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Experience with a GM crop cultivation by a Member State: Spain

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Current situation of maize crop

- 359,600 has. of maize cultivated in Spain in 2009, 90% of this area under irrigation.
- 79,269 has. of Bt maize in 2008, (22% of total)
- Incidence of corn borer attack in most areas is high to medium.
- Ostrinia nubilalis is the main borer in Europe but in the Mediterranean Region, Sesamia nonagrioides is more preponderant.
- Pesticides against corn borer are seldom used due to their high cost and low efficiency

WHY Bt-MAIZE? Resistant to corn borers

Sesamia nonagrioides
(MCB)

Ostrinia nubilalis
(ECB)

Yield losses caused by corn borer

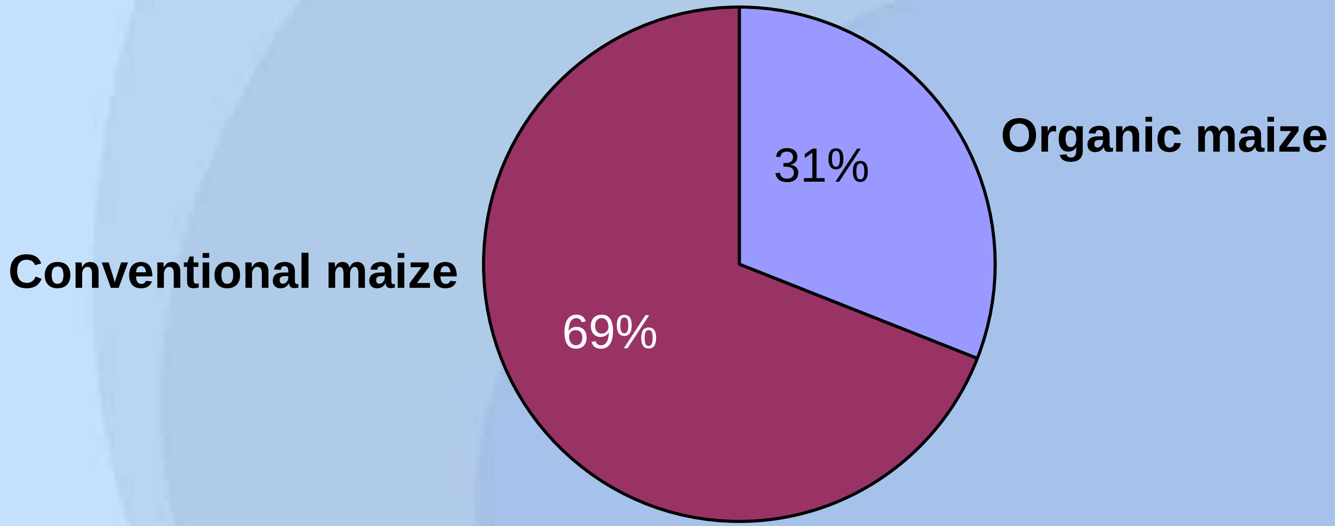
- 15% when the pest attack is high and no treatment is applied.
- 10% when the pest attack is high and treatment is not applied at the right time.
- 5-7% on average at the national level
- The level of attack is highly variable, depending on changing with the locality, the weather, the sowing date, the use of pesticides and their time of application.

Benefits of using Bt maize

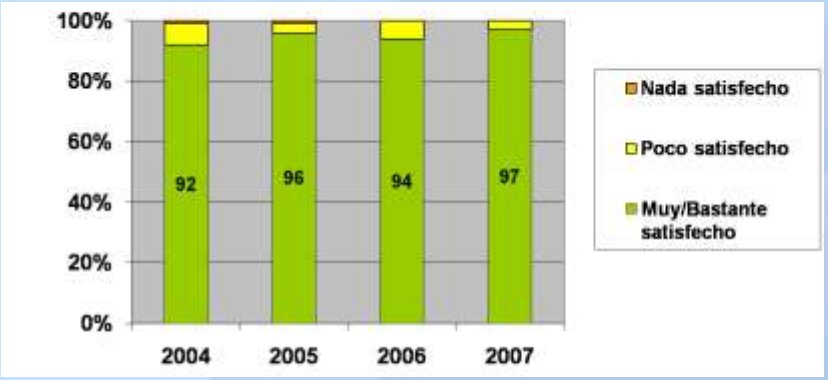
1. Higher yields
   - When the level of infestation is high the increase of yield ranges from 10 to 20%
   - When level of infestation is low the increase of yield ranges from 0 to 1%
   - As an average, the increase of yield is 6.3% (ranging from 2,9 to 12,9%)
2. Lower use of pesticides
3. Higher gross margin for the maize crop
4. Lower incidence of oportunistic fungal infections and thus decrease in contamination of the grain with fumonisines

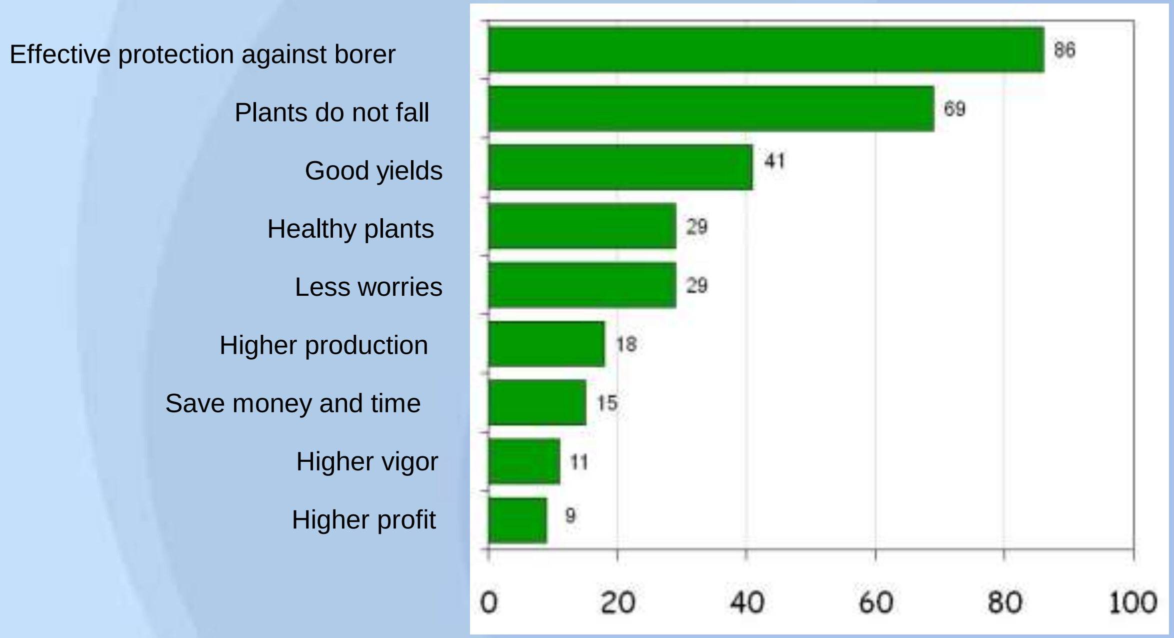
Feed alerts due to contamination of maize with fumonisines

