional production. In Italy and Germany the farmer either did not use any abatement measures against the ECB (Case 2) or the farmer used abatement measures like spraying insecticides (Case 3).

First of all we calculated the gross margin for every farm as described further down. After we received the results, the (potential) Bt maize production results were assessed and a cross-country evaluation was put together. This approach is explained as final method (Comparison) in this section.

Case 1

As farmers in that case planted Bt maize, we calculated the gross margin (as explained in more detail under Case 2) deducted the incremental gross revenue which was generated from Bt maize planting in comparison to conventional maize and also deducted the additional seed cost for Bt maize. To put it simply, Case 1 is the reverse calculation of Case 2, which is explained in detail as follows.

Case 2

In this case the farmer did not use any abatement measures, neither Bt maize nor insecticides against ECB. Firstly, the conventional production situation was computed for every farmer before assessing the Bt maize leverage. A simple gross margin calculation was used. Gross margin of the conventional maize farmer (GM_i^{Con}) equals the gross revenue (GR_i^{Con}) minus the variable costs (VC_i^{Con}) of farmer i.

$$GM_i^{Con} = GR_i^{Con} - VC_i^{Con} \quad (3\text{-}1)$$

$$GR_i^{Con} = Y_i^{Con} * TP_i^{Con} \quad (3\text{-}2)$$

$$VC_i^{Con} = S_i^{Con} + VMC_i^{Con} + W_i^{Con} + Fer_i^{Con} + Ins_i^{Con} + Herb_i^{Con} + Dry_i^{Con} + CC_i^{Con} + I_i^{Con} + OVC_i^{Con} \quad (3\text{-}3)$$

By multiplying the maize yield (Y_i^{Con}) with the trading price (TP_i^{Con}) we achieve the gross revenue (GR_i^{Con}) shown in equation (3-2). The variable costs (VC_i^{Con}) are the sum of all costs that arise by planting one additional hectare of maize. Variable costs include the costs for seeds (S_i^{Con}), machinery (VMC_i^{Con}) including the tractor and machine, wageworkers (W_i^{Con}) fertilizer (Fer_i^{Con}), insecticide (Ins_i^{Con}), herbicides ($Herb_i^{Con}$), drying (Dry_i^{Con}), contractor costs (CC_i^{Con}), insurance (I_i^{Con}) and other variable costs (OVC_i^{Con}).

As there were no data of Bt maize production available in this case, the idea was to calculate the additional yield that is necessary to cover additional costs that come up by planting Bt maize instead of conventional maize. The point where the additional revenue covers the additional costs is the break-even point. To assess the breakeven the GM_i^{Con} has to be equalised with the gross margin of the Bt maize (GM_i^{Bt}). This further means that the additional VC (ΔVC_i) have to be covered by the additional GR (ΔGR_i)

$$GM_i^{Bt} = GM_i^{Con} \quad (3\text{-}4)$$

$$\Delta VC_i = \Delta GR_i \quad (3\text{-}5)$$

If the only costs that differ between cultivation of conventional and Bt Maize are the seed costs, the additional variable costs for Bt maize equal the additional seed costs for Bt maize (ΔS_i^{Bt}). An assumption had to be made for seed prices of Bt maize. We assumed seed prices for Bt maize ranging somewhere between the prices of other European countries and past prices in Germany.

$$\Delta VC_i^{Bt\text{-}Con} = \Delta S_i^{Bt\text{-}Con} \quad (3\text{-}6)$$

To calculate the required ΔGR_i^{brk} for covering the ΔVC_i to reach the breakeven point and therefore the same GM_i that is achieved with conventional production, the yield of conventional maize production has to be multiplied with the required relative yield increase factor yif. That implies that the GR_i^{Con} has to be multiplied with the yif to get the GR_i^{brk}, as well.

$$Y_i^{Bt} = Y_i^{Con} * yif \qquad (3\text{-}7)$$

$$GR_i^{brk} = GR_i^{Con} * yif \qquad (3\text{-}8)$$

$$yif_i = GR_i^{brk} / GR_i^{Con} = (GR_i^{Con} + \Delta S_i^{Bt\text{-}Con}) / GR_i^{Con} \qquad (3\text{-}9)$$

$$ryi_i^{brk} = (yif - 1) * 100 \qquad (3\text{-}10)$$

To calculate the yif with which the maize yield has to be multiplied, the GR_i^{brk} has to be divided by GR_i^{Con}. By subtracting one from yif_i and multiplying it with 100 we receive the relative yield increase (ryi^{brk}) in percent of the conventional maize yield to reach the breakeven.

Case 3

The whole computation gets more complicated, if the farmer used insecticides in the year 2010. The gross revenue GR_i^{Ins} by using insecticide is higher than the GR_i^{Con} since we assume that the farmer has less damage of ECB and therefore a higher yield. To calculate the GR_i^{Con}, the GR_i^{Ins} has to be divided by the yif^{Ins}.

$$\Delta GR_i^{Con} = \Delta GR_i^{Ins} / yif^{Ins} \qquad (3\text{-}11)$$

$$ryi^{brk} / ryi^{Ins} = \Delta VC_i^{Bt} / \Delta VC_i^{Ins} \qquad (3\text{-}12)$$

$$ryi^{brk} = (ryi^{Ins} * \Delta S_i^{Bt}) / \Delta VC_i^{Ins} \qquad (3\text{-}13)$$

The proportion of ryi^{brk} to the ryi^{Ins} is the same as the proportion of the ΔVC_i^{Bt} to ΔVC_i^{Ins}. Therefore the ryi^{brk} equals the ryi^{Ins} multiplied with the ΔVC_i^{Bt} and divided by ΔVC_i^{Ins}. The ΔVC_i^{Bt} equals the ΔS_i^{Bt} (see above). But to get the ΔVC_i^{Ins} more factors must be taken into account, such as the cost of insecticides for ECB (Ins_i^{Ins}), the VMC for spraying the insecticide (VMC_i^{Ins}), variable costs for wage workers (W_i^{Ins}) and the contractor costs (CC_i^{Ins}) if a contractor was used for insecticide application. In sum, these costs equal the ΔVC_i^{Ins}.

$$\Delta VC_i^{Ins} = VMC_i^{Ins} + Ins_i^{Ins} + W_i^{Ins} + CC_i^{Ins} \tag{3-14}$$

We assume that the farmer would completely abandon spraying if s/he were able to plant Bt maize. That means that s/he has higher costs for Bt seeds but no longer faces costs for controlling the ECB by applying insecticides.

Comparison

By reviewing all three cases we are able to compare them. Case 1 always gives us real evaluations whereas in Case 2 and 3 were based on assumptions. The findings of the relative yield increase (ryi_i) in Case 1 can be compared with results from experiments and other studies to estimate one ryi^{est} which we can compare with all the ryi_i^{brk}. The ryi^{est} is the potential ryi_i. For that every farmer could potentially increase his yield by ryi^{est}. If the farmers ryi_i^{brk} is lower then the estimated increase, he will not only cover the extra variable costs for planting Bt maize but will also gain an extra margin.

Positive $\Delta ryi^{est\text{-}brkev}$: Gain from planting Bt maize (3-15)

Negative $\Delta ryi^{est\text{-}brkev}$. Loss from planting Bt maize

If the farmers' ryi_i^{brk} is higher than the ryi^{est} the farmer loses money. By multiplying $\Delta ryi^{est-brk}$ with the conventional gross revenue we achieve the gross margin gain or loss.

$$\Delta GM_i^{Bt} = GR_i^{Con} * ryi^{est-brk} \quad (3-16)$$

Finally we were able to compare all three EU Member States with each other. By only looking at the results in gross margin difference it is worth to plant Bt maize, if the farmer gains from it. But we also have to consider that neither transaction costs nor costs from ex-ante regulation or ex-post liability to comply with coexistence regulations are included. At this point, it should be mentioned, that an extra gross margin must at least cover any extra costs that are associated with coexistence measures to still gain from Bt production.

All necessary data for the calculation were collected from participants of the three case study countries in the way described in the following section (3.3).

3.3. Data Collection

Spain, Italy and Germany were chosen to conduct the case studies. The reason for these three countries was that this paper should compare different farming and policy situations in the EU. One national case study takes into account an EU Member State in which Bt maize varieties had been planted in 2010. The remaining two national case studies were set in Italy and Germany and take into account conventional maize production in 2010. Italy was chosen because maize production plays an important role to farmers there, but Bt maize had never been planted. Germany was chosen because policy allowed farmers to plant Bt maize there before but had been banned for the last three years since 2009.

As all case study results had to be comparable with each other, all calculations had to be structured accordingly. Firstly, five to ten farmers in every country took part in the survey. It did not matter whether the participants were from different regions but they were required to plant either grain and/or silage maize. They should also have had problems with keeping ECB under control. After contacting and informing them about the survey, every farmer was questioned in a face to face interview wherever possible. In case the farmer was not available in person, the survey took place by a personal phone call.

Our case study included five Spanish, five Italian and ten German farmers from different country regions. We tried to speak to the chief executive farmer or if this was not possible to a secretary who had good knowledge of the farm; all interviews were done in May 2011. Each interview was conducted according to a standardized questionnaire and lasted between 60 and 90 minutes. However, given the nature of the research, the interviewees were not required to stay within the standard questions. The questionnaire was created to ascertain the farmer's situation and his/her opinion on Bt maize and the GM policy. The Spanish questionnaire was structured slightly different with detailed questions on the farmers' handling of Bt maize and results of Bt maize production. Accordingly we compiled a separate Bt questionnaire (for Spain) and a non-Bt questionnaire (for Italy and Germany). The Bt questionnaire is structured as follows: part A contains questions on farming, in part B we tried to get some information about the attitude of the interviewee towards GM maize and the reason for planting and part C contains adjacent status information on the handling of the Bt maize production and coexistence measures. In the Non-Bt questionnaire, part C includes mainly questions about the opinion towards the government policy. In part D the farmer was asked about the results from Bt maize production like quality and operational costs. Part E (or part D for non-Bt) finishes the questionnaire by asking about the future of GMOs. After discussing the questionnaire, we collected data from the farmer to calculate the gross margin of either Bt maize or maize.

All data to calculate the gross margin were listed in a spread sheet in the calculation programme MS Excel. Two separate spreadsheet data had to be used to separate grain and silage maize. To calculate the gross revenue the farmer had to quantify maize yields, the trading prices and the moisture content. In case s/he planted silage maize s/he had to quantify the dry matter content and loss and energy concentration. To calculate the variable costs, the respondent had to list all prices per unit and in unit per ha. Since some farmers often have the exact aggregated variable costs available from a plant database we could use these costs per ha.

In the following sections 4 to 6 all three case study countries are described. The first subchapter of these sections point out the GMO and coexistence policy, the second subchapter introduces the regions, in which the farmers are placed, the third subchapter goes into the detailed farmers' situation referring to the results of the questionnaire and the fourth subchapter gives the result of the calculation of gross margin from farmers maize production. These parts are important to compare later on in section 7 the three countries and calculate the influences of Bt maize production.

4. Results of Surveys: Spain

4.1. GMO and coexistence policy in Spain

4.1.1. GMO policy

In Spain the cultivation of GM maize is approved since 1998. Permitted varieties were derived from two separate events: the MON 810 and BT 176 but commercialization of BT 176 stopped a few years ago. Thus all transgenic maize varieties now grown in Spain are derived from event MON 810. Those transgenically modified varieties caused great losses and are prevalent in the valley of the Ebro: “taladro”. Two lepidopterene, the *Ostrinia nubilalis* and the *Sesamia nonagrioides* have common characteristics and similar modes of action and cause such damage. The first generation of these insects causes damage by grubbing holes into the maize stalks. This weakens the stalks, which can break down by the pressure of the wind. Wind can be very strong especially if there is north wind or "cierzo" in the middle Ebro valley. Direct damage caused by the following insect generations is galleries in the ears, leading to consequent losses of production and grain quality.

Since the authorization of GMO plating, the percentage of hectares each year has been increased (Table 4)

Table 4: GMO maize planting in Spain since 2005

	2005	2006	2007	2008	2009	2010
GMO	53,226	53,667	75,148	79,269	79,706	76,575
Conventional	364,043	299,950	279,672	286,841	272,985	252,563
GMO (%)	13	15	21	22	23	23
Total	417,269	353,617	354,820	366,110	352,681	329,138

There are currently 88 registered varieties of GM maize approved for planting in Spain, 69 registered in Spain and 19 in the European Plant Variety Catalogue. Corresponds to commercial varied as: Pioneer Hi-Bred, Monsanto Agricultura, Limagrain Ibérica, Semillas

Fitó, Arlesa (Euralis), Koipesol, Agrar Semillas, Maize States Int., KWS, Caussade Semences y RAGT.

4.1.2. Coexistence policy

There is no obligation in current legislation requiring a farmer to have strict minimum distances between GM production and other non-transgenic varieties, but there are different distances determined by several scientific studies. Regulations require an obligation to respect some areas of "refuge" of non-GM maize planted 20% of each five hectares planted with GM maize. In most cases takes the limits of the plot to establish these zones.

There is no evidence that in the thirteen years they have been coexisting transgenic maize with conventional and organic crops there has been no demand from farmers for cross-contamination problems.

Finally remark that there is a Ministerial Council on Genetically Modified Organisms, which in turn has a Participation Committee in which consumer associations are represented environmental groups, professional agricultural organizations, seed producers, etc.

4.2. Introduction: Case Study region

Aragón, which lies north of Spain, is one of the 17 Spanish autonomous communities separated from France by the Pyrenees mountains and lies on the borders of Navarra, La Rioja, Castilla León, Castilla La Mancha, Valencia and Catalonia. The Ebro River runs through the central area of its territory where the lower altitude of the Autonomous Community is named by the valley of the Ebro.

Aragon has a great diversity of landscapes with its three provinces: Huesca, Zaragoza and Teruel. The UAA in 2008 was 1,820,747 ha whereof 25% was irrigated. The total area of

Aragon is 4,764,192 hectares, with an UAA of 38%. This includes 387,879 ha of grasslands, being 8% of the total are.

The percentage of irrigated land is higher in Huesca with 39% of the total UAA, compared to 25% in Zaragoza and 8 % in Teruel.

4.3. Selection of farmers and their description

4.3.1. Selection of farmers and GM planting

The five chosen farms are in the region of Aragón in Los Monegros, Cinca Medio and Hoya de Huesca. These farms irrigate land with a modern underground watering system. They use the “three crops in two years”-system alternating spring crops (barley and wheat), summer crops (maize and sorghum), oilseeds (sunflower) and legumes (alfalfa). Sometimes industrial crops are introduced into the rotation (green beans, endive, etc.) by contractors.

Maize is the most important crop in the rotation, because it grows independently of watering provided. Depending on the preceding crop planted, one can find maize in the first season, planted between March and April, or in the second season, planted between May and June. These selected farms are of a similar size or slightly bigger than the average farms of that region. Sometimes these are irrigated farms only or a combination of irrigated and dry farming. It is also very important to mention the pureness of the fertilizer used for the maize and therefore it is a very important way to save costs of fertilization. This is above all used in the region of Los Monegros because it has a very high density of pig farms. Regarding the problems of drilling, many of the interviewed farmers said they had few problems with the drills because they use different kinds of the GMO maize.

