Public Policy and Farm-level Strategies for Coexistence in Germany – A Case Study of Bt-maize in Brandenburg

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Abstract— **The regulatory framework for growing GM crops in Germany comprises quite liberal ex-ante regulations with very strict ex-post liability rules to protect other production forms from possible negative side effects of transgenic plants. Regulation is assumed to impose additional costs on farmers who intend to plant Bt-maize. This paper investigates the significance of these costs and the possibility of minimizing them by farm-level strategies such as coordination and cooperation between the Bt-maize growing farmer and his neighbours. A case study investigating the behaviour of Bt-maize growing farmers was carried out in the Oderbruch region in the federal state of Brandenburg, Germany. This region is leading in Bt-maize cultivation in Germany and has a high incidence of the European Corn Borer (*Ostrinia nubilalis* Hübner). The interviews revealed that additional costs due to ex-ante regulation and ex-post liability were only of minor importance to the Bt-maize growing farmers. All farms were large-scale and could easily manage the construction of buffer zones within their own fields and deliberately avoided the planting of Bt-maize close to their neighbours. Thus advanced inter-farm coordination and cooperation was not necessary to achieve coexistence. However, the fact that Bt-maize was only grown on large-scale farms indicates a significant threshold effect due to the regulatory framework in Germany likely to prevent small-scale farms from planting Bt-maize unless innovative farm-level strategies of coexistence will be developed.**

Keywords— **coexistence, ex-ante regulation and ex-post liability, Germany**

I. INTRODUCTION

In 2003, the European Commission published guidelines for coexistence of transgenic and non-transgenic plants (CEC 2003a). No form of agriculture should be excluded in the EU, which means that farmers are free to choose between farming conventionally or organically as well as to use genetically modified (GM) crops. Similarly, consumers must be given the opportunity to decide freely on buying the produce from either of these agricultural production systems.

The realisation of coexistence follows the principle of subsidiarity. This means that every EU Member State can design and implement national regulations to guarantee coexistence.

Germany incorporated rules of ex-ante regulation such as Good Agricultural Practice (GAP) and a public site register and ex-post liability rules into the German Genetic Engineering Act (GenTG) in 2004 but has not (yet) developed a particular law for coexistence of transgenic and non-transgenic plants like for instance the Netherlands and Denmark. In fact, the German Genetic Engineering Act (GenTG) still lacks defined distance requirements to avoid gene outcrossing by pollen movement and liability rules (GentTG 2006). An amendment is under way and is expected to be debated in the German parliament and federal council in 2008.

By now, Bt (*Bacillus thuringiensis*)-maize is the only transgenic plant approved for commercial growth in the EU. Bt-maize expresses a toxin derived from the soil bacterium *Bacillus thuringiensis* which targets the larvae of the European corn borer (ECB, *Ostrinia nubilalis* HÜBNER) when feeding on the plant. Since the end of 2005, five transgenic varieties of Bt-maize MON810 have been approved for commercial cultivation in Germany and were planted on 950 ha throughout Germany and 443 ha in the federal state of Brandenburg (BVL 2007a) in 2006. The main focus of Bt-maize cultivation in Brandenburg lay in the Oderbruch region close to the Polish border where infestation rates with the ECB are high (Schroeder, Goetzke and Kuntzke 2006). In 2007, commercial cultivation increased up to 2,690 ha at the national level, and 1,344 ha still cultivated in Brandenburg. Also in 2008 a general increase can be noted with 1,720 ha in Brandenburg and 3,714 ha nationally (BVL 2007a).

Increasing cultivation of transgenic plants raises the question of coexistence of agricultural production systems. Pollen movement and gene outcrossing can cause economic damage to conventional and organic farmers if the produce is subjected to labelling and, thus, selling is restricted or the product yields a lower market price. The labelling threshold for adventitious and unavoidable presence of GM traces has been set at 0.9% for food and feed throughout the EU (CEC 2003b).

According to the polluter-pays-principle, GM farmers have to carry the (additional) costs of ex-ante regulations and ex-post liability which emerge from the GenTG. This includes field registration in a national cadastre, compliance with security measures, and liability in case of damage (GenTG 2006).

In this paper, we first aim at identifying and assessing the additional costs for the GM farmer which arise from ex-ante regulations and ex-post liability rules defined by the legal framework in Germany. Secondly we address the question whether these costs could be reduced by farmers' coordination and cooperation. The empirical analysis is based on case study interviews with eight Bt-maize growing farmers and six of their adjacent neighbours in the federal state of Brandenburg where coexistence between GM and non-GM farms can already be observed.

In the subsequent Section II, we give a short introduction to the legal background of GM cultivation in Germany and potential costs of ex-ante regulation and ex-post liability. Here, we also describe the role of cooperation and coordination for cost reduction. Section III gives a short overview on the case study carried out in the Oderbruch region on Brandenburg in 2006. In Section IV, we discuss the results from the empirical analysis, and we finish with some conclusions in Section V.

II. LEGAL BACKGROUND, COSTS OF EX-ANTE REGULATION AND EX-POST LIABILITY AND THE ROLE OF COOPERATION

A. Legal background of Bt-maize cultivation in Germany

Regulations concerning the cultivation of GM crops are embedded in the German Genetic Engineering Act (GenTG) which dates back to 1990. In 2004, the Act underwent its first partial amendment under the former red-green coalition (SPD, die Grüne) to include the establishment of a public site register (§16a, GenTG) and the compliance with Good Agricultural Practice (§16b, GenTG) as forms of ex-ante regulation. Furthermore, ex-post liability rules were defined in §36a, GenTG. However, no distance requirements were given in this Act to keep gene outcrossing below the EU-wide labelling threshold for adventitious and technically unavoidable GM traces of 0.9%. The German Genetic Engineering Act had to undergo another amendment which was necessary to finally implement the EU Directive 2001/18/EG (CEC 2001) on deliberate release of genetically modified organisms (GMO) into the environment. This finally took place under the new coalition (SPD and CDU) in 2006 after the German Federal Council refused consent in 2005.

The public site register is provided by the Federal Office of Consumer Protection and Food Safety (BVL) which is the supreme authority responsible for the field of genetic engineering in Germany. The register gives detailed information on the planting of GM