- No feed alerts from genetically modified corn flour or corn derived products
- 62 feed alerts from organic and conventional corn derived products



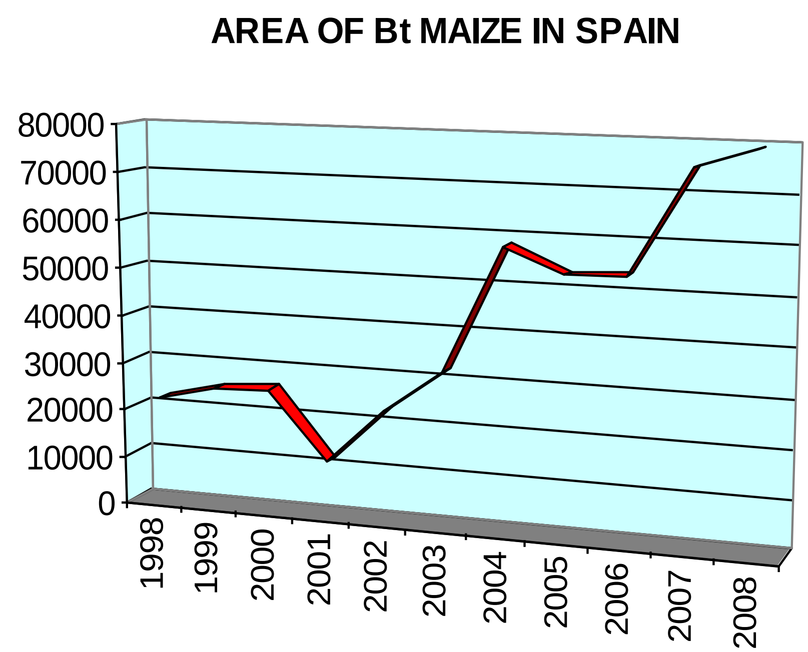
Advantages derived from the use of MON810 varieties as viewed by the grower





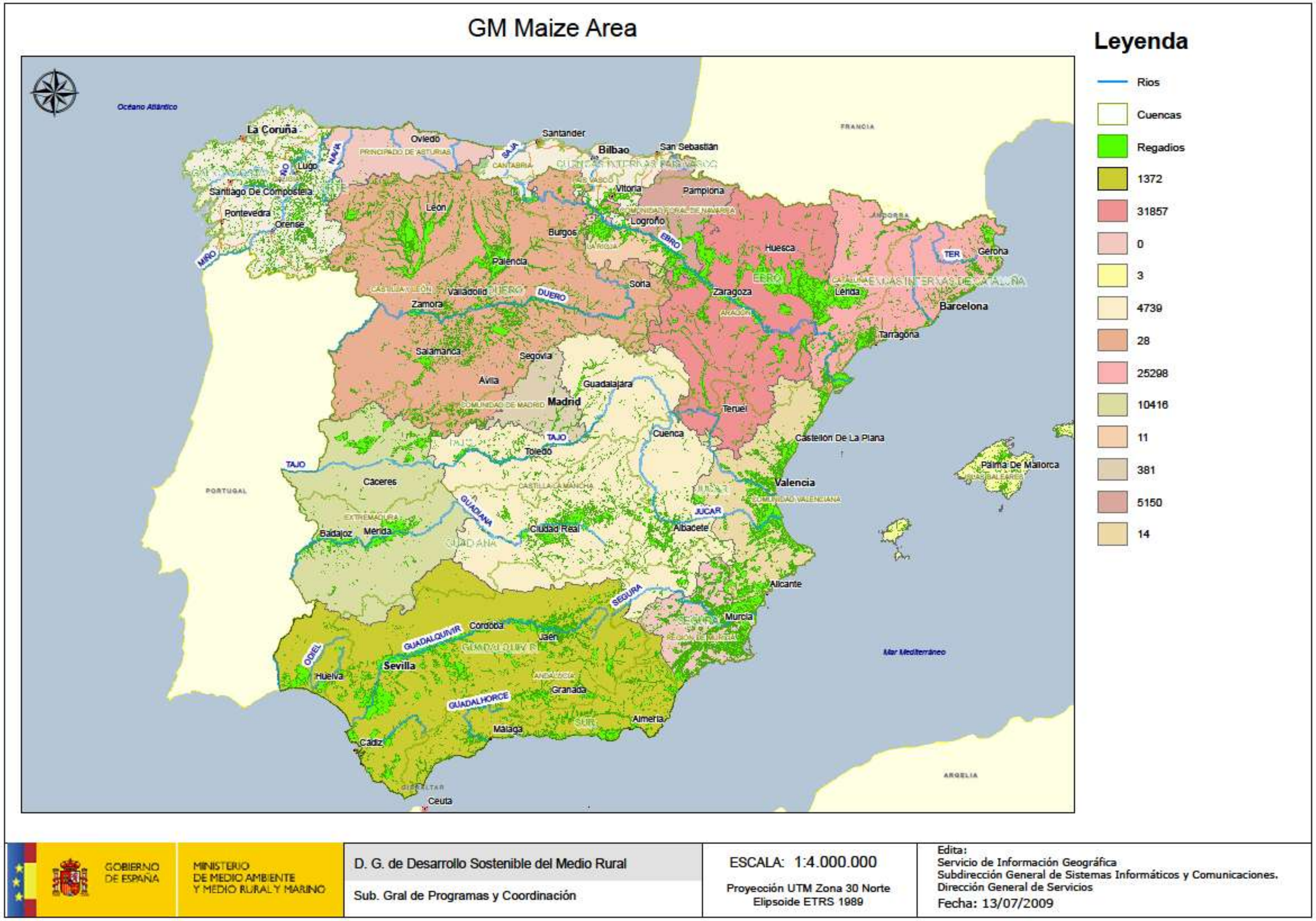
Survey from Markin Institute for MONSANTO (% answers)