The farmers remember they used to have more problems with the drills before they were allowed to use the GMO maize decreasing production and difficulties at the recollection time. The Ebro valley which is one of the most economic region for drilling in Spain had serious damage in previous recollections before they used the GM maize. Maize of the surveyed farms is GM maize only except for the refuge areas which are planted with conventional maize. Both crops the conventional and the GM crop are harvested together at the same time and sold as GM later on. Farmer are able to get informed about GM cropping can go on the Spain's countryside and participate in meetings organized for the distributing companies of seeds, cooperatives of agricultural organizations. It is recommended to take part in these kind of events. One of the farmers has a university degree as an IT agricultural engineer and two others have had professional agriculture training.

Regarding their relationship as neighbours, they have had problems because of the GM crops if their neighbours plant GM crops as well. Three farmers had told their neighbours about their intentions to plant this crop.

Referring the information of the Administration they did this at the time when filing the "Common Agricultural Policy" (CAP).

All farmers are seeing the advantages of GM maize in the increase of production an a safer product, and they could reduce the need of insecticides down to zero. As a disadvantage the costs of the seeds in comparison with the conventional maize can be named, although these costs are to supply a bigger production and better surface unity.

None of the farmers concerned think that there is a risk in human safety and the environment from GM farms and they show their intentions to continue planting this kind of maize. All these landowners want to increase the transgenic events authorized similar as in other countries with production brought to Europe.

4.3.2. Farm description

Farm 1

Farm 1 is located in Grañén, Piraces and Tramaced between the regions of la Hoya de Huesca and Los Monegros. 420 hectare were used for grain maize and the other 160 hectare were used as silage maize. The grain maize was maize of the first season and the silage maize was planted after barley. In the case of grain maize the labor of cultivation was the following: preparation of the land with a chisel and router, rolling the ground, background distribution of fertilizer, planting and application of pre-emergency herbicide. This is followed by applying the cover fertilizer (N 32%) in one or two steps by injecting it into the sprinkler irrigation. If needed an emergency herbicide treatment can be injected into the irrigation system or a company that provides this service can be hired. The second season maize of the silo is made with a direct planting after the barley saving the labor of chisel, roller and mill. The rest of the planting is similar to the grain maize. At the time of fertilization cow manure has been used applied. The planting and recollection are effectuated using a specific service business. In both systems an insurance which cover production risks have been signed.

Farm 2

The farm lies in Morilla, in the region of Cinca Medio. This farm uses their own machinery except for the recollection where they hire a combine harvester. The farm measures 115 hectare of which 50 are designed to grain maize only for the sale to companies or intermediaries. The preparation of the land is done by a chisel and a standard router. After that they condition it with a roller after which they apply fertilizer and seeds. After that they make a treatment with pre-emergency herbicide and one insecticide treatment. The cover fertilizer (N 32%) is applied into a sprinkler system irrigation. This can be repeated. If it is necessary a post-emergency herbicide treatment with own machinery can be done as well. Also in this case an insurance has been signed to cover production risks.

Farm 3

Farm 3 is located in Sariñena inside the region of Los Monegros. The cultivation has 330 hectare and 150 of them are dry cultivations and the rest are irrigated cultivations. 150 hectare of the irrigated cultivation are designed to grain of the second season or “disc tiller” after barley and peas.

In the case of maize, it is planted after peas. The field has been prepared with the chisel and router, and the roller afterwards. Then the fertilizer has been applied and then the seeds sown. Immediately after planting a pre-emergency herbicide is applied and the other kind of work that needs to be done is similar to what has to be done when planting maize after barley.

All the work is done with the farm’s own machinery. As in the other cases an insurance has been signed to cover the production risk.

Farm 4

Farm 4 is located in Grañén in Los Monegros. This is an agricultural business because of which they have to hire staff. The farm has 235 hectare of which 106 are destined to grain maize. 66 hectare are used to plant maize of the first season and 40 of them for maize of the second season. In the case of maize of the first season the following steps need to be done: preparation of the field with a chisel and router afterwards the roller is used to apply the fertilizer, followed by planting and application of the pre-emergency herbicide. After that more fertilizer (N 32%) is put onto the field via the sprinkler irrigation system. The work of planting and recollection is done by a contractor. Again an insurance to cover the risk of cultivation needs to be taken out.

Farm 5

This farm is located in Alcubierre and Robres in Los Monegros. The farm has 260 acres of which 140 are irrigated. 56 acres of the irrigated land are destined to maize of the second season or "disc tiller".

Planting the maize is done by direct planting after which fertilizer is applied and the field is treated with a pre-emergency herbicide. After that the fertilizer (N 32% and purines) is applied via the sprinkler irrigation system or the Spanish hay tedder depending on the fertilizer chosen. If necessary a post-emergency herbicide treatment can be done. In that case all the work is done by a contractor and again an insurance has been signed.

4.4. Results: Gross margin of maize production

Table 5 shows the gross margin calculation of the five farmer of the region of Aragon in 2010. Trading prices, which are about 19 € per dt are very similar to all farms and grain yields range between 130 and 140 € dt per ha.

Table 5: Gross margin for grain maize of surveyed farmers for the harvest year 2010

Description	unit	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Size of the farm	ha	420	150	330	235	260
Grain maize	ha	160	50	105	106	56
Grain humidity	%	21.0	21.5	20.0	20.5	21.0
Grain yield	dt / ha	135	140	138	135	130
Trading price	€ / dt	19.03	18.99	19.10	19.06	19.03
Gross revenue	**€ / ha**	**2,568**	**2,659**	**2,636**	**2,573**	**2,474**
Variable machine costs	€ / ha	379	379	289	311	239
Wage work	€ / ha	[a]	[a]	[a]	[a]	[a]
Seed	€ / ha	331	331	331	331	331
Fertilizer	€ / ha	631	631	631	631	481
Herbicides	€ / ha	160	160	160	160	160
Insecticides	€ / ha	50	50	50	50	50
Contractor Cost	€ / ha	0	0	0	0	0
Drying	€ / ha	300	300	300	300	300
Insurance	€ / ha	30	30	30	30	30
Variable machine costs (Maize borer)	€ / ha	0	0	0	0	0
Insecticides (Maize borer)	€ / ha	0	0	0	0	0
Contractor Cost (Maize borer)	€ / ha	0	0	0	0	0
Variable costs	**€ / ha**	**1,881**	**1,881**	**1,791**	**1,813**	**1,591**
Gross margin	**€ / ha**	**688**	**778**	**845**	**760**	**883**

[a] Note that Wage work is included in variable machine costs

To calculate the cost of the machinery the price that the contractors charge in the examined region needs to be considered. The difference between the cultivations lies in the difference of the systems they use. Direct planting or conventional planting relies on the second season maize or the first harvest. Speaking about the costs of the seeds there is no difference between the farms because all of them have the same or similar providers and there are only few providers.

The costs of fertilization are identical, except for farm number 5 which use purines as a part of the process of fertilization which saves them costs.

The other costs as herbicides, irrigation and fungicides are similar between the farms and at that time we couldn't find any differences in the costs of amortization of the pipes used for the irrigation and the equipment of the allotment, which have not been included in the calculation. The difference in the selling price relies on the basic price with a discount for dryness until a humidity of 14 %, the calculation is based on the table submitted by the Spanish Asociación Nacional de Deshidratadores de Cereales, Leguminosas y Piensos (ANSEDE).

5. Results of Surveys: Italy

5.1. GMO and coexistence policy in Italy

5.1.1. GMO and coexistence policy in Italy

Directive 2001/18 was implemented in Italy in 2003 by Decree-Law 224/2003 (Italian Government, 2003). This decree identifies the Ministry for Environment and Territory and Sea as the Italian National Competent Authority with regard to GMOs. The ministry coordinates administrative and technical-scientific activities and, after a consultation process, provides the authorisation for the deliberate release of the GMOs into the environment. However, other authorities are involved in the process and two other ministries, Health and Agriculture, can appeal to the safeguard clause.

EU Recommendation 2003/556 concerning coexistence was implemented with the law n.5/2005 (Italian Government, 2005). This law introduced the principles of coexistence and the freedom of choice of farmers, operators of the supply chain, and consumers among conventional, organic and transgenic products. Based on this law, the Ministry of Agriculture was supposed to draw the general coexistence rules and, accordingly, regional governments had to implement the specific coexistence plans (the law states that without coexistence plans GM plant commercial cultivation is not allowed). However, after an appeal by the Marche Region to the Constitutional Court, the Court sanctioned that coexistence regulations and management are exclusive pertinence of Regions and autonomous Provinces (Italian Constitutional Court, 2006).

The Conference of Regions and autonomous Provinces approved in 2007 the guidelines for the implementation of regional coexistence regulations. Suggested rules include both ex-ante and ex-post liability measures for maize and soybean and *de facto* exclude the possibility of cultivation for canola (Conferenza delle Regioni e delle Province Autonome, 2007)[2]. However, up to date coexistence plans have not yet been implemented by regional governments.

Without coexistence plans farmers could not obtain authorization for cultivation of EU approved GM crops. Differently from the case of the deliberate release of the GMOs into the environment, this authorisation is released by the Ministry of Agriculture. Following this situation, in early 2010, after an appeal by a farmer willing to cultivate GM maize, the Italian State Council (2010) sentenced that authorisation for GM plant cultivation cannot be linked to a preliminary implementation of coexistence plans. Therefore, the Ministry of Agriculture should proceed with the authorization procedure independently from the existence of these plans. Nevertheless, up to now the Ministry responded negatively to all farmers requesting authorization. With a press release of May 2010, the Ministry underlines that requests received from farmers were all identical and not providing the necessary technical information (from location of the field to type of machinery used...) to open the procedure (MIPAF, 2010).

In October 2010, the Conference of Regions and autonomous Provinces approved a new document concerning coexistence (Conferenza delle Regione e delle Province Autonome, 2010). With this document Italian regions ask the Ministry of Agriculture to appeal to the safeguard clause in order to prohibit the cultivation of maize MON 810 and the potato

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[2] Among the different rules, the Conference of Regions and autonomous Provinces (2007) suggests the following guidelines for the coexistence of maize crops:

- Minimum distance for separation:
  a) 1000 meters, as suited distance to guarantee the absence of GMO contamination (<0,01%) referring to neighbouring maize field;
  b) 300 meters, as suited distance to keep admixture under 0,9% (compliance with the law on conventional production) referring to neighbouring maize field.
- Area with particular weather characteristics: Regions may consider areas with particular climatic conditions (windy or extreme and cyclical weather conditions), where the distances can be tripled, or only doubled if there are suitable wind-breaks or other measures to reduce the wind speed and the dispersion of GM material.
- Specific measure of cultivation for crops resistant to insects: GM crops 20% of the cultivated area has to be planted with non-GM as refuge-areas.

Amflora on the Italian territory. With the same document, Italian regions withdraw the guidelines for the implementation of regional coexistence regulations considering them out of date, given the prospects of the new EU legislative framework on GMOs. Their objective is to define and support an Italian model of agriculture that is free of GM crop cultivation on the whole territory. This document was signed by all Italian regions, with the exception of Lombardy.

5.1.2. GM framework in the case study regions

Although Lombardy did not sign the document on coexistence proposed by the other Italian regions, the Region is now discussing a legislative proposal that excludes the release of the GMOs into the environment in many areas (Regione Lombardia, 2011). For example, under this proposal territories with PDO products will be defined as GM-free and any farmer can ask the regional government a GM-free status for his fields. With a GM-free status, the prohibition of GM plant cultivation would be extended to all neighbouring areas with a distance that will protect GM-free areas from any form of direct contamination.

Friuli Venezia Giulia recently approved the law n. 5/2011 that prohibits the planting and the growth of GMO in the regional area, with the exception of experimental purposes, and provide severe fines to farmers not respecting the prohibition (Regione Friuli Venezia Giulia, 2011). In this way the Region aims to protect the biodiversity and the quality of traditional products. The text explicitly states that is in compliance with the proposed article 26b amending directive 2001/18/EC.

With the same aim of the above regions, in march 2011 Veneto proposed a bill allowing GM cultivation only for research purposes. Again, the objective is to label the whole Region as “GM-free”.

5.2. Introduction: Case Study region

5.2.1. Utilized Agricultural Area

The area included in the case study involves three important regions located in the north of Italy: Lombardia, Veneto, and Friuli Venezia Giulia. According to the National Institute of Statistics (ISTAT) the three regions present an UAA (Utilized Agricultural Area) of 2.04 million hectares representing 16% of the total UAA of Italy. As Table 6 shows, considering the sole cereal cultivation this percentage rises to 24.4% and it reaches 51.7% for oilseed cultivation. Cereals are the most important crops in the three regions, while oilseeds play a minor role in terms of land allocation.

In Lombardy the agricultural area allocated to cereals is mainly cultivated with maize and wheat. Forages cover more than half a million of hectares and their development is strictly linked to the presence of large herds. Veneto is characterized by cereal and oilseeds production, especially soybeans. This last crop covers almost one third of the entire national oilseeds areas. Apparently, soybean is preferred to others crops thanks to its low production costs and its agricultural advantages in regard to crop rotations (Veneto Region, 2009). Friuli Venezia Giulia presents a smaller UAA, but it is similar to the previous regions in terms of the production system, regarding the high suitability of the plain area and the good irrigation system allowing for the cultivation of maize and soybean in the region (Friuli Venezia Giulia Region, 2010).

Table 6: UAA per cereal and forage crops (ha) in 2010

	Lombardy	Veneto	Friuli Venezia Giulia	Italy
Total cereals	330,070	347,345	107,403	3,210,161
Oilseeds	32,334	75,602	40,502	286,850
Temporary forages	252,383	73,088	10,991	1,963,951
Permanent forages	250,350	129,259	31,711	4,397,670
Total	865,137	625,294	190,607	9,858,632

Source: Istat

5.2.2. Farm structure

Table 7 shows the structure of Italian farms in terms of total number and average UAA. From 2003 to 2007, at the national level there is an important reduction in the number of farms and a resulting increase in their average size. Nevertheless, the Italian agriculture continues to be made up mostly of small and medium-sized farms.

In the three regions under consideration, the number of farms does not show a particular trend and the average size is slightly rising thanks to an increase in total UAA. The production system in Lombardy appears to be more specialized compared to the other regions and the rest of Italy: in 2007, farms size in Lombardy was twice the hectares of the average Italian farm.

Table 7: Number of farms and average UAA per farm (ha) in Italy

	Number of farms			UAA (ha)		
	2003	2005	2007	2003	2005	2007
Lombardy	61,308	57,231	57,342	16.0	17.1	17.4
Veneto	145,756	142,896	144,473	5.7	5.6	5.7
Friuli Venezia Giulia	25,294	23,820	24,206	8.7	9.4	9.4
Italy	1,962,537	1,725,589	1,677,765	6.7	7.4	7.6

Source: Istat

5.2.3. Maize cultivation

Maize production is progressively concentrating in the North of Italy, with 830 thousand hectare in 2010. The concentration process was favoured by the decoupled payments of the EU Common Agricultural Policy (CAP). Following Frascarelli (2011), two features further the profitability of maize cultivation: the synergy with livestock breeding and the growing demand for bio energy (biogas).