Bt maize in Spain



YEAR	AREA
1998	22317
1999	24952
2000	25816
2001	11540
2002	23280
2003	32249
2004	58219
2005	53226
2006	53667
2007	75148
2008	79269

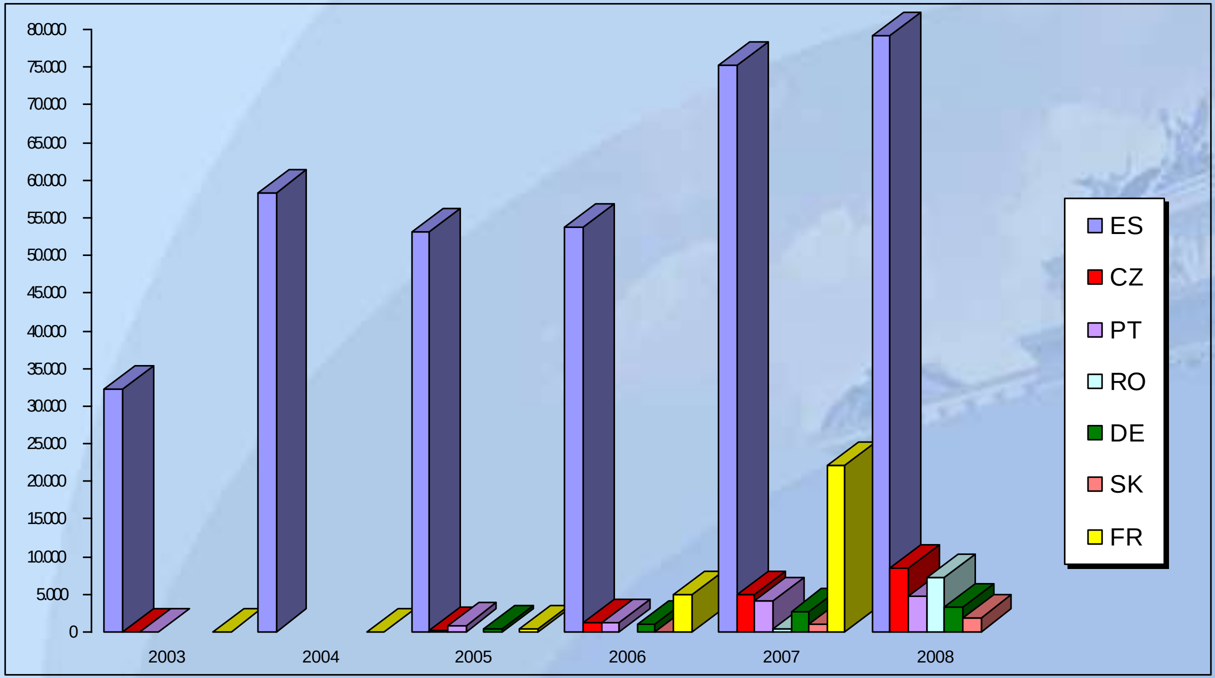
Distribution of Bt corn fields in Spain



124 GM maize varieties derived from MON-ØØ81Ø-6 are authorised for comercialisation in Spain (junio 2009)

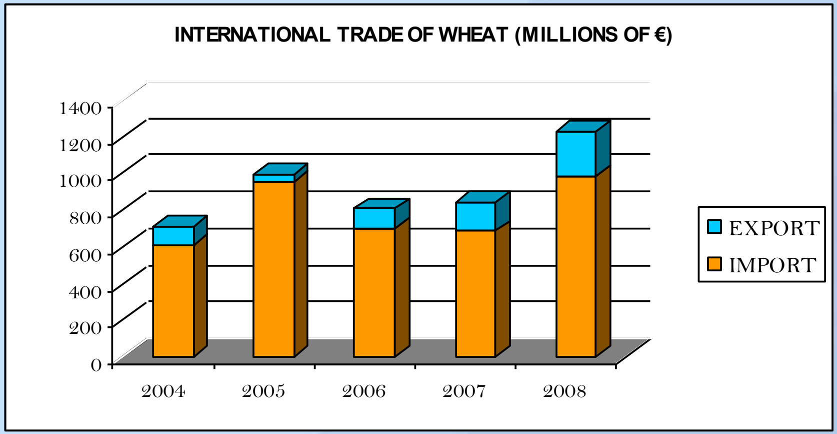
Empresa comercializadora	Variedad (fecha de autorización en BOE o en el *Catálogo Europeo**) **Las variedades marcadas en verde son las registradas en el Catálogo Europeo*
Pioneer Hi-Bred	**PR33P67** (11/03/03), **PR32P76** (16/02/04), **BACILA** (11/08/05), **PR32R43** (11/08/05), **PR32W04** (11/08/05), **PR34N44** (11/08/05), **PR36R11** (11/08/05), **PR31N28** (07/09/06), **PR33B51** (07/09/06), **PR36B09** (07/09/06), **PR31D21** (25/04/08), **PR31D61** (25/04/08), **PR31P43** (25/04/08), **PR32T86** (25/04/08), **PR35Y69** (18/04/09), **PR32D80** (18/04/09), **PR32P27** (18/04/09), **PR33D48** (18/04/09). **PR33T60** (18/04/09), **PR33Y72** (18/04/09), **PR34P86** (18/04/09), **PR35A56** (18/04/09), **PR33W86** (17/06/09), ***ELGINA** (17/09/04), **OLIMPICA** (17/09/04), **BOLSA** (17/09/04), **LEVINA** (17/09/04), **PR38F71** (21/04/06), **PR39V17** (21/04/06), **PR39F56** (22/06/06), **PR39D82** (28/08/07), **PR38A25** (28/08/07), **PR32G49** (16/04/08), **PR32K62** (16/04/08), **PR39T47** (30/04/08), **PR34N23** (24/03/09)*
Monsanto Agricultura	**DKC 6575** (11/03/03), **DKC 6550** (16/02/04), **DKC4442YG** (11/08/05), **DKC5784YG** (11/08/05), **DKC6041YG** (11/08/05), **DKC 5018YG** (07/09/06), **DKC6531**YG (06/10/06), **DKC6419YG** (11/05/07), **DKC6451YG** (11/05/07), **DKC6667YG** (11/05/07), **DKC6844YG** (11/05/07), **TABALA YG** (25/04/08), **CONSUELO YG** (12/11/08), **EC6303EZA1** (12/11/08), **DKC6877YG** (18/04/09), **ROXXY YG** (18/04/09), **ES MANADE YG** (18/04/09), ***DKC513** (17/09/04), **DKC3421YG** (21/04/06), **DKC3946YG** (28/08/07), **DKC2950YG** (30/04/08), **DKC3350YG** (22/08/08), **DKC3512YG** (22/08/08)*
Limagrain Ibérica	**ALIACAN BT** (11/03/03) , **ARISTIS BT** (11/03/03), **GAMBIER BT** (16/02/04), **CAMPERO BT** (16/02/04), **HELEN BT** (11/08/05), **BELES SUR** (07/09/06), **LUSON BT** (07/09/06), **ASTURIAL BT** (07/09/06), **PONCHO YG** (11/05/07), **LG3711 YG** (25/04/08), **ANGOON YG** (18/04/09), **AVIRRO YG** (18/04/09), **LG3540YG** (18/04/09), ***NOVELIS** (17/09/04), **LG3233YG** (28/08/07), **ANJOU 277YG** (15/11/07)*
Semillas Fitó	**JARAL BT** (16/02/04), **SF1035T** (11/08/05), **SF1036T** (11/08/05), **SF1112T** (11/08/05) , **SF4701T** (07/09/06), **AZEMA YG** (07/09/06), **CARELLA YG** (25/04/08)
Arlesa (Euralis)	**CUARTAL BT** (16/02/04), **RIGLOS BT** (11/08/05), **ES MAYORAL YG** (25/04/08), **ES ARCHIPEL YG** (25/04/08), **ES CAJOU YG** (25/04/08), **ES PAOLIS YG** (25/04/08), **ES ZODIAC YG** (25/04/08), ***ES LIMES YG** (15/11/07), **EUROSTAR YG** (15/11/07), **ES COCARDE YG** (21/02/09)*
Koipesol	**PROTECT** (16/02/04), **KAPER YG** (23/03/07)
Agrar Semillas	**FOGGIA** (11/08/05), **MAS 60YG**(11/05/07), **MAS 58YG** (25/04/08), **MAS 71YG** (25/04/08), ***MAS29YG** (22/08/08), **MAS 52YG** (24/03/09)*
Corn States Int.	**EVOLIA YG** (07/09/06), **BENJI YG** (07/12/06), **KOFFI YG** (07/12/06), **ROCCO YG** (07/12/06), **PLACIDO YG**, (23/03/07), **TONIC YG** (11/05/07),
KWS	**KXA5491 YG** (11/05/07), **KARTER YG** (18/04/09), ***KURATUS** (22/06/06), **KARAS YG** (22/08/08), **KONTRAS YG** (22/08/08)*
Caussade Semences	**VENICI YG** (23/03/07), **VIVANI YG** (18/04/09), ***MAGGI YG** (24/03/09)*
RAGT	**RUGBYXX YG** (25/04/08), **BERGXXON YG** (18/04/09), **GALEXX YG** (18/04/09), **KOTOXX** (18/04/09), **KOXXMA** (18/04/09), **REMIXX** (18/04/09), **ROXXANE YG** (18/04/09),**TIXXUS YG** (18/04/09), **TYREXX YG** (18/04/09), ***LYNXX YG** (24/03/09)*

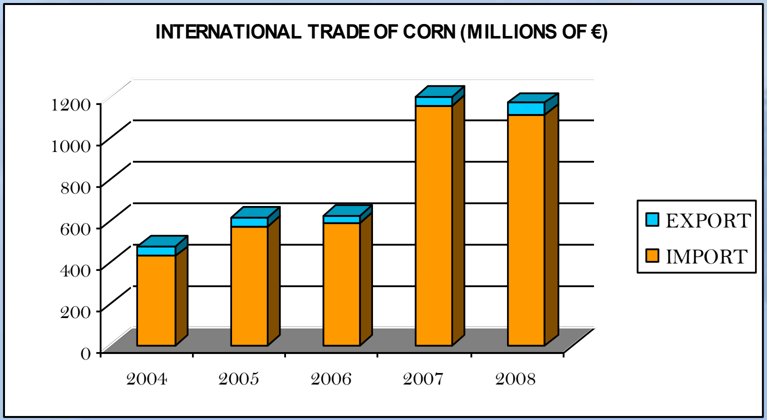
GM (Bt) maize in the EU

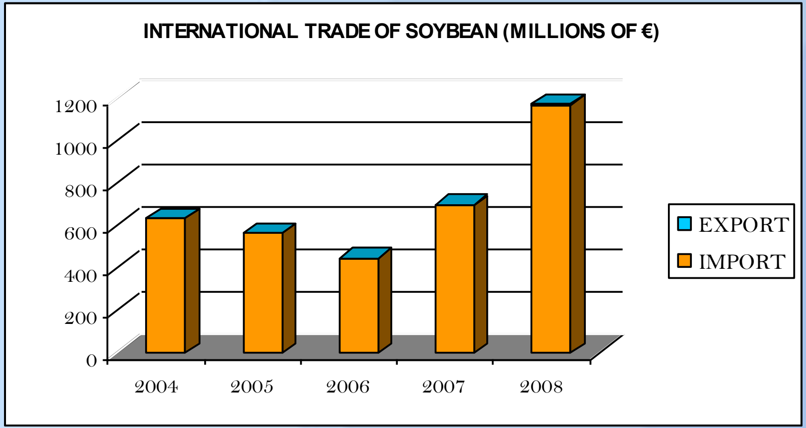


- Spain is the only country in the EU where GM maize is cultivated significantly (more than 50.000 has).
- In 2007 Bt maize was cultivated in seven countries. In 2008 cultivation of Bt maize was banned in France and in 2009 in Germany, so currently five countries cultivate Bt maize inthe EU.
- Corn borer attack is a major problem only in southern europe