As Table 8 shows, Lombardy, Veneto, and Friuli Venezia Giulia cover about 60% of Italian maize arable land. The land allocated to maize decreased during recent years. This trend is common in other cereal crops and it is probably linked to the effects of the new CAP, favouring decoupling of subsidies.

Maize yields did not show a particular trend over the last ten years (Table 9). The numerous droughts, the limitation in nitrogen use, and the reduced possibility to use germplasm from extra-European States contributed to the stagnating maize yields (Nomisma, 2008). Yield in the three regions are similar to the Italian average in Veneto and Friuli Venezia Giulia and above the average in Lombardy.

With a decreasing internal production and an increasing demand, Italy is a net-importer of maize with 2.15 million tonnes imported in 2010. Relevant flows come from EU Member States, with France and Hungary being the main suppliers.

Table 8: Maize UAA in Italy (ha)

	2001	2006	2007	2008	2009	2010
Lombardy	285,285	261,913	234,953	253,741	238,304	220,487
Veneto	281,376	310,856	309,306	237,797	234,752	231,649
Friuli Venezia Giulia	126,788	107,806	106,310	85,320	72,935	90,461
Italy	1,109,644	1,108,419	1,053,396	1,238,924	916,158	925,087

Source: Istat

Table 9: Maize yield (tonnes/ha)

	2001	2006	2007	2008	2009	2010
Lombardy	10.9	11.1	11.3	11.6	10.6	11.2
Veneto	9.8	7.9	9.2	9.6	9.8	9.6
Friuli Venezia Giulia	10.2	8.6	10.0	10.0	7.9	9.6
Italy	9.6	8.7	9.3	9.1	9.0	9.6

Source: Istat

5.2.4. Organic production

In 2009, there were 40,462 organic producers in Italy. The largest number of organic farms is in the South (especially in Sicily and Calabria), whereas the related processing industry is mainly located in Emilia Romagna and Lombardy (SINAB, 2009). As Table 10 shows, the three regions under consideration show a relatively small number of organic producers compared to the rest of Italy.

The land suitable for organic agriculture covers over 1.1 million hectares (Table 11). It is mainly used for cereal production, followed by forages and pastures (SINAB, 2009). In 2009, maize counts for 5% of the total cereal area under organic production with 12,788 hectares (2,392 ha in Lombardy, 1,020 ha in Veneto, and 149 ha in Friuli Venezia Guilia).

Table 10: Number of organic producers in Italy

	2000	2005	2006	2007	2008	2009
Lombardy	849	880	823	756	646	646
Veneto	882	1075	974	926	902	924
Friuli Venezia Giulia	166	298	279	249	246	256
Italy	49,790	44,733	45,115	43,159	42,037	40,462

Source: SINAB

Table 11: Organic UAA (ha) in Italy

	2000	2005	2006	2007	2008	2009
Maize	6,377	13,907	13,115	10,135	9,247	12,788
Cereals	194,616	258,848	239,092	241,430	231,569	251,906
Total	1,040,377	1,067,102	1,148,162	1,150,253	1,002,414	1,106,684

Source: SINAB

5.2.5. Nature 2000 lands

As Table 12 shows, Nature 2000 covers about 21% of the Italian surface partially overlapping the protected natural area (especially parks and reserves). Of the three considered regions, Lombardy show the lowest share of Nature 2000 areas, while Veneto has the highest, with mountain areas representing almost half of the designed territory. Other important areas are river-basins, lagoons and see areas (Veneto Region, 2009).

Table 12: Nature 2000 network in 2010

	Ha	(%)
Lombardy	372,067	15.6
Veneto	414,741	22.5
Friuli Venezia Giulia	149,733	19.1
Italy	6,217,144	20.6

Source: Italian Ministry of Environment

5.3. Selection of farmers and their description

5.3.1. Selection of farmers and GM planting

A total of five farms were selected in the three regions of Lombardia, Veneto, and Friuli Venezia Giulia. Generally, the selected farms present a cultivated area that is much larger than the average farm in the region. Therefore, results are not intended for generalization. All farmers are full time farmers.

All of the farms cultivate maize as a major crop and declare having problems with the ECB. According to three farmers, these problems have been increasing over time, while the remaining two state that ECB presence varies year by year.

Farmers use non-GM maize varieties from well-known brands (Pioneer, Dekalb, NK) and get their seeds from the company, by local brokers, or agricultural consortiums. All farmers are well aware of the debate regarding GMOs, although the sources of information on GM maize issues vary. Companies that sell seeds seem to have a strong influence through their sales force, agronomists, and their marketing activities, includign company magazines, events and visits to maize fields and research labs. Other sources of information are seminars organized by farmers' associations or specialized farm journals. One farmer, also being an agricultural engineer, occasionally reads scientific journals.

All farmers have a positive opinion on GM product cultivation and consumption. They do not see any particular threat to the environment and humans' health for approved varieties. On the contrary, they stress the negative implications of traditional practices such as the distribution of insecticides.

All farmers would plant GM maize if allowed. The main addressed reason is the presumed better plant health in GM maize. This particularly refers to the presence of micotoxines which downgrade maize quality on the market and as for feed use within the farm[3]. A healthier plant would also contribute to higher yields and to a lower use of chemicals saving costs and benefiting the environment.

Planting GM-maize would require dealing with neighboring farms. Here, minimum distances from the legislation and field sizes are crucial. Except for two farmers having large fields, the other farmers are concerned about this issue and the proposed solutions depend on their relationships within the territory. Some of them are confident of finding an agreement with neighbors, while others declare that this would require creating a common GM area. Informing neighbors about GM planting is seen as useful by two farmers, while others feel discriminated on this account in comparison to other measures ("then, I should also inform when I use chemicals"..) or stress how reciprocity is also important ("they should also inform me if they grow organic"). However, except for one farm, farmers have good relationships with their neighbors and they do not see particular acceptance problems.

Relationship with the local community is also seen as uncomplicated. Four farmers consider having good relationships with the local population and believe that, if properly informed, there should be no acceptance problems. On the other side, activists and non-GM consumers' organizations from the outside are perceived as a problem.

All farmers have a very bad opinion on the GM maize prohibition in Italy. They consider it as unscientific, not respecting their freedom of choice, biased against innovation, demagogic, and not taking into account the fact that GM feed is already on the market.

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[3] Several farmers show concern about the tendency of feed and food dealers to purchase maize from abroad for quality reasons

Three farmers do not think that GM maize cultivation will be allowed in the near future, i.e. next three years. They see the negative prejudice of the population as too strong. They state that this, together with distorted information and overall ignorance, will give an incentive to policy makers in keeping a strong opposition toward GMOs by any means. In addition, the opposition by certain farmers' associations is of no help. On the other side, the remaining two farmers believe that GM maize cultivation approval will be an unavoidable consequence. This is linked to economic reasons: without this approval, there will not be a domestic market for maize in the future and Italy will import the quantity and the quality needed from abroad in the form of GM grains.

5.3.2. Farm description

Farm 1

Farm 1 is located in Veneto in the province of Rovigo. It presents a total UAA of 75 ha, of which 30 ha were cultivated with maize in 2010. The farm uses only family labor. Production is limited to grain maize that is totally sold on the market after harvesting and drying grains. The farm is divided into two: one part presents a pivot system of irrigation. The remaining half of the farm is irrigated using traveling sprinklers. Maize land preparation and sowing takes place as follows: 1) manure in liquid and/or solid form is distributed only on 5% of the land where the farmer thinks it is needed most; 2) plowing; 3) harrowing; 4) sowing, which includes in the same process the distribution of fertilizer (urea) and herbicide (pre-emergence). Insecticides against ECB are distributed on the total maize area via two different methods: the pivot system and, where this is not available, hired contractors to who the farmer provides the insecticide. Contractors are also used for harvesting the crop. All of the cultivated maize area is covered by insurance for hail and wind damages.

Farm 2

Farm 2 is located in Veneto in the province of Venice. It presents a total UAA of 500 ha, with 140 ha cultivated for grain maize and 20 ha for silage in 2010. The farm uses family and hired labor. Harvested grains are all dried and either sold on the market or used for bovine feeding. Silage production is used for bovine feeding completly. The farm adopts different cultivation procedures according to the heterogeneity of the land. After distribution of manure, which covers only 25% of the maize area, land preparation can be divided into three practices: a) plowing and harrowing (50% of land); b) weeding and harrowing (40%); c) no-tillage (10%). As a fertilizer only nitrogen is distributed in the form of NH_3. This is done by contractors that provide both the machinery and chemicals. Herbicides are distributed both pre- and post-emergence. Insecticides against ECB are distributed on the total maize area by hired contractors to who the farmer provides the insecticide. Irrigation is for largest part conducted as sub-irrigation; only 5% of the maize is irrigated using travelling sprinklers. Harvesting is done with own machinery except for silage maize, where a contractor is hired who also takes care of transportation. Finally, the farm does not insure the crop, since past events were very rare and, more in general, the size of the farm allows for what the farmers defines as a "self-insurance principle".

Farm 3

Farm 3 is located in Friuli Venezia Giulia in the province of Pordenone. It presents a total UAA of 70 ha, with 56 ha cultivated with grain maize in 2010. The total maize produced is sold on the market after harvesting and without drying. The farm uses family labor and also operates as a contractor with other farms in the area as customers. This is important to consider, since machineries of this farm are sized appropriately for a farm cultivating 200 ha.

The farm adopts two different soil cultivation procedures for maize, according to the heterogeneity of the land: a) plowing and harrowing (80% of land); b) subsoiling and harrowing (20%). Liquid manure is distributed on 30% of the land, since neighboring piggeries have the problem of respecting nitrates waste distribution limits given by the legislation. In contrast to previous farms, fertilizers are also distributed before sowing using products containing nitrogen, phosphorus and potassium. Herbicides are distributed pre-emergence and, on 40% of the land, also post-emergence. Insecticides against ECB are distributed on the total maize area hiring contractors to who the farmer provides the insecticide. Irrigation is conducted using travelling sprinklers 2-6 times per season according to the different soils. Contractors are used for harvesting the crop. All of the cultivated maize area is covered by insurance for hail damages.

Farm 4

Farm 4 is located in Friuli Venezia Giulia in the province of Udine in a hilly area. It presents a total UAA of 45 ha, with 35 ha cultivated with grain maize in 2010. Maize production in total is sold on the market after harvesting and without drying. The farm uses only family labor. Soil cultivation starts with the distribution of liquid manure, coming from the farm breeding activity, on the total maize area. This is followed by plowing, harrowing, and sowing. As fertilizer, only urea is distributed prior to sowing and in a post-emergence weeding practice. Herbicides are distributed pre-emergence on the total land. Insecticides against ECB were not distributed in 2010. Contractors are used for harvesting the crop. All of the cultivated maize area is covered by an insurance for hail and draught damages. The farm does not perform irrigation on maize fields.

Farm 5

Farm 5 is located in Lombardia in the province of Brescia. It presents a total UAA of 400 ha, with 130 ha cultivated for wet grain silage and 130 ha for silage in 2010. Maize production is totally used within the farm: wet grain silage is used for feeding pigs, while whole plant silage is used for biogas energy production. The farm uses family and hired labor. As for the previous farm, soil cultivation starts with the distribution of liquid manure, coming from the farms piggery, on the total maize area. This is followed by plowing, harrowing, and sowing. As fertilizer, only urea is distributed. Herbicides are distributed pre-emergence on the total land and post-emergence on 40% of land. Insecticides against ECB are distributed on the total maize area hiring contractors that provide also the insecticide. Irrigation is totally conducted using furrow irrigation. Contractors are used for harvesting the crop. All of the cultivated maize area is covered by insurance for hail damages.

5.4. Results: Gross margin of maize production

In order to perform a comparative gross margin analysis for the five surveyed farms, some assumptions were necessary:

1) An average cost of labor of 15€/h was used for all farms. Since most of the farms use family labor, this would require a complex valuation of farm-specific opportunity cost of labor. Moreover, farmers declared a cost of labor ranging from 13 to 25€/ha, based on hired workers. Considering the characteristics of the labor market, these differences do not reflect a different regional cost, but are probably related to the cost components the farmer considered, e.g. taxes, standard or overtime hourly wage, permanent or temporary workers. Therefore, to simplify comparison, we preferred avoiding introducing this element of variability.

2) The cost of nutrients intake from manure was considered according to its replacement value for substitution. For example, given the nitrates problem, Farm 3 could replace manure received from neighbors free of charge with manure from other neighbors having the same waste management problem. So the cost of manure is zero. Among the interviewed farms, a positive cost of manure was only considered for Farm 4 and 5 having breeding activities and distributing manure on 100% of the land. This cost was computed taking into account only the nitrogen intake, considering a content of 1.7 kg/m^3 at a price consistent with the distributed mineral fertilizers.

5.4.1. Grain maize

Table 13 shows the computation of the gross margin for the five farms for the harvest year 2010, distinguishing gross revenue from a series of different categories of variable costs. In the table prices and yields are shown according to the average humidity level at which maize was traded or used within the farm (only Farm 1 and 2 dry the grains). Table 14 allows a better comparison since it compares yield and prices at a standard humidity level of 14.0%. Trading price range from 18.3 to 22.1 €/dt. Price variability depends in some measure to the quality of the harvest (dry, wet, purity and health of grains), to local market conditions, and to the different timing of sale[4]. Yield ranges from 105 to 132 dt/ha and, together with cultivation practices, clearly depends on local factors, such as climatic conditions and soil characteristics.

[4] Note that Farm 5 does not sell its harvest. The given price follows this reasoning: it considers the price at which wet maize grains were purchased by the farm in 2010 (15€/dt) and it augments this price by 1€/ha, assuming the traded price would have been higher if the farm was in a selling position (it could have waited higher peaks rather than the opposite).

Table 13: Gross margin for grain maize of surveyed farmers for the harvest year 2010

Description	unit	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Size of the farm	ha	75	500	70	45	400
Grain maize	ha	30	140	56	35	130
Grain humidity	%	14.0	14.5	22.3	23.0	30.0
Grain yield	dt / ha	105	110	146	128	145
Trading price	€ / dt	20	22	17	18	16
Gross revenue	**€ / ha**	**2,100**	**2,420**	**2,420**	**2,312**	**2,320**
Variable machine costs	€ / ha	145	65	217	123	77
Wage work	€ / ha	155	90	97	139	198
Seed	€ / ha	159	165	165	165	159
Fertilizer	€ / ha	245	232	366	233	150
Herbicides	€ / ha	52	53	84	72	113
Insecticides	€ / ha	0	0	0	0	0
Contractor Cost	€ / ha	100	0	95	197	115
Drying	€ / ha	188	104	0	0	0
Insurance	€ / ha	35	0	30	43	32
Variable machine costs (Maize borer)	€ / ha	1	0	0	0	0
Insecticides (Maize borer)	€ / ha	35	24	23	0	0
Contractor Cost (Maize borer)	€ / ha	20	25	28	0	75
Variable costs	**€ / ha**	**1,134**	**758**	**1,105**	**972**	**918**
Gross margin	**€ / ha**	**966**	**1,662**	**1,315**	**1,340**	**1,402**

Table 14: Gross revenue for grain maize of surveyed farmers for the harvest year 2010 at a 14.0% humidity level

Description	unit	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Grain yield	dt / ha	105.0	109.4	131.9	115.0	118.0
Trading price	€ / dt	20.0	22.1	18.3	20.1	19.7
Gross revenue	**€ / ha**	**2,100**	**2,420**	**2,420**	**2,312**	**2,320**

Variable machine costs show a high variability across farms. Part of this variability depends on the limits of the survey method: farmers were asked to self-assess the timing of each cultivation practice and the hourly incidence of tractors and machine variable costs. So although minimized by the help of the interviewer, a certain degree of subjectivity is still present. However, cultivation practices and farm structure are still very important in determining these differences. Farm 3 has the highest cost: this is basically linked to the high incidence of irrigation costs given by the use of travelling sprinklers. For other farms irrigation has a much lower incidence in terms of variable machinery costs: as previously described, Farm 1 uses a pivot system on half of the land, farm 2 uses sub-irrigation, farm 4 does not irrigate, and farm 5 uses furrow irrigation. Farm 2 and 5 show the lowest variable machine costs: in this case the large size of the farm matters, since higher fixed costs for machinery investments compensate in lower variable costs per hectare.