International trade of grain crops in Spain







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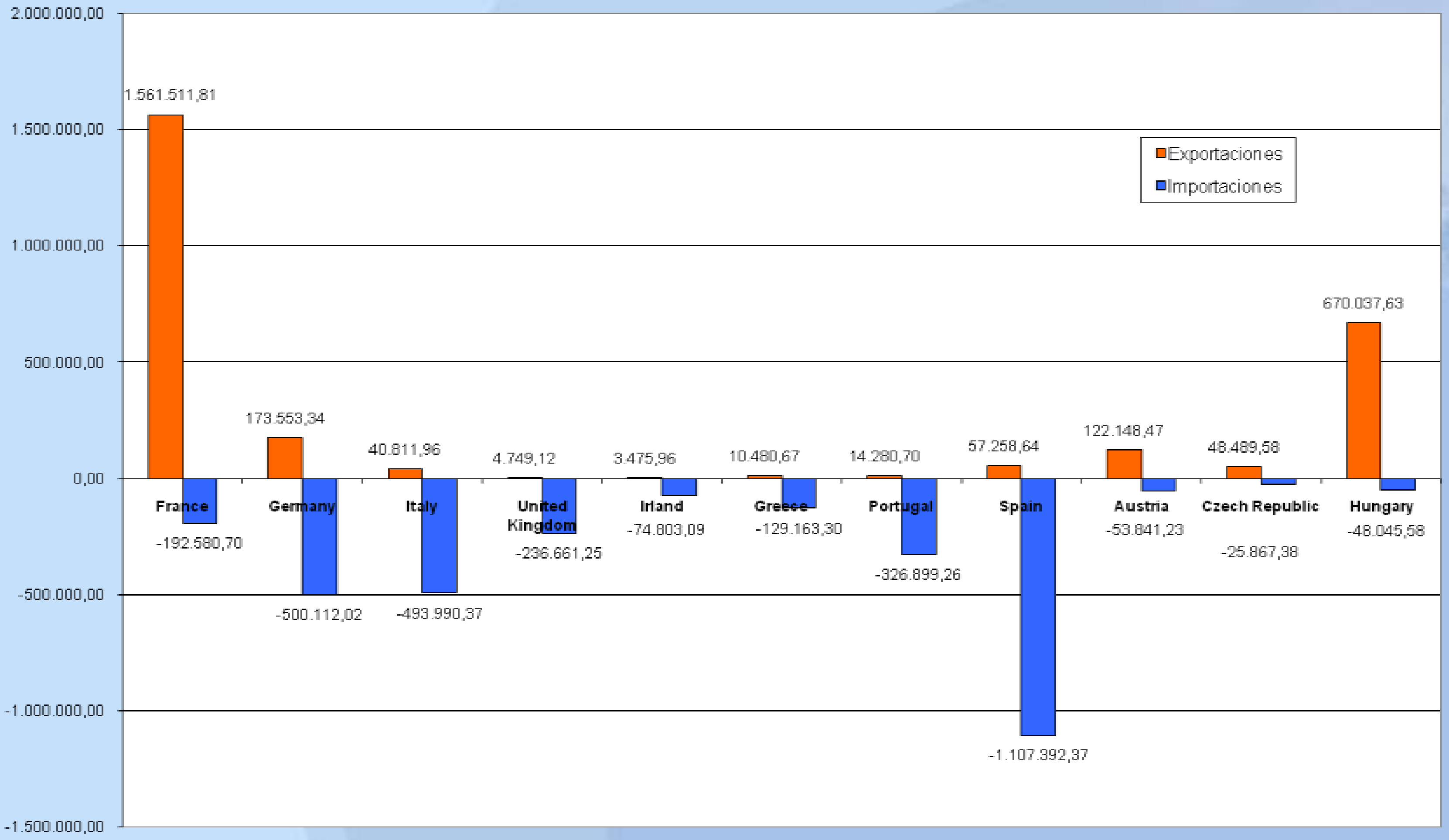
MAIZE EXPORT-IMPORT



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Impact on farm income

	Year first planted GM IR maize	*Area GM IR maize 2007 (ha)*	*Average yield impact (%)*	*Cost of technology 2007 (€/ha)*	*Net increase in gross margin 2007 (€/ha)*	*Impact on farm income at national level 2007 (,000 €)*	*Cumulative Impact on farm income at a national level year of first use to 2007 (,000 €)*
Spain	**1998**	**75,148**	**+10**	**35**	**+201.27**	**+15,125**	**+49,339**
France	2005	22,135	+10	40	+186.72	+4,133	**+4,806**
Germany	2005	2,685	+4	40	+85.99	+231	**+294**
Portugal	2005	4,263	+12.5	35	+105.51	+450	**+557**
Czech Republic	2005	5,000	+10	35	+107.20	+536	**+614**
Slovakia	2005	948	+12.3	35	+75.03	+71	**+72**
Poland	2005	327	+12.5	35	+90.40	+30	**+31**
Romania	2007	360	+7.1	32	+25.40	+9	**+9**
Total		**110,866**			**+185.67**	**+20,585**	**+55,722**

Source: Graham Brookes, 2009

CO-EXISTENCE

The Spanish experience with co-existence after ten years of cultivation of GM maize

Is co-existence possible?

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Field tests and Co-existence studies made in Spain

- The Office of Plant Varieties from Spain that belongs to the Ministry of Environment, and Rural and Marine Affaires, in collaboration with various official institutions, programmed a series of field trials and Co-existence studies during the 2003, 2004 and 2005 campaigns.

- The aim of this study was to analyze the transfer of pollen from a plot sowed with GM maize to a neighbour plot with conventional maize (gene flow).

- In this study it was very important to distinguish cross pollination from direct contamination from seeds remaining in seeders or harvesters.

The co-existence of different varieties of GMO and conventional maize was simulated:

- *Under the most extreme conditions,*
- *On different land surfaces*
- *With different distances between the crops.*

Sources of accidental presence of GMO

The most important sources of accidental presence of GMO in the maize crop are:

- Impurity of the seed
- Contamination from seeders and harvesters
- Remains from the previous crop
- Pollen flow between neighbouring plots
- storage of the grain.

The accidental presence of GMO cannot exceed the threshold of 0.9 %

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Purity of the seed: Results of the analyses carried off on lots of maize seeds in Spain

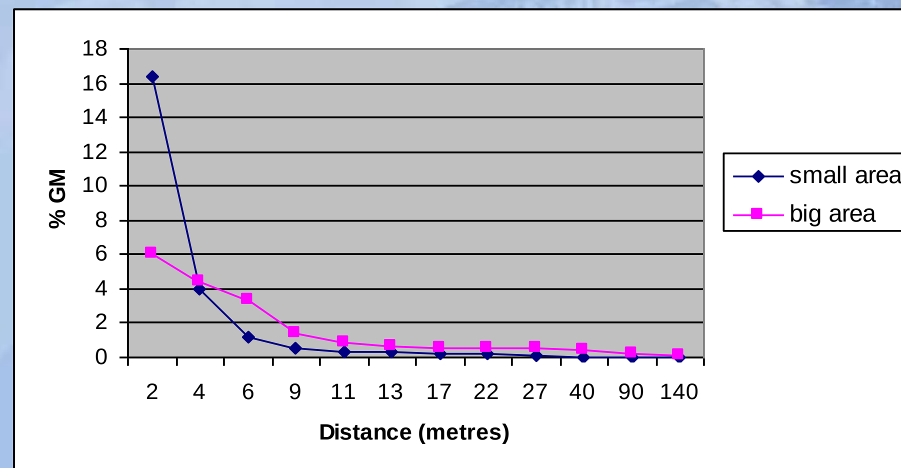
- The main source of accidental presence of GMO in the harvests is the contamination of GMO in seeds
- Every campaign, 800 lots of conventional seeds are analyzed for accidental presence of GMO. The limit is 0.5%

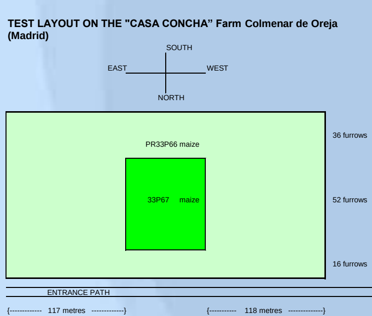
Year	Number of lots analyzed	Number of lots with GMO	% lots with GMO	Number of lots with content of GMO					
				>0.9%	>0.7 % <0.9 %	>0.5 % <0.7 %	>0.3 % <0.5 %	>0.1 % <0.3 %	<0.1 % > 0 %
2005	903 conv	25	2.8	5	0	3	4	12	1 (*)
2006	870 conv	49	5.6	3	0	2	6	15	23
2007	608 conv	79	13.0	2	4	3	11	24	35
	136 MON 810	6 non MON 810	4.4	0	0	0	0	0	6 (**)

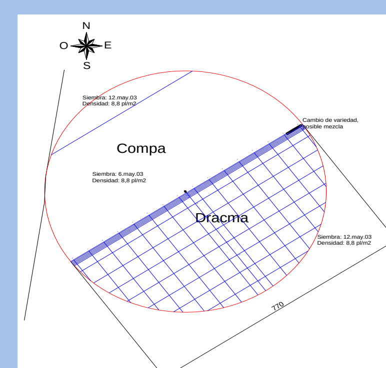
Pollen flow between neighbouring plots

- **Field tests in 2003 with adjacent GM and non GM maize for evaluation of gene flow**
- **For distances greater than 15 meters, the average content of GMO is less than 0.9%.**

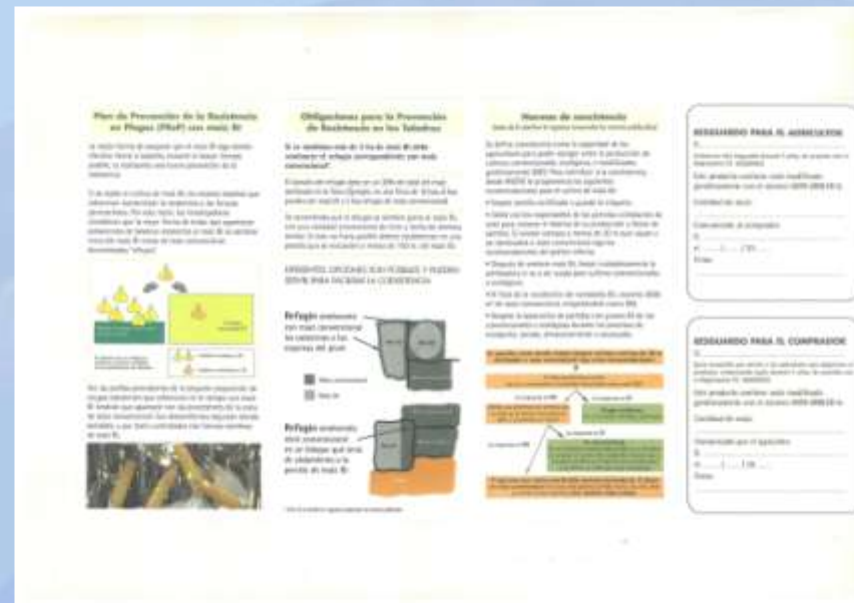
Distance	% GMO	
Metres	Small area GM	Big area GM
	Madrid	Albacete
2	16,4	6
4	4,01	4,4
6	1,18	3,3
9	0,58	1,43
11	0,375	0,9
13	0,3	0,67
17	0,24	0,55
22	0,17	0,57
27	0,09	0,5
40	0	0,45
90	0	0,2
140	0	0,07