Wage work differences are also important. Farm 5 has the highest incidence and this again depends on the irrigation practice. Furrow irrigation, although having no machine costs needs constant monitoring and it is repeated several times per season in the same farm field. Lower labor incidences are, as expected, in farm 2 and also in farm 3. In this case, Farm 3 takes advantage from outsized machineries given its activity as a contractor.

Seed cost is basically constant across farms, indicating that there is no variability in the quality of seed chosen by farmers and in the prices practiced by seed companies.

Fertilizers are used in a different amount by the surveyed farms: Farm 4 and 5 use only nitrogen fertilization, Farm 2 uses nitrogen and phosphorous, and the remaining two farms distribute the classical three elements (N, K, P). Nitrogen is distributed mainly in the form of urea by all farms except for Farm 2 that uses only ammonia fertilization. Farm3 bears the highest expenditure in fertilizers that is mainly due to a large incidence of potassium fertilization (more than 100€/ha). Farm 5 shows the lowest expenditure: also considering manure distribution, it appears to distribute the lowest total amount of nitrogen among the five farms.

Herbicides are distributed by all farms in pre-emergence and successively integrated by post-emergence ones according to the need. Weeds seem to be a particular problem in Farm 5. This farm is also treating fields in the fall season with glyphosate in order to reduce the degree of infestation.

Except for Farm 2, contractors are used for harvesting and, for Farm 4, also for transportation of grains. Contractors are also used to treat against maize borer. The incidence of ECB treatment is slightly above 50€/ha for the first three farms, while Farm 4 did not treat in 2010: according to the farmer, cost of treatments are too high in this territory (120€/ha +insecticide cost) compared to the benefits. Excluding Farm 4, the incidence of ECB treatment on total variable costs range from 4.6 to 8.2%.

Overall, Farm 2 takes advantage from its size and presents the lowest variable cost level. It is followed by Farm 5 that is penalized by a high wage incidence although benefiting from a large size and from a low cost of fertilizers. It follows Farm 4, having no irrigation and ECB costs; Farm 3 that is penalized by the irrigation system and a high use of fertilizers; and Farm 1, where drying costs are particularly important. The resulting gross margin shows the same order for the above farms.

5.4.2. Silage Maize

Table 15 shows the computation of gross margin for the two farms producing silage maize in 2010. Yield appears very different between the two farms. Concerning market price, it has to be noted that both farms do not trade their silage maize. Therefore, the provided values reflect their perception of the market. Moreover, Farm 2 indicated a trading price corresponding to the final silage product, while Farm 5 provided the price of maize sold as a crop before chopping.

Variable costs are the same of grain production for what concerns cultivation practices, fertilizers and chemicals. What varies is the cost of harvesting. Farm 5 indicated an incidence of chopping, transportation and silage practices in 1.5 €/dt[5]. Farm 2 better specified the

[5] They were not included in the table, since the indicated trading price is for the crop before chopping. However, variable costs were changed, compared to grain maize production, taking into account that harvesting practices are now different or conducted by contractors.

different cost of harvesting, and the "contractor cost" refers exclusively to maize chopping and transportation practices. Overall, silage maize results in a lower gross margin for Farm 2, mainly because of the lower yield, and a higher margin for Farm 5.

Table 15: Gross margin for silage maize of surveyed farmers for the harvest year 2010

Description	unit	Farm 2	Farm 5
Size of the farm	ha	500	400
Silage maize	ha	20	130
Silage yield	dt / ha	50.0	65.0
Trading price	€ / dt	5.0	3.5[a]
Gross revenue	**€ / ha**	**2,500**	**2,275**
Variable machine costs	€ / ha	80	70
Wage work	€ / ha	123	183
Seed	€ / ha	165	159
Fertilizer	€ / ha	232	150
Herbicides	€ / ha	53	113
Insecticides	€ / ha	0	0
Contractor Cost	€ / ha	350	0
Insurance	€ / ha	0	32
Variable machine costs (Maize borer)	€ / ha	0	0
Insecticides (Maize borer)	€ / ha	24	0
Contractor Cost (Maize borer)	€ / ha	25	75
Variable costs	**€ / ha**	**1,052**	**782**
Gross margin	**€ / ha**	**1,448**	**1,493**

[a] Crop is sold before harvesting.

6. Results of Surveys: Germany

6.1. GMO and coexistence policy in Germany

6.1.1. GMO policy

In 2009, Germany as the sixth country in Europe banned the cultivation of MON 810 maize varieties. The Federal Minister for Food, Agriculture and Consumer Protection (BMELV) Ilse Aigner based this decision on the safeguard clause of the EU's release directive. There were no reasons given that related to risks or new specific evidence of MON 810 (GMO-Compass, 2009).

The EU Regulation 2001/18/EC was implemented in Germany into national law in 2006 by adopting it to the German Genetic Engineering Act (GenTG) from 1990. As a result, every deliberate release of a GM crop into the environment has to be approved by the relevant federal authority. The GenTG issues the application of genetic engineering and regulates the prevention of risks. It consists of seven parts dealing with the release of GMOs in Part Three. To ensure the adherence of coexistence is one of the main objectives of the GenTG.

6.1.2. Coexistence policy

Measures in Germany guiding the cultivation of GMOs include the GMO location register (GenTG), the best practice measures cited in the Gentechnik-Pflanzenverordnung (GenTPflEV) as well as labelling issues.

GMO location register

The register is kept by the higher federal authority for the purpose of monitoring the effects of GMO and informing the public. The operator who plants the GM crop has to inform the federal authority three months in advance and has to provide information on the label and unique identifiers of the GMO product, its GM trait, the name and address of the person who cultivates the fields, the property of the cultivation and the field size. Name and address are not made public.

GenTPflEV

The general rules on best practice are established in the GenTG and complemented in detail by the GenTPflEV for the production of GM crops. They contain technical segregation measures and regulate:

- The storage, transport and harvest of GM plants,
- The obligation to inform neighbouring farmers about the planting of GM crops three month before seeding (for GM maize, neighbours in the perimeter of 300 m),
- The minimum isolation distances to neighbouring fields with the same cultivated crop (for GM maize: 150 m to conventional maize fields and 300 m to organic maize fields),
- The possible reduction of minimum distance between GM and non-GM fields with the same cultivated crop by arrangements of the affected farmers; this has to be entered into the location register,
- The control of second growth on fields in the following year; this second growth has to be destroyed,
- The recording of details from the cultivation of the GM crop which has to be stored over five years,
- The crop rotation; conventional maize can be soonest grown in the second year after growing GM maize on that field.

Labelling

GMO crops, as food and feed products consisting of GMO or containing it, have to be labelled to avoid mixing them with conventional products. This applies to products containing a GMO amount that exceeds the threshold level of 0.9 %.

All cost arising from coexistence measures have to be carried by the farmer according to the polluter-pays-principle. Strict liability means to the farmer that s/he is liable "… for all economic losses incurred on neighbouring farms due to unwanted admixture regardless of whether or not a direct link can be ascertained." (EC, 2009) In the case of more than one causer of the damage, farmers of a region are commonly liable (§32 GenTG).

6.2. Introduction: Case Study region

6.2.1. Utilized Agricultural Area

The regions chosen for conducting the German case study are spread over a wide area of Germany: Brandenburg, Saxony, Thuringia and Bavaria. The regions cover a size of 6.2 million ha which equals 37 % of the total UAA of Germany. Table 16 shows the areas cropped by the different plants in 2009. In all regions, cereals play the biggest role, whereby also permanent forages are very important. Oilseeds are in all regions winter oilseed rape reaching 87 to 99 % of the oilseed area. Temporary forages are mainly silage maize with nearly 50 % in all regions.

In Brandenburg, the main cereal grown is rye with more than 40 % of the cereals. The types of cereals grown in Saxony are evenly distributed between winter wheat, winter and summer barely, rye and oat. In Thuringia, winter wheat occupies nearly 60 % and in Bavaria 44 % of the UAA in those states. In addition a large area in Bavaria is cropped with barely.

Table 16: UAA per cereal and forage crops (1,000 ha) in 2009

	Brandenburg	Saxony	Thuringia	Bavaria	Germany
Total cereals	543.8	422.6	384.9	1,227.9	6,908.4
Oilseeds	151.0	136.8	121.5	170.5	1,506.8
Temporary forages	242.0	113.9	79.3	483.9	2,347.3
Permanent forages	285.3	188.0	173.1	1,103.2	4,741.4
Others (e. g. root crops)	105.0	53.6	31.9	225.1	1,385.7
Total	1,327.1	914.9	790.7	3,210.6	16,889.6

Source: Eurostat

6.2.2. Farm structure

Due to the German farm structure it is necessary to distinguish between farms run by a farmer as a natural person and farms owned by legal entities or cooperatives. After World War II, legal entities and corporations were strongly supported in East Germany. Many LPGs (Landwirtschaftliche Produktionsgenossenschaft) that were formed had to dissolve after the reunification of Germany in 1990. **Table 17** shows the number of farms managed by a single farmer and their UAA. The number of farms in the former East German states Brandenburg, Saxony and Thuringia increased after the reunification although the size of the average UAA per farm increased. This can be explained by looking at the changing number of farms managed by legal entities and corporations and their UAA after 1990 (Table 18). Many of these farms in the former East German states split up and thus got smaller which increased the number of farms and corporation and allowed single farmers to acquire a farm. In comparison, the number of farms of single persons in Bavaria has strongly declined and the number of corporation increased instead.

Table 17: Number of farms (single farmers)

	Number of farms			UAA (ha)		
	1990	2003	2007	1990	2003	2007
Brandenburg	4,120	5,190	4,990	24	59	65
Saxony	4,790	7,000	7,100	19	30	33
Thuringia	3,260	3,970	3,810	15	35	40
Bavaria	213,730	130,470	117,030	16	23	25
Germany	646,270	388,650	346,330	19	30	33

Source: Eurostat

Table 18: Number of farms (juristic persons and cooperatives)

	Number of farms			UAA (ha)		
	1990	2003	2007	1990	2003	2007
Brandenburg	920	1,520	1,670	1,276	672	605
Saxony	730	1,120	1,140	1,022	590	566
Thuringia	570	1,000	930	1,261	653	691
Bavaria	1,130	4,480	3,930	29	64	72
Germany	7,280	23,660	24,150	678	223	222

Source: Eurostat

6.2.3. Maize cultivation

Table 19 shows the UAA of grain maize and silage maize in the German case study regions. There has been a much higher cultivation of silage maize compared to grain maize in the last years. The relative amount of grain and silage maize production in the year 2007 lies at 1.9 % in Brandenburg, 1.6 % in Saxony, 0.5 % in Thuringia and 3 % in Bavaria for grain maize and at 8.5 %, 6.6 %, 5.4 % and 10.1 % for silage maize respectively. In Germany as a whole, grain maize occupies 2.3 % and silage maize 8.7 % of the total UAA in 2007 where grain maize made 21.3 % of the maize production. In the year 2010, the amount of grain maize has increased to 464 thousand ha (tha); silage maize even rose to 1,846 tha (Destatis, 2011).

In Brandenburg, maize production is the second most important crop after rye. The increase of silage maize on the one hand and the slower decrease of grain maize on the other hand are mainly based on a rising number of biogas plants (LVLF, 2010)

In Bavaria, 18 % of the silage maize area is used for biogas production in 2010 (LFU, 2010).

Table 19: Grain maize and Silage Maize UAA (ha) in Germany

	Grain maize			Silage Maize		
	2005	2007	2009	2005	2007	2009
Brandenburg	22,550	25,800	25,100	94,010	112,930	143,8
Saxony	16,820	15,020	13.643	58,550	60,960	67,498
Thuringia	5,060	3,630	3,760	38,490	42,630	48,132
Bavaria	112,160	98,770	113,097	303,630	325,280	356,500
Germany	443,100	397,770	464,300	1,262,530	1,466,490	1,646,700

Source: Eurostat

By looking at the average maize yield per ha of the case study region, it becomes clear that all regions had lower yields in the years 2006 to 2009 than the average maize yields per ha in one year for Germany in total, except for Bavaria and Thuringia. This applies to grain and silage maize. Especially the farms in Brandenburg do not have good farming conditions due to bad weather and soil conditions, which leads to comparatively low yields (MIL Brandenburg, 2010).

Table 20: Grain maize yield (tonnes/ha)

	2006	2007	2008	2009	2010
Brandenburg	5.9	8.2	7.3	7.3	
Saxony	7.2	9.2	8.7	9.3	:
Thuringia	7.3	9.5	8.6	9.5	:
Bavaria	8.8	10.0	10.3	10.3	9.2
Germany	8.0	9.5	9.8	9.8	8.8

Source: Eurostat

Table 21: Silage maize yield (tonnes/ha)

	2006	2007	2008	2009	2010
Brandenburg	23.73	39.16	31.58	33.11	:
Saxony	34.70	45.00	42.07	42.80	:
Thuringia	40.10	47.56	38.81	42.92	:
Bavaria	48.32	52.60	51.18	51.55	:
Germany	39.46	47.05	45.29	44.67	40.35

Source: Eurostat

6.2.4. Organic production and Nature 2000 lands

In 2007, 14.500 farms were organic producers who cropped 5.1 % of the total UAA and increased up to 5.6 % in 2009. Nearly half of that area in 2007 was permanent grassland (49 %) and 46 % was acreage with again half of that was cerial. Organic production is of high importance in Brandenburg with 9.1 % of the UAA (Table 22).

Table 22: Organic production in 2007 in Germany (1000 ha)

	Ha	(%)
Brandenburg	133.8	9.1
Saxony	32.0	3.6
Thuringia	40.4	4.1
Bavaria	146.5	3.8
Germany	861.2	5.1

Source: Destatis,

Table 23 shows that Nature 2000 lands in Germany are covering about 14.1 % of the total UAA. In the case study regions they are above the national average level except for Bavaria with 11.3 %.