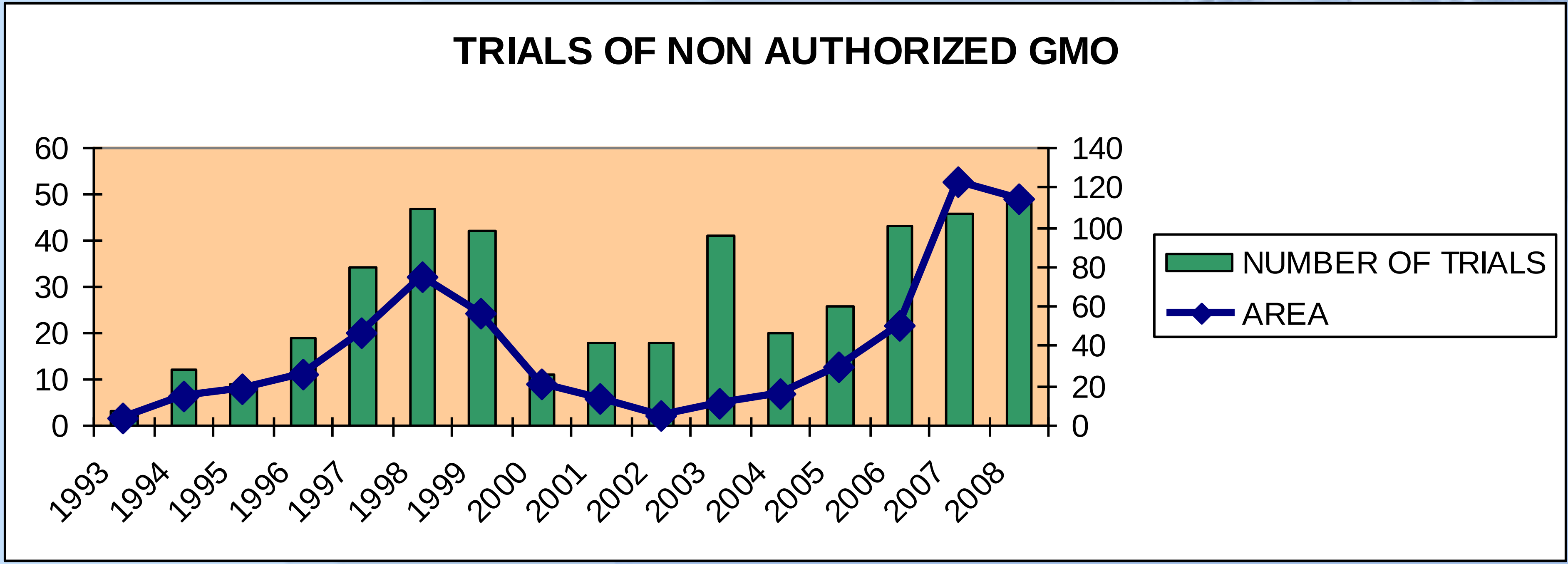


Good Agricultural Practices with Bt maize



- Prevention Plan for insect resistance: 20% of conventional maize as a refugee for corn borer.
- Isolation distance: 20 m.
- When the distance is less than 20 m and the neighbour plot is sowed with conventional maize and there is no time delay of 4 weeks in April or 2 weeks in May between them, 12 rows of conventional maize must be sowed that also serve as refuge.
- Comply with the trazability and labeling regulation.

Trials of non authorized GMOs



Monitoring requirements for Bt maize in Spain

Spanish legislation for the registration of commercial varieties since 1998 already implemented the requirements included in Directive 2001/18/EC.

Bt176 varieties (1998-2005)

MON810 varieties (from 2003)

Case Specific
Monitoring of corn borer resistance
Potential effects on non-target arthropods
Potential effects on soil microorganisms
Potential effects on digestive tract bacteria (only for Bt-176)

General Surveillance (only MON810)
Farmer questionnaires

Seed sales by localities. Distribution. Buyers.

Information to farmers on specific measures for GM cultivation

Monitoring of corn borer resistance

Spanish Programme (MARM-CSIC)
(1998-2009)

Industry
(2004-2009)

a) define the agro-ecological areas of interest.

b) establish the baseline susceptibility to the insecticidal protein.

c) detect changes over time in susceptibility by regular monitoring.

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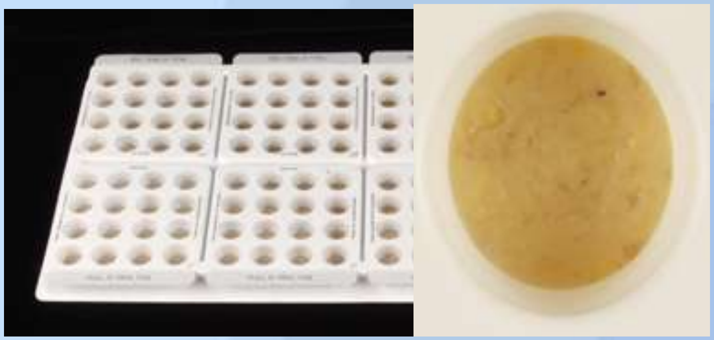
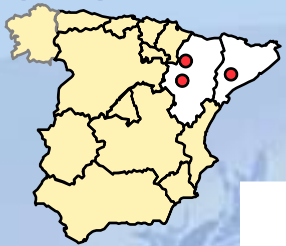
Agro-ecological areas of interest

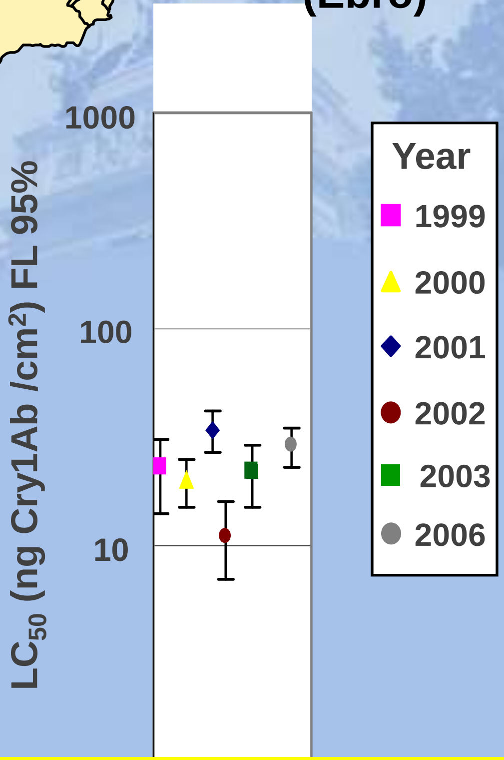
Susceptibility of field corn borer populations