Table 23: Nature 2000 network in 2010

	Ha	(%)
Brandenburg	766,500	26.0
Saxony	292,777	15.9
Thuringia	270,000	16.8
Bavaria	797,000	11.3
Germany	7,374,400	14.1

Source: German Federal Environmental Ministry (BMU)

6.3. Selection of farmers and their description

6.3.1. Selection of farmers and GM planting

Ten German farmers, who have planted Bt maize from 2005 to 2008 have been chosen to participate in the survey. The farmers' ages range between 21 and 61. Seven farmers are agronomists, one has an engineering degree in Agro Chemistry, one is a business economist and one a skilled farmer without degree. The different locations of their farm are arranged to cover a large area of Germany.

Four farmers are located in Saxony, three in Brandenburg, two in the northern of Bavaria and one in Thuringia. Four of the farms are organized as agricultural corporation, whereby in each case the interviewed farmer is the chairman of the corporation. Another four farms are organized as limited corporations (ltd.); in these cases, the interviewed farmers have the position of chief executives. Two Bavarian farmers do not form any kind of corporation. The area cultivated by corporations per farm is average for the kind of organization in the newly formed German states (average of 1,419 ha in 2007; BMELV, 2010) but much higher than the area of average agricultural enterprises in the respective federal state. The surveyed ltd's cultivated area is larger than average for the newly formed German states, where the average was 614 ha per ltd. in 2007 (BMELV, 2010). The size of the cultivated area of the two Bavarian farms is above the average in the region.

All farms report damages by the ECB. For the year 2010, the farmers classified the corn borer problem between somewhat less and slightly higher than average.

All farmers are well informed about GM maize. The first time they decided to plant GM maize was mainly due to conviction by companies that sell seeds. Three farmers read about the ECB-resistant varieties in an agricultural journal and contacted the GM-seed selling companies. Most of them also got in touch with the German InnoPlanta e. V., a company which tries to increase the public acceptance of plant biotechnology.

According to the interviewees every surveyed farmer had profited from planting Bt maize or would have profited if there had not been any damage by GMO opponents. Therefore, they all have a positive attitude towards Bt maize. If cultivation of Bt maize would allowed again in Germany, eight farmers said they surely would cultivate Bt maize. Two of them would like to cultivate it, but are afraid about threatened by anti-GMO campaigners. As the decisive argument for planting Bt maize varieties the farmers named a higher yield. That referred not only to a higher and safer (meaning more constant) yield quantity but also to a higher yield quality, due to healthier plants. Lower damage of the stalks would also lead to a better tolerance of dryness.[6] They also mentioned a more stable stalk. A stronger stalk would not only lead to a reduction of broken stalks but also to a lower damage from wild boars, which three of the farmers noticed when they planted GM maize. Against this statement, one farmer, who had lower wild boar problems, too, proclaimed that this referred to the different taste of the varieties of maize, no matter if GM or non-GM maize and thus is according to him not only due to the more stable stalks. Farmers who were not spraying insecticides against ECB found it economically inefficient, since on the one hand, the process for optimal timing to spray requires a substantial amount of time for monitoring. On the other hand, they argued that maize is already quite tall at the time of spraying against ECB. Thus, the spraying might cause damage by breaking the stalks. In combination with the spraying costs, this might not be compensated by the benefits of less ECB infestation.

All farmers, except for three said they would not have problems in keeping a minimum distance to their neighbouring fields. For one of those three where the minimum distance plays a role, the neighbour adjoins to a lot of fields and this would mean a lot of restructuring when planting the maize. For the remaining two, the size of the farm and the fields are reasons why the distance to the neighbouring field is of great importance. Half of the farmers

[6] Drought is important except for the farms located in Bavaria.

think that informing their neighbours about GM maize planting is useful and that it should be mandatory. Some mentioned that it is not necessary, as there is no need to inform a neighbour about spraying chemicals, too. Others said it is useful to keep a good relationship to their neighbours, but it should not be possible to be taken to court for not providing information.

Neighbourhood and community acceptance was a big issue for all farmers when they cultivated GM maize. Seven of them had neighbours who were against the cultivation. These neighbours tried to stop the cultivation and complained about losses in their crop production. One farmer's neighbours also talked to the landowners and tried to convince them not to lease their fields to the farmer any more. But the farmer and two more claimed that if the landowner did not like to plant GM maize on his/her fields for whatsoever reason, they would accept it. A more important issue than the neighbours is the attitude of others towards GMO cultivation. Opponents destroyed fields, machines, and threatened farm workers, but none of the farmers did face substantial problems in their local community. Some of them even organized local events to inform about and discuss Bt maize cultivation.

All farmers except for one are convinced that GM maize cultivation will not be allowed within the next years. They justify their expectation seeing the prohibition of GM maize as a political issue only. They do feel their view being ignored in the debate and consider the ban as not being supported by substantiated scientific research and just a political decision. All farmers see a chance of GM crop planting being permitted in the more distanced future since the pressure on politics and the markets are rising. Another argument was that in order to get more renewable energies for biogas, even more maize will have to be planted in the future, thus increasing the pressure on the ECB.

Eight farmers asserted that the reasons for the politically borne prohibition lie in the general attitude of the society being against GMO. As the main reason for this refusal of acceptance they named the representation of GMO in the media. One famer argued that this was a vicious circle, where politics permitting GM maize cultivation would meet society's needs, while society disregards GMOs.

6.3.2. Farm description

Farm 1, 2, 3 and 4 are located in Saxony, Farm 5, 6 and 7 in Brandenburg, farm 8 in Thuringia and farm 9 and 10 nothern Bavaria. The farmers (except for two of them) provided most crop data on their computers that they collected with average calculations of prices, units per ha and working time per procedure. They all specialized on silage maize for feeding or biogas production and harvested grain maize mostly if their silage silos were full or in case to case situations when market prices ranged high for grain maize.

Farm 1

Farm 1 is a cooperative and is located in Saxony in the district of Meißen. It spans a total UAA of 1,500 ha of which 50 ha were cultivated with grain maize and 200 ha were cultivated with silage maize. The farm uses only hired labour for production and a contractor for harvesting grain maize. All of the grain maize was dried and sold to the market whereas 90 % of the silage maize was used for bovine feeding while the rest was sold. The farm uses the dung from cattle which is put on a dung spreader with an excavator and distributed evenly across the fields. After ploughing and preparation of the seed-bed, the farmer sows about 80.000 grains seed per ha. In Addition to cattle dung, DAP (Diammonium phosphate) is distributed with a fertilizer spreader. The silage maize was harvested with an in-house forage harvester and the grain maize was harvested by a contractor. Both products were transported to the farm or to the drying plant with own machinery. The silage maize was put into a silo with a silage medium where it was compressed and covered with a silage film. All fields were insured via a compact insurance of which one part included insurance for maize.

Farm 2

Farm 2 is a limited company (Ltd.) located in Saxony in the district of Nordsachsen. It has a total UAA of 1,600 ha with 50 ha cultivated with grain maize and 170 ha cultivated with silage maize in 2010. All of the work was done by hired labour and contractors. The farm kibbled 50 % of the grain maize for feeding dairy cattle and used 90 % of the silage maize for feed as well. The rest was sold to the neighbouring farm. The farm spread out the dung from the cattle, ploughed and harrowed before sowing approximately 72,000 kernels per ha. Contractors distributed the fertilizer and sprayed herbicide which had been provided by the farmer. Insecticide was only used against ECB and was also sprayed by a contractor who offered a compact price for spraying including the insecticide. The grain and the silage mais was harvested by contracts, too. The maize was not dried and not insured.

Farm 3

Farm 3 is a limited company (Ltd.) located in Saxony in the district of Nordsachsen. It presents a total area of 1,900 ha and planted 300 ha of silage maize in 2010. The farm uses only hired labour. The obtained maize is partially used for dairy cattle and partially for biogas production. Liquid manure is used as an organic fertilizer. The manure gets harrowed in and afterwards the field is prepared with a chisel cultivator before seeding. The sowing is followed by blind grooming and spraying mineral fertilizer UAN (Urea and Ammonium Nitrate). Herbicides were sprayed as a last step before harvesting with own machinery. The maize was transported and put into a silo where it was compressed and covered with silage film. The maize was not insured and there were no abatement measures applied on the farm in 2010.

Farm 4

Farm 4 is a cooperative located in Saxony in the district of Bautzen. It covers a total UAA of 1,100 ha, of which 300 ha were planted with silage maize in 2010. The farm uses only hired labour and no contractors. 50 % of the maize were used for feeding dairy cattle and the other 50 % were sold to a separated part of the farm for producing biogas. The farm used cattle dung as fertilizer, which was worked in with a disc harrow. In addition, they applied mineral fertilizer NPK and NP Diammonphosphate. The only procedure done by a contractor was spraying herbicide provided by the farmer. There were no insecticides distributed against ECB. The maize was harvested and transported by own machinery.

Farm 5

Farm 5 is a Ltd. located in Brandenburg in the district of Elbe-Elster. It spans a total UAA of 1,150 ha including 50 ha of grain maize and 100 ha of silage maize in 2010. The farm used hired labour and contractors. All maize produced is used by the farm itself. Silage maize and grain maize which is processed to moist grain silage are used for dairy cattle and bull feeding. After herbicide spraying, ploughing, liquid manure spraying and dung spreading, the seed was planted. There was another herbicide sprayed after seeding and no mineral fertilizer used. The grain maize was harvested by a contractor and the silage maize with an own forage harvester. The produce was transported to the silo on the farm and none of it was dried and/or sold. No insecticide was used against the ECB.

Farm 6

Farm 6 is a cooperative located in Brandenburg in the district of Märkisch-Oderland. It covers a total UAA of 1,320 ha of which 110 ha were planted with grain maize and 182 ha were planted with silage maize. The farm uses hired labour and a contractor only for harvesting grain maize. Silage maize was completely used for bovine feeding. 75 ha of grain maize were sold on the market whereas the remaining 35 ha were used on the own farm as moist grain maize silage. The cattle dung was worked in with a chisel plough and after preparation of the seed-bed the seed was planted. A sprayer was used for liquid fertilizer and herbicide spraying. Insecticides against ECB were distributed separately from other pesticides with own machinery. Silage maize was harvested and transported with own machinery while the grain maize was harvested by a contractor and dried before selling. The maize was not insured.

Farm 7

Farm 7 is a companionship located in Brandenburg in the district of Märkisch-Oderland. It spans a total UAA of 620 ha of which 300 ha were cultivated with silage maize in 2010. The farm uses hired labour and contractors. The whole silage maize was sold to the biogas plant which is separated from the farm. The digested residue from biogas production was spread on the field and worked in with a chisel cultivator. Also, mineral fertilizer was used before sowing. The farm used chalk every three years, too, which was distributed by a contractor. The maize harvest was done by a contractor, as well. The maize was transported to the farm and rolled before the silo was covered with a silo film. No ECB abatement measures were applied on the farm.

Farm 8

Farm 8 is a limited company (Ltd.) located in Thuringia in the district of Altenburger Land. The farm covers a total UAA of 1,830 ha of which 71 ha were planted with grain maize and 181 ha were planted with silage maize in 2010. The whole amount of grain maize was sold to the market and the silage maize was used for the biogas plant. The farm uses hired labour and a contractor for harvesting grain maize. The farm used the digested residue from biogas production and distributed it with a dung spreader. After cultivating, harrowing and sowing, liquid mineral fertilizer (UAN) and herbicides were distributed. The silage maize was harvested with an own forage harvester and the grain maize was harvested by a contractor and dried before selling it to the market. The farm did not apply measures against ECB.

Farm 9

Farm 9 is a single farmer located in Bavaria in the district of Weißenburg-Gunzenhausen. It covers a total UAA of 140 ha of which 70 ha were cultivated with maize used for silage maize. The whole maize was used for fattening bulls. The farm uses family labour and contractors. The dung from the bulls was distributed on the field and worked in with a plough. A cultivator and seed-bed combination were used before sowing. Mineral fertilizer is only used instead of dung on about 50 % of the arable land. Since mineral fertilizer is the easiest and cheapest substitution for dung, the cost for the mineral fertilizer was used for estimating fertilization cost. The maize was harvested by a contractor. Other farmers transported the harvest and filled the silo and they may be seen as contractors, since they were paid a wage per hour for work including their own machinery. The whole maize was insured by a hail insurance. Contrary to previous years, the farmer did not use insecticides against ECB in 2010.

Farm 10

Farm 10 is a single farmer located in Bavaria in the district of Kitzingen. It spans a total UAA of 95 ha of which 23 ha were planted with silage maize in 2010. The silage maize is used for feeding dairy cattle and fattening bulls. The farm uses both family labour and contractors. Liquid manure from cattle and bulls is worked in with a plough and the land is harrowed before sowing. Additionally, some mineral npk-fertilizer was distributed. On six ha of the maize fields, two different insecticides were applied against ECB; one on three ha each time for own field studies. The maize was harvested by a contractor, while the harvest was transported with own machinery. The maize was not insured in 2010.

6.4. Results: Gross margin of maize production

Silage maize production will be presented first for the German case, since all farmers cultivated silage maize and only half of them planted grain maize. The variable machine costs are mainly the same for both types of product. The actual difference lies in the cost for harvesting and drying.

6.4.1. Silage maize

Table 24 and Table 25 show the gross margin calculations for silage maize for all ten farms in the harvest year of 2010. The yields vary between 296 and 520 dt/ha. This range is mainly due to different natural conditions in the respective region, like weather and soil. Since silage maize was mainly used on the farm for feeding or biogas production, the farmers calculated with internal prices which reflect the price for which silage maize could have been sold in the region. Farm 4 and 7 sold their maize to their own biogas plants due to fiscal considerations. Therefore, they also used a transfer price which was determined by the farmer. Farm 9 did not know the yield or trading prices but he could have sold his maize for 1,400 €/ha on the market before harvest.

Table 24: Gross margin for silage maize of surveyed farmers for the harvest year 2010 (Germany) (Farm 1 to 5)

Description	unit	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Size of the farm	ha	1,500	1,600	1,900	1100	1150
Silage maize	ha	200	170	300	300	100
Silage yield	dt / ha	330	400	296	400	413
Trading price	€ / dt	2.8	3.0	3.3	2.9	3.0
Gross revenue	**€ / ha**	**924**	**1,200**	**975**	**1.160**	**1,239**
Variable machine costs	€ / ha	300	215	262	316	416
Wage work	€ / ha	70	15	47	80	0[b]
Seed	€ / ha	120	105	119	110	93
Fertilizer	€ / ha	62	0	39	105	0
Herbicides	€ / ha	72	106	43	78	36
Insecticides	€ / ha	0	0	0	0	0
Contractor Cost	€ / ha	0	169	0	13	0
Insurance	€ / ha	4	0	0	0	0
Variable machine costs (Maize borer)	€ / ha	0	0	0	0	0
Insecticides (Maize borer)	€ / ha	0	0[a]	0	0	0
Contractor Cost (Maize borer)	€ / ha	0	55	0	0	0
Variable costs	**€ / ha**	**627**	**693**	**509**	**601**	**536**
Gross margin	**€ / ha**	**296**	**506**	**465**	**459**	**694**

[a] Insecticide costs for maize borer included in Contractor costs (Maize borer)
[b] Wage work included in variable machine costs

The variable costs range between 509 and 953 €/ha, which is mainly due to differences in variable machine and labour costs. One possible reason is that farmers who did not have the costs compiled in there plant database had to estimate the time and fuel expenditure in litres per hour for each process. In case the farmer did not know the variable cost for their machinery and tractors, the type of machinery and its size and the machine power of the tractor were recorded and standard values were taken from the KTBL[7]. Farm 5 had the highest variable machine costs but this does include labour costs. Farm 9 had the lowest costs

[7] KTBL is an information medium that includes a lot of calculation data and expert information for farmers. The data are verified and actualized every year. (KTBL, 2011)

but the reason for this is that most of the work was conducted by contractors. Also, farm 2, 7 and 10 had fewer variable machine costs but instead higher contractor costs.