- First laboratory generation of field collected larvae
- Toxin (Cry1Ab) applied on surface of diet in cells of plastic trays
- 7 concentrations (10- 90% mortality) + Control
- 3 subsamples (16-32 larvae)/dose
- Mortality at 7 days



Bt-maize





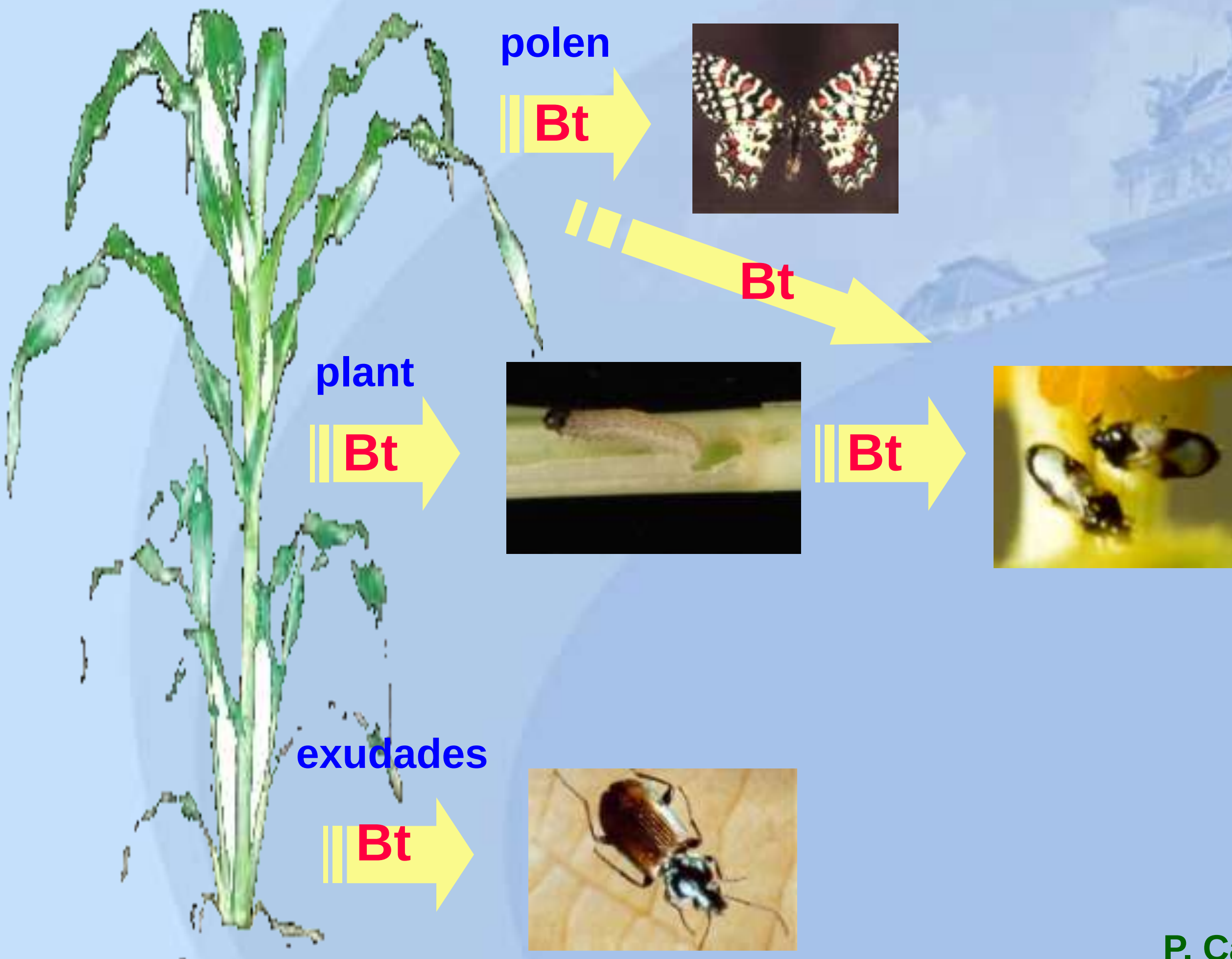
- No increase in the resistance to the toxin.
- No changes in the susceptibility

González-Nuñez et al., 2000. J. Econ. Entomol. 93: 459-463
Farinós et al., 2004. Ent. Exp. Appl. 110: 23-30

Summary: Resistance monitoring

✓ The Spanish monitoring programme has found no consistent shifts in susceptibility for field populations of MCB and ECB after ten years of Bt maize cultivation.

Monitoring: potential effects on non-target arthropods



Monitoring strategies for non-target arthropods

Spanish Programme (MARM-CSIC) (2000-2009)	Industry (2005-2009)

- Arthropod fauna in maize fields.
- Exposure of non-target arthropods to Bt maize toxins.
- Field trials to assess abundance and diversity of non-target arthropods.
- Laboratory assays to test worst-case scenarios.

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Potential effects on non-target arthropods

Spanish Programme (1998-2006)

Other scientific information

- ✓ **No detrimental effects on composition and abundance of predatory arthropods have been found in commercial Bt-maize fields.**
- ✓ **Bt maize could be compatible with the natural enemies that are common in maize fields in Europe and which contribute to reduce insect pest populations.**
- ✓ **Field trials in the same areas for long periods are necessary to discard potential accumulative effects.**
- ✓ **Additional studies are being conducted for some groups that are poorly studied, such as staphylinids.**

Potential effects on soil microorganisms

Ministry of Education-Industry 2000-2002

Analysis of bacteria population levels in soil:

- No effect on total and ampicillin-resistant bacterial population levels
- High percentage of natural ampicillin resistant bacteria (1-20%)
- Lack of detection of gene transfer from Bt-maize to cultivable soil bacteria

Badosa et al. (2004) FEMS Microbiology
Ecology 48: 169-178