Table 25: Gross margin for silage maize of surveyed farmers for the harvest year 2010 (Germany) (Farm 6 to 10)

Description	unit	Farm 6	Farm 7	Farm 8	Farm 9	Farm 10
Size of the farm	ha	1320	620	1830	140	95
Silage maize	ha	182	300	180	70	23
Silage yield	dt / ha	380	297	292	0	520
Trading price	€ / dt	2.5	3.1	3.1	0	2.6
Gross revenue	**€ / ha**	**950**	**921**	**917**	**1,400**[b]	**1,335**
Variable machine costs	€ / ha	202	163	280	144	177
Wage work	€ / ha	45	25	127	35	0
Seed	€ / ha	124	132	167	143	139
Fertilizer	€ / ha	86	93	178	80	162
Herbicides	€ / ha	73	51	45	70	84
Insecticides	€ / ha	0	0	0	0	0
Contractor Cost	€ / ha	0	218	0	385	165
Insurance	€ / ha	0	0	0	22	0
Variable machine costs (Maize borer)	€ / ha	2.7[a]	0	0	0	1.1
Insecticides (Maize borer)	€ / ha	36.8	0	0	30	9.4
Contractor Cost (Maize borer)	€ / ha	0	0	0	45	0
Variable costs	**€ / ha**	**569**	**680**	**797**	**953**	**738**
Gross margin	**€ / ha**	**381**	**241**	**120**	**447**	**597**

[a] Wage work (Maize borer) is included in variable machine cost (Maize borer)

[b] Farmer did not know yield and trading price. He could buy silage maize for 1,400 €/ha

Furthermore, the ten farms vary distinctly in cost of labour. Partly, this is due to different time estimates and partly due to differences in labour costs. Farm 9, e.g., only sometimes used family labour and family members were remunerated with 10 €/h, whereas the remaining work done by the farmer himself was not included with the costs. Farm 4 and 8 had the highest labour costs. These farms also recorded changeover times for machines.

The seed costs ranged from 93 to 167 €/ha. Reasons for this wide range are different prices between 60 and 95 € per 50,000 kernels (converted), as well as different application rates ranging from 72,000 to 100,000 kernels per ha. Prices varied due to seed characteristics such as dry matter content, energy value, starch-content and –yield. For grain maize, mainly the grain yield matters. The application rate depended on the row spacing (either 75 or 45 cm) and the distance within a row.

Organic fertilizer is used on all farms in form of either liquid animal manure and dung or digested residue from biogas production. On all farms except for farm 10 there was no internal price for manure and the replacement value for substitution on all farms was zero. That means if the farm had not had its own manure, they could have received it from any neighbour for free. Only farm 9 could not get manure for free. Farm 2 and 5 did not use mineral fertilizer alongside organic fertilizer and therefore had no fertilizer cost.

Only farms 1 and 9 had hail insurance for maize. Farm 1 had a combined insurance whereas the insurance costs the farmer named were very low.

On all farms, herbicides were used depending on the amount and type of weeds. Insecticides were not applied except the ones against ECB.

Contractors were hired for the harvest on farm 2, 7, 9 and 10. They also transported the harvest on farm 9, spread chalk on farm 7, sprayed herbicide on farm 2 and 4, as well as fertilizer on farm 2.

Abatement measures against the ECB were only used on farm 2, 6, 9 and 10. Farm 2 and 9 used contractors whereas farm 6 had its own machinery for applying the ECB insecticide and farm 10 hired the machinery and sprayed 3 ha with one type of insecticide and 3 ha with another. Farm 10 also made investigations and stated efficiencies of 55 % reduction in ECB-damage by the first insecticide and 85 % by the second.

6.4.2. Grain Maize

Table 26 shows the gross margin calculation for the five farmers producing grain maize in 2010. Yields seem to be very similar at first glance, but they are given at different humidity levels which result in significant differences at normalized humidity levels. The grains of farm 1, 6 and 8 were dried and sold on the market. Different prices were gained due to different times of sale. The grains from farm 2 and 5 were squeezed and used as moist grain silage. Farm 2 sold some of the grain maize to a neighbouring pig farm. An internal price for farm 5 was used as all grain maize was used on-farm as feed. The reason for the low yield of farm 2 was late harvest in February 2011.

Table 26: Gross margin for grain maize of surveyed farmers for the harvest year 2010 (Germany)

Description	unit	Farm 1	Farm 2	Farm 5	Farm 6	Farm 8
Size of the farm	ha	1,500	1,300	1,150	1,320	1,830
Grain maize	ha	50	50	50	110	71
Grain humidity	%	14.4	33.3	30	15.0	15.0
Grain yield	dt / ha	84	70	81	80	90
Trading price	€ / dt	18.0	10.5	13.5	18.5	16.0
Gross revenue	**€ / ha**	**1,512**	**735**	**1,093**	**1,480**	**1,440**
Variable machine costs	€ / ha	176	118	254	173	148
Wage work	€ / ha	50	15	0[a]	42	127
Seed	€ / ha	120	105	93	124	167
Fertilizer	€ / ha	62	0	0	86	178
Herbicides	€ / ha	72	106	36	73	45
Insecticides	€ / ha	0	0	0	0	0
Contractor Cost	€ / ha	90	116	110	0	110
Drying	€ / ha	370	0	0	335	365
Insurance	€ / ha	20	0	0	0	0
Variable machine costs (Maize borer)	€ / ha	0	0	0	2.7	0
Insecticides (Maize borer)	€ / ha	0	0	0	36.8	0
Contractor Cost (Maize borer)	€ / ha	0	55	0	0	0
Variable costs	**€ / ha**	**960**	**515**	**493**	**872**	**1,140**
Gross margin	**€ / ha**	**552**	**220**	**601**	**608**	**300**

[a] Wage work is included in variable machine costs

Differences in variable costs can be explained by the differences in harvesting methods, transport of harvested maize as well as in the costs for drying. On all farms, except for farm 6, contractors accomplished the harvest whereas the product was transported with an own tractor and tipper. Drying costs of farm 1, 6 and 8 are very similar and are accountable for the highest part of the variable costs.

7. Comparison of the three national Case Studies and Bt maize impact evaluation

In the previous section 4 (Spain), section 5 (Italy) and section 6 (Germany) the GMO and coexistence policy of the country, the farming structure of the case study regions, the concerned farmers and their situation, as well as the results of the gross margin calculations were described in detail. This allows it now to work out on which extent the effects on farms which plant Bt maize are influenced.

7.1. Cross country evaluation: Economical impact of Bt maize production

7.1.1. Case study farm differentiations

The surveys in this study includes five Spanish farms with only grain maize, five Italian farms, all of which cropped grain maize and two of them also cropping silage maize, and ten German farmers which all harvested silage maize and half of them grain maize additionally in 2010. The grain maize yields and prices that were gathered from the case study farms are highly coinciding with the average yields and prices in these regions within the countries. Figure 1 shows the average yields and variance of grain maize in tonnes reached by the farms.[8]

[8] Note that Spanish yields are adjusted yields from those of Bt maize to be comparable with Italian and German conventional yields. Therefore the yield increase farmers reached by planting Bt maize was deducted to get the yield of conventional maize.

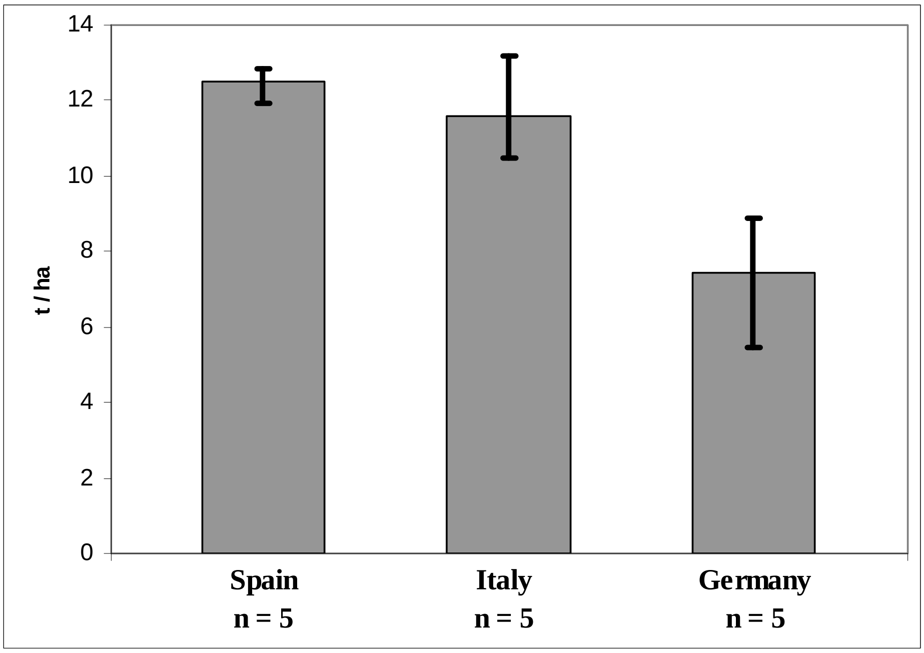

Figure 1: Average grain maize yields of case study farms at a 14 % humidity level (tonnes/ha)

Spanish farmers reached the highest yield of grain maize with 12.5 tonnes per ha ranging from 11.9 to 12.8 tonnes. Another relatively high yield was reached by the Italian farmers with 11.6 tonnes per ha ranging from 10.5 to 13.2 tonnes. German case study farmer only had 7.4 tonnes on average with the highest range from 5.5 to 8.9 tonnes[9].

As Figure 2 shows, silage maize yields of Italian farms are much higher than those from Germany. The average yield of the two Italian farmers is 58 tonnes per ha whereas the yield of the ten German farms is 37 tonnes. The farm with the highest yield in Germany obtained 52 t per ha and is just above the lowest yield (50 t) of the Italian farms.

[9] The low value of 5.5 tonnes per ha was due to a delayed harvest in February 2011 instead of the planned harvest in October 2010 and can be seen as an exceptional case.

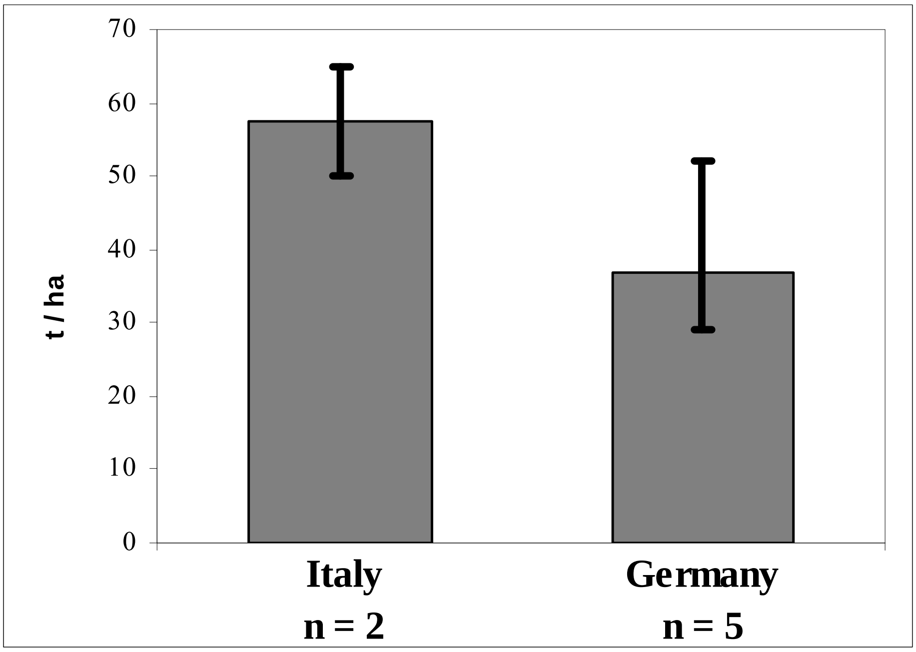

Figure 2: Average silage maize yield of case study farms (tonnes / ha)

Trading Prices

Spanish case study farmers were able to sell their grain maize at about 190 € with a grain humidity of 22 %, Italian farmers at 185 € and German farmers at 153 € per tonne, the latter ones with an average grain humidity of 21 %. Since it is not possible to compare prices that are based on different humidity levels, these values should just give an overview on the different farming situations. The prices also depend on quality, time and regional differences. Overall prices in the particular countries follow the same order, reaching the highest prices in Spain with 183 € per tonne, Italy with 168 € and Germany, only slightly below with 164 € per tonne in 2010 (Eurostat, 2010, Destatis, 2011). Prices for silage maize are mostly internal prices, since most of the maize is used on the farm for feeding animals. Internal prices range from 2.5€ to 3.3€ per tonne for German farms and 3.5€ and 5.0€ per tonne for the Italian farms.

7.1.2. Farm level cost of Bt maize

As described in section 3.1, we have to distinguish between farms that did not use any abatement measures in 2010 (Case 2) and farms that did use measures which were limited to insecticide spraying in Italy and Germany (Case 3). Before calculating the gain or loss of Bt maize cultivation, some assumptions have to be made, because there is no real seed costs nor a relative yield increase available for the surveyed farms in Italy and Germany. Also, the cost for Bt maize, that were assumed to be the same between grain and silage maize but to benefit from Bt maize production can not be treated the same (see section 7.1.3).

In Italy and Germany, we estimated additional seed costs for Bt maize seed to be 23 € per unit (50,000 grains bag)[10]. The case study farmers, who planted Bt maize for the cropping year 2008, confirmed this additional price. Estimating additional seed cost per ha affects German case study farms negatively, referring to a higher requirement of units per ha. Using 1.5 to 1.9 bags per ha leads to additional seed costs between 33 and 44 € per ha compared to 35 to an average of 38 € per ha for Italian and Spanish farmers.

7.1.3. Farm level benefit or loss of Bt maize – Grain maize

The estimated relative yield increase (ryi^{est}) if Bt maize is planted has been assumed to be 8.7 %. This reflects the average yield increase that five Portuguese case study farmers received by planting Bt maize compared to conventional maize in 2009 (Skevas et al., 2010). A yield increase of 8.7 % can be seen as conservative, since Degenhardt et al. (2003) calculate yield increases of 14 % in Rhine Valley (Baden-Württemberg) and 15 % in Oderbruch (Brandenburg). These computations were based on data from field experiments between 1998 and 2002. The yield increase mainly depends on the damage the ECB causes within the maize

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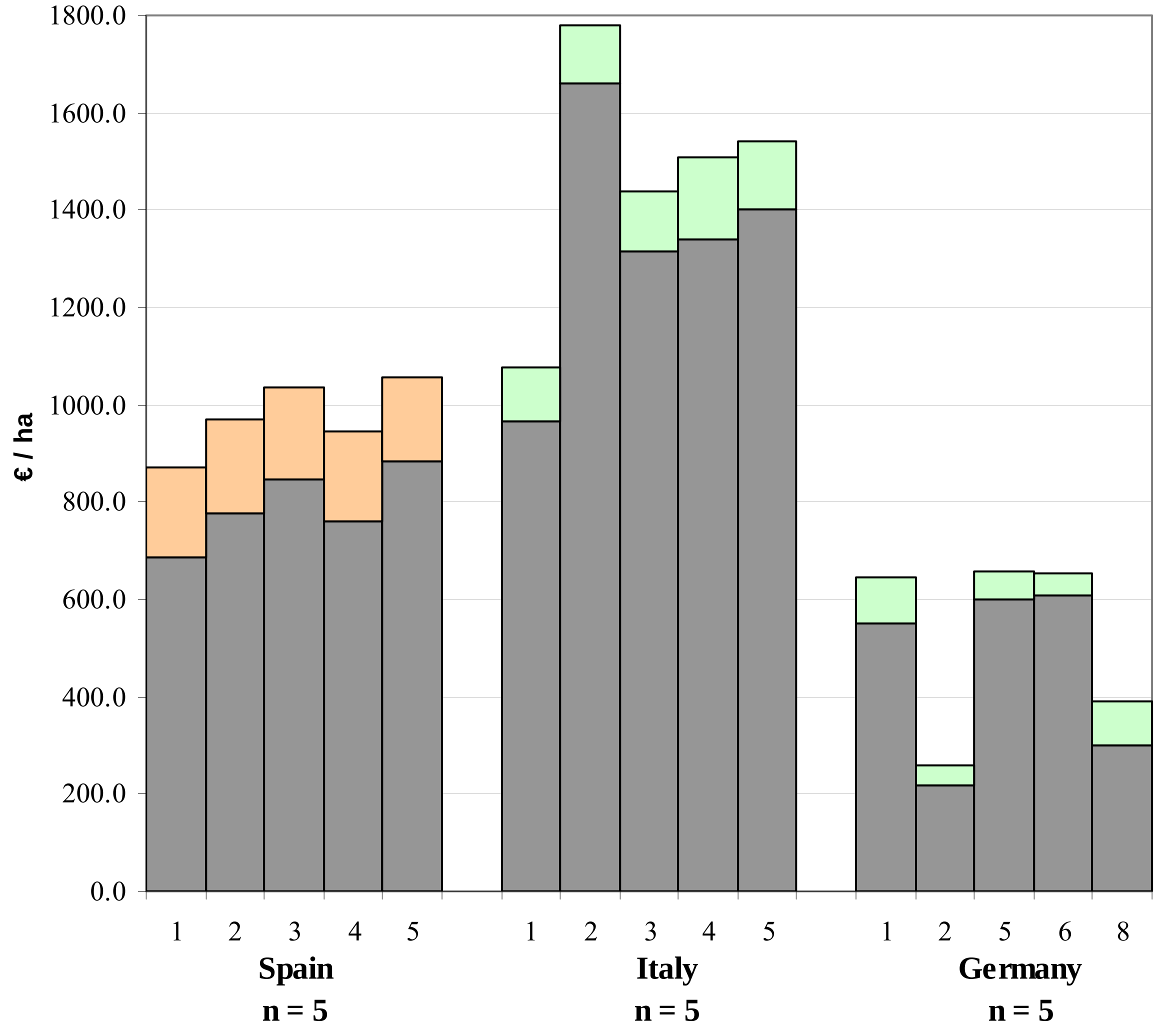
[10] The additional seed price of 23 € was stated in an email from June, 6th answered by Björn Kiepe, Monsanto Germany, 2011 and referred to the Yieldguard seed price of the year 2008.

field. If there was no damage, the farmer would not have any additional benefit of planting Bt maize, but still would have extra cost for seed. However, the 14 % yield increase was assessed at an ECB infestation rate of 0.11 to 0.42 grubs per maize plant and 15 % yield increase at an infestation rate of 0.68 to 1.18 grubs per maize plant (Degenhardt, 2003). Comparing the infestation level with the average infestation rate in the case study regions leads to the presumption that these regions could also have high yield increases: In German case study regions an average of 37 % in 1999/2000 and 38 % in 2005 of the maize area had infestation rates > 0.10 grubs per plant (Drucksache 16/3059, 2006). The same applies to Spanish case study farmers from the region of Aragon, who face high ECB pressure of an average of 6.1% to 6.5 % yield losses (Brookes, 2002).

Figure 3 shows the gross margin and the gross margin surplus which was realized by Spanish farmer and those which could have been realized by Italian and German farmers assuming a yield increase of 8.7%. The figure includes farmers that used insecticides and farmers that did not. To adjust the results, on the one hand insecticide cost for ECB had to be deducted from variable costs and on the other hand, the gained surplus which was acquired from spraying had to be deducted from gross revenue.



Note that Spanish conventional gross margins in this figure are only adjusted gross margins from those of Bt maize, to be comparable with Italian and German conventional gross margins. Therefore the additional margin shown in this figure shows the gross margin Spanish farmers would have lost by planting conventional maize instead of Bt maize.

Figure 3: Gross margin and additional gross margin at 8.7 % yield increase level from Bt maze planting in Spain, Italy and Germany

Italian farmers reached the highest (conventional) gross margins with 1,337 € (min: 965, max: 1,401) per ha average, followed by Spanish farmers with 781 € (min: 688, max: 883) and German farmers with 456 € (min: 219, max: 608) per ha. Although Spanish farmers had somewhat higher gross revenues, Italian farmers gained from lower variable costs to reach the high gross margins. But as a result of the high gross revenues (2,545 € / ha), Spanish farmers had the highest surplus from planting Bt maize with on average 185 € per ha. Next are the Italian farmers with an average of 132 € per ha and German farmers with an average of 66 € per ha. German farmers had the lowest gross revenues but also the lowest variable costs, hence the lowest average gross margins.

The yield increases necessary to reach the breakeven point for Bt maize cultivation are 1.4 % (Spain), 2.8 % (Italy) and 3.3 % (Germany).

7.1.4. Insecticide abatement cost

We assume a yield increase from insecticide application of 5.2 % which is 60 % of the ryi^{est} of Bt maize. 60 % reflects approximately the proportion calculated by Degenhardt et al. (2003). The Federal Government of Germany reports a mode of 80 % efficiency of insecticides (ranging from 60 to 90 %[11]) against the ECB if the optimal time of application is chosen (Drucksache 16/3950, 2006).

Figure 4 shows that the average cost of controlling ECB with insecticide are 57 € per ha and ECB treatment cost with Bt maize are 36 € per ha resulting in a yield increase of 5.2 % and 8.7%, respectively.

[11] Yield losses can be reduced by this amount (90 %) if treatments are applied at optimal times.

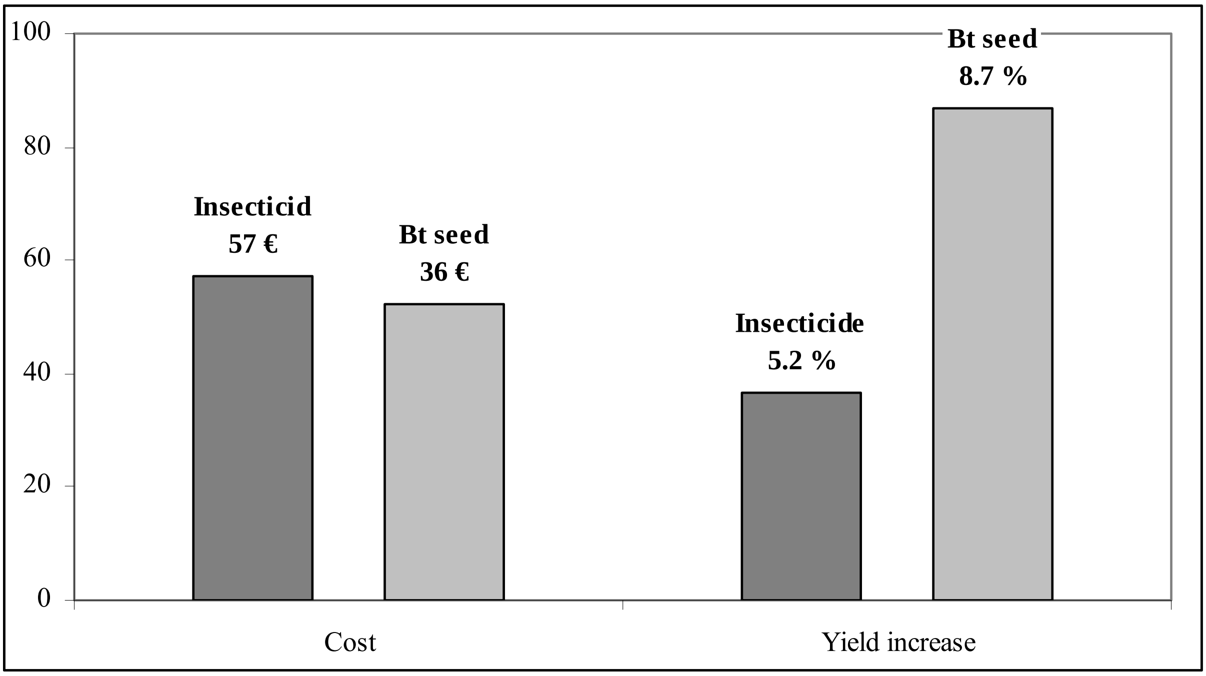


Figure 4: Yield increase costs of Bt maize (€/ha) compared to insecticide abatement (n = 6 farmers)

Comparing the ECB treatment with insecticide and that with Bt maize, insecticide abatement costs 11 € to increase yield by 1 % and Bt maize costs 4 € per 1 %. Moreover by regarding insecticides as pollution due to CO_2 emission from spaying by using machinery or as a danger for farmers who distribute it, we can analyze how much this pollution abatement costs. Since farmers can abandon this emissions and danger, the insecticide abatement cost result would be negative compared to Bt maize, which is a cheaper way to get the same or even higher surplus.

7.1.5. Farm level benefit or loss of Bt maize – Silage maize

Analyzing a benefit or loss of Bt maize planting for silage maize occurs much more difficult than to compute the benefit or loss for grain maize. Hassan et al. (1993) and Langenbruch et al. (1999) acknowledge that harvest is affected due to broken stalks which decrease yields if less maize plants can be captured from the forage harvester. Then again, Schorling (2005) did not determine any acknowledgeable yield differences between Bt and conventional silage maize but differences of mycotoxin and fusarium content in field trials in Germany. Since there was no reliable literature found that determines yield increases of silage maize, we concentrated on calculating the necessary yield increase to reach the breakeven point (Figure 5).

German farms would need to increase their yield by at least 3.6 % and Italian farms by at least 2.9 % on average to gain from planting Bt maize with a range of 2.3 % to 5.6 %. Farms with low necessary yield increase had high yields or gross revenues and low additional seed cost. Farm 6 which had the highest additional seed cost of 44 € needs a yield increase of 5.6% to cover the additional costs.

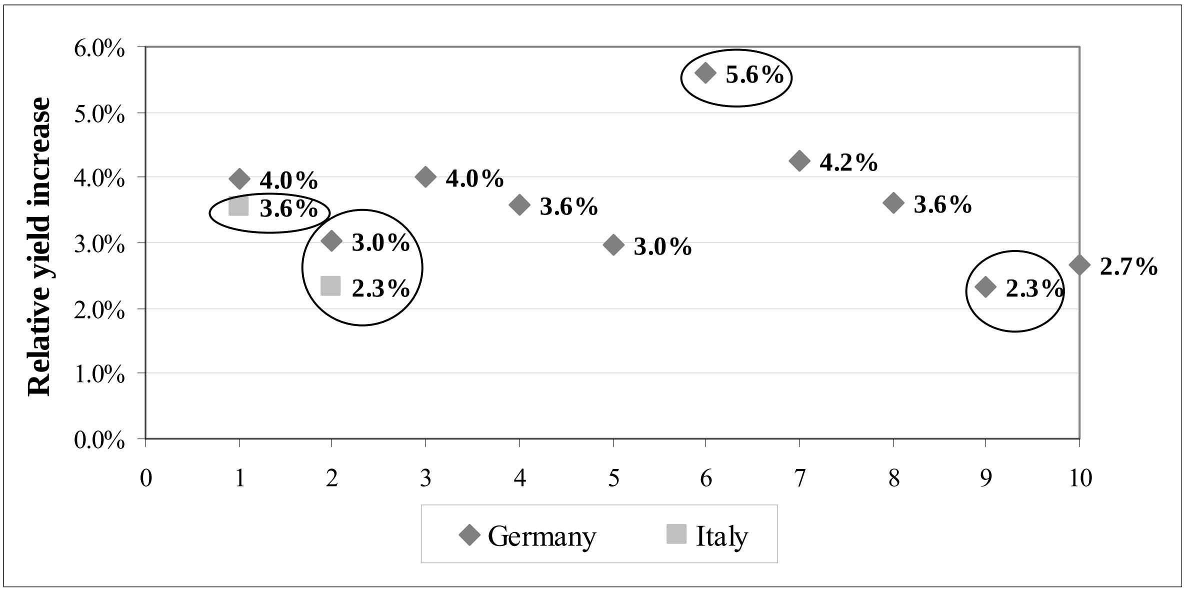


Figure 5: Necessary yield increase to reach the breakeven (%)

The circles in Figure 5 show the farms that distributed insecticides on their fields. There is no clear trend noticeable between farms that used insecticides and farms that did not.

Analyzing the absolute economic effects of Bt maize, when also considering quality effects like lower mycotoxin and/or fusarium levels in addition to yield increases, is not possible with the information this case study provides.

8. Conclusion and Recommendation

The results in this research show econmomic advantages from planting Bt maize for all case study farms in Spain, Italy and. Potential yield increases outweigh higher seed costs. Yield increases of grain maize arising from planting Bt maize were assumed to be equal for all surveyed farms. The relative increase of 8.7 % is a conservative assumption since some field experiments and surveys estimate values of up to 15 % for regions with medium to high infestation rates (Riesgo et al., 2011 Degenhardt et al., 2003). As the infestation rates and accompanying yield losses differ from country to country and region to region, the yield increase also differs. A farm with no ECB infestation would therefore have no yield losses and thus no yield increase from planting Bt maize. For the Spanish and the German regions considered medium to high ECB infestation rates have been reported (Drucksache 16/3059, 2006, Brookes, 2002). The farmers' themself assess the damages from ECB high with losses of up to 40%. In addition to the 8.7% yield increases the minimum necessary yield increase to reach the breakeven point for adopting Bt maize cultivation was calculated. This value ranges between 1.3% and 3.3% for grain maize and 2.3% and 5.6% for green maize,

Yield increases of silage maize arising from planting Bt maize were not seen as much important by farmers than quality aspects as for instance lower mycotoxin and fusarium contamination of Bt maize compared to conventional maize.

Costs of Bt maize

Direct costs of Bt maize cultivation are the additional seed cost for using Bt maize seed instead of conventional maize seed. Here, we also used one additional seed price of 23 € per 50.000 grains for all case study farmers. Riesgo et al. (2011) report additional seed cost of about 10 € per ha for Spanish farms. The additional seed price was multiplied with the amount of units a farm uses per ha to calculate the additional seed costs per ha. This assumes that the farmer would use the same amount of Bt maize and non-Bt maize seed per ha.

Indirect costs of Bt maize cultivation are costs that might accompany with the compliance of coexistence measures which are different to Spain, Italy and Germany. These costs are difficult to quantify and depend on the ex-ante and ex-post regulation of the country as well as on the farming situation, like the size of the GM field, width of the buffer zone and the adoption rate of GM crops in the region (Messean et al., 2006). Hence in this research the profit from Bt maize planting is independently of the costs arising from coexistence measures but it has to cover these costs that farmers will benefit from Bt maize cultivation. A comparison of the increase in gross-margin with coexistence compliance costs for Bt maize as reported by Skevas et al. (2010) shows they can easily be covered.

Profit of Bt maize cultivation

Differences of the gross revenues and also of the extra seed costs per ha where found for the case study farms, which lead to different gross margins benefits. Spanish farms have the highest average gross revenue with 2,545 €, therefore they have the highest absolute yield increase to cover additional seed cost of 37 € and reach a gross margin surplus of 185 € on average. Italian farms had the second highest gross revenues with an average of 2,226 € to reach the second highest absolute yield increase to cover extra seed cost of 35 € and reach a gross margin benefit of 132 €. German farms had the lowest gross revenue of 1,231 € and therefore the lowest absolute yield increase to cover the additional seed cost of 37 € and reach a gross margin surplus of 66 €. Seed cost vary quite high for German farmers from using different amounts of grains per ha.

A relatively low yield increase is necessary to reach the breakeven point. This relative yield benefit is about 1.5 % for Spain, 2.8 % for Italy and 3.3 % for Germany. There is almost no difference of the yield increase between grain maize and silage maize to reach the breakeven point. Italian farmers would need a yield benefit of 2.9 % and German farmers of 3.6%.

Other ECB abatement measures

A lower efficiency of insecticide applications compared to the possible efficiency of Bt maize to control the ECB was shown in this study. In the case of not being able to use Bt maize, insecticide treatments are an effective abatement measure. Case study farms, which used insecticides against the ECB would be able to benefit from Bt maize planting. The insecticide costs for Italian farms are 77 € per ha and for German farms 57 € per ha on average. The savings in insecticides alone would already compensate for the increase in seed costs.

Recommendation on further research

This research evaluates the effects of Bt maize planting of overall 20 farms from Spain, Italy and Germany. Since farms are covering structures, like higher UAA than average, they do not represent average farm structures of the country and results cannot be generalised for the EU as a whole. A representative survey covering Spain, Italy and Germany but also other important maize producing EU member states such as France and Hungary would be worthwhile to have a more complete as well as regionally differentiated picture about maize production and the potential for Bt maize production in the EU.

The positive effect of Bt maize on yields for farms, which are less specialized maize producers, may be greater than for farms with higher specialization. Specialized farms are very often more professional and better equipped with own machinery and are often better up to date with farming processes to get good results of maize production. Thus, specialized farms may be also better in controlling the ECB and keep the pressure lower than farms where maize cultivation is of less importance. This implies higher ECB pressure and damage and thus a higher benefit of Bt maize cultivation in less specialized farms compared to specialized maize farms. In this context we can expect the calculated Bt maize yield benefits to be on the lower side and thus the aggregate benefit of Bt maize adoption to be larger than suggested by the numbers reported in this case study.

Bt maize may reduce the presence of ECB in a region not only in Bt maize fields but also in conventional maize fields. Wu et al. (2008) show a negative correlation of the number of years and the egg and larval density of the cotton bollworm in cotton fields. The larval density in non-Bt cotton was still estimated higher than in Bt cotton but the overall population decreased. In regions, were Bt maize is cultivated, the ECB population may also decrease and lead to a lower need for insecticide spaying. Therefore Bt maize may have a positive external effect on non-Bt maize. This external effect has not yet been quantified, but it is important for having a complete picture about the environmental benefits and costs of Bt maize production.

The ECB larvae can produce tunnels in the maize stalks and thus weaken the stability of the maize plant. Changing weather conditions towards extreme weather situations like stronger winds and more frequent pelting rains or hail may lead to higher damage of the maize, which is weakened from the ECB. Influences of extreme weather conditions on maize yields between Bt maize and non-Bt maize fields have not been assessed in Europe. In particular the contribution of Bt maize to the adaptation to climate change in Europe would be worthwhile to investigate further, in particular, as there is also a growing thread from damages caused by the Western corn root worm.

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Annexes

GM Farmers Questionnaire

Date: …………………….

Age: ……………………..

Education: ……………………..……………………….……………………….…………………….

A. Farm Information

1. Location of Agricultural Enterprise: ……………………..……………………..…………

2. Type of farmer: ☐ Part time farming ☐ Full time farming

3. Total Cultivated area (ha): ……………………..

4. Total cultivated area with maize (ha): ……………………..

5. Do you have problems in controlling corn borers in general? ❑ Yes ❑ No

6. The corn borer problem last year (2010) compared to average was:

❑ Much less ❑ Somewhat less ❑ The same ❑ Slightly higher ❑ Much higher

B. GM maize information

7. What was the obtained product? ❑ Grain maize: ……………ha

❑ Silage maize: ……………ha

8. What was the use of the obtained product?

❑ All sold

❑ All own farm use

❑ Partially sold: ……….. % and partially farm use: ………… %.

9. Is it the first time you planted GM maize varieties? ❑ Yes ❑ No

If **No**, since when do you plant GM maize? ……………………………………………..

10. How many hectares did you cultivate last year with GM maize? ……………ha

11. Who was the buyer of your GM maize? ……………………………………………...

12. Name up to three major reasons for planting Bt maize:

……………………………………………...……………………………………………

……………………………………………...……………………………………………

……………………………………………...……………………………………………

13. How did you learn about GM maize? (You can select more than one choice).

❑ Governmental Institutions

❑ Cooperative

❑ Neighbours

❑ Companies that sell seeds

❑ Internet

❑ TV, radio

❑ Others (please specify)

……………………………………………………...……………………………………..

14. From where did you obtain the seeds?

……………………………………………………...……………………………………………

15. Do you think that the information attached to the seed packages is useful?

❑ Yes ❑ No

Please justify your answer:

……………………………………………………...……………………………………………

……………………………………………………...……………………………………………

16. Did you have problems following the instructions attached to the seed packages?

❑ Yes ❑ No

If **Yes**, specify your answer:

……………………………………………………...………………………………………

……………………………………………………...………………………………………

17. Did you notify in advance the respective authorities for your intention to plant GM maize?

❑ Yes ❑ No

18. Did you have problems with the documentation of GM maize production in accordance to the Regulation 1830/2003 for traceability and labelling?

❑ Yes ❑ No

If **Yes**, what were the problems?

……………………………………………………………………………………………….

19. Did you receive any training course that aimed to inform you about the planting of GM maize, the coexistence regulations, ets?

❑ Yes ❑ No

If **Yes**, how would you evaluate the course?

❑ Very good ❑ Good ❑ Neither ❑ Bad ❑ Very bad

20. How difficult is it for you to keep the 20 % refuge area?

❑ Very difficult ❑ Difficult ❑ Neither ❑ Easy ❑ Very easy

21. Did you keep the appropriate distances from conventional/organic maize and other crops?

❑ Yes ❑ No

22. Did you harvest GM maize and conventional maize separately?

❑ Yes ❑ No

If **Yes**, did you sell GM maize and conventional maize separately?

❑ Yes, because: ……………………………………………………………………………….

❑ No, because: ………………………………………………………………………………..

23. Did you rent/share any agricultural machinery such as seeder, harvester, cutters, etc?

❑ Yes. The following: ……………………………………………………………………

❑ No

Please answer questions 24 and 25 only, if you had rented/shared any agricultural machinery. If not, continue with question 26.

24. If you had rent/shared agricultural machinery, do you know if it had been cleaned properly by the owner or the previous user?

❑ Yes ❑ No

25. Did you clean the machinery properly after using it?

❑ Yes ❑ No ❑ The owner has to clean it

C. Surrounding status information

26. Did you have any neighbours that plant conventional and/or organic maize?

❑ Yes. Number of Conventional: ………., Number of Organic: ……….

❑ No

If **Yes**, did you plan your production in a way to achieve different flowering and harvesting periods from them?

❑ Yes ❑ No

27. Did you have any problems with your neighbours to plant GM maize?

❑ Yes ❑ No

If **Yes**, what were the problems?

………………………………………………………………………………………………….

28. Did you inform your neighbours about your intention to plant GM maize?

❑ Yes ❑ No

Please answer questions 29 till 33 only if you had informed your neighbours about your intention to plant GM maize. If not, continue with question 34.

29. How did you inform your neighbours about your intention to plant GM maize?

❑ By telephone

❑ By letter (normal post)

❑ By email

❑ Personal contact

❑ Other (please specify): ……………………………………………………………….

30. Did you find it difficulty to inform your neighbour about your intention to plant GM maize?

❑ Yes ❑ No

If **Yes**, please explain:

………………………………………………………………………………………………….

31. How much time did it take you to inform your neighbours about you GM cultivation plans?

Approximately in minutes: ………………...

32. Did you find the procedure of informing your neighbours costly?

❑ Yes ❑ No

If **Yes**, can you specify according to your opinion an indicative price (in Euros) of the cost of the procedure to inform your neighbours?

…………………………………………......

33. Did you reach an agreement with your neighbours for planting GM maize?

❑ Yes ❑ No

If **Yes**, please specify the terms of the agreement and the coordination cost in Euros (if it existed)

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

34. Did you cause any damage to your neighbouring fields?

❑ Yes ❑ No

If **Yes**, die you pay it?

❑ Yes, it was …………….. Euros

❑ No

D. Agronomical Conclusion

35. What are the conclusions that you draft from the use of GM maize:

Ease of planting

❑ Easier ❑ Same as conventional maize ❑ More difficult ❑ I don´t know

Application of insecticides

❑ More often ❑ Same as conventional maize ❑ Less ❑ I don't know

Yield

❑ Increase ❑ Same as conventional maize ❑ Decrease ❑ I don't know

Quality of the obtained product

❑ Increase ❑ Same as conventional maize ❑ Decrease ❑ I don't know

36. The planting of GM maize minimizes the cultivation risk (related to the loss of earnings due to corn borers)?

❑ Very much ❑ Much ❑ Little ❑ Not at all ❑ I don't know

37. Which of your operational costs increased (by planning GM maize)? (You can select more than one Choice).

❑ Land preparation ❑ Irrigation

❑ Seeds ❑ Fertilizers

❑ Agrochemicals ❑ Harvesting the produce

❑ Drying the produce ❑ Other (please specify): ……..…………………………

38. Which of your operational costs decreased (by planning GM maize)? (You can select more than one Choice).

❑ Land preparation ❑ Irrigation

❑ Seeds ❑ Fertilizers

❑ Agrochemicals ❑ Harvesting the produce

❑ Drying the produce ❑ Other (please specify): …..……………………………

E. Information about the future of GMO´s

39. Are you going to plant GM maize again?

❑ Yes ❑ No ❑ I have not decided yet

40. Do you believe that the cultivation and consumption of GM products can pose a threat to the environment and to humans' health?

❑ Yes ❑ No ❑ I don´t know

Comments & Suggestions:

……………………………………………………………………………………….......

……………………………………………………………………………………….......

……………………………………………………………………………………….......

……………………………………………………………………………………….......

……………………………………………………………………………………….......

Non-GM Farmers Questionnaire

Date: …………………….

Age: ……………………..

Education: ………………………………………………………………………………………

A. Farm Information

1. Location of Agricultural Enterprise: …………………….……………………….……………

2. Type of farmer: ☐ Part time farming ☐ Full time farming

3. Total Cultivated area (ha): ……………………..

4. Total cultivated area with maize (Conventional and/or Organic) (ha): …………………..

5. Do you have problems in controlling corn borers in general? ❑ Yes ❑ No

6. The corn borer problem last year (2010) compared to an average year was:

❑ Much less ❑ Some less ❑ The same ❑ Slightly higher ❑ Much higher

7. What was the obtained product? ❑ Grain maize: ……………ha
   ❑ Silage maize: ……………ha

8. What was the use of the obtained product?
   ❑ All sold

   ❑ All own farm use

   ❑ Partially sold: ……….. % and partially farm use: …………. %.

   Specify (e. g. to feed pigs):

…………………………………………………………………………………………

…………………………………………………………………………………………

B. GM maize information

9. How did you get informed about GM maize?

❑ Governmental Institutions

❑ Cooperative

❑ Neighbours

❑ Companies that sell seeds

❑ Internet

❑ TV, radio

❑ Others (please specify)……………………………………………………………...

10. Did you plant GM maize, when it was allowed in Germany?

❑ Yes ❑ No ❑ I don´t answer

11. From where did you obtain your maize seeds?

…………………………………………………...……………………………………………

12. Would you plant GM maize, if it was allowed again?

❑ Yes ❑ No ❑ I don´t know/answer

Name up to three reasons for your decision:

……………………………………………………………………………………….....

……………………………………………………………………………………….....

……………………………………………………………………………………….....

13. Would you like a neighbour that plants GM maize to inform you about his intention to plant it and to keep the segregation distance or you would have been indifferent?

❑ I would like him to inform me and to keep the appropriate distance

❑ I do not care. Let him do whatever he wants (indifference)

C. Government Policy

14. What do you think about the GM maize cultivation prohibition in Germnay?

❑ Very good ❑ Good ❑ Neither ❑ Bad ❑ Very bad

Explain:

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

15. If GM maize was allowed, should there be any refuge areas?

❑ Yes ❑ No ❑ I don´t know/answer

Specify your answer:

……………………………………………………………………………………………

……………………………………………………………………………………………

16. Would you have problems, to keep a minimum distance to your neighbour?

❑ Yes ❑ No ❑ I don´t know/answer

Explain:

……………………………………………………………………………………………

……………………………………………………………………………………………

17. Do you think it is necessary to inform your neighbour when you cultivate GM maize?

❑ Yes ❑ No ❑ I don´t know/answer

If **Yes**, should it be mandatory to inform your neighbour, when you want to cultivate GM maize?

❑ Yes ❑ No ❑ I don´t know/answer

18. If you planted GM maize, would you have any acceptance problems with…

… your neighbours? ❑ Yes ❑ No ❑ I don´t know

If **Yes**, what would the problems be?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

… the community? ❑ Yes ❑ No ❑ I don´t know

If **Yes**, what would the problems be?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

D. Information about the future of GMO´s

19. Do you think, that GM maize will be allowed in Germany within the next 3 years?

❑ Yes ❑ No ❑ I don´t know

Please explain your answer:

……..………………………………………………………………………………………

…......……………………………………………………………………………………

……….......………………………………………………………………………………..

20. Do you believe that the cultivation and consumption of GM products can pose a threat to the environment and to humans' health?

❑ Yes ❑ No ❑ I don´t know

Please explain your answer:

……..………………………………………………………………………………………

…......……………………………………………………………………………………

……….......………………………………………………………………………………..

Comments & Suggestions:

………………………………………………………………………………………….......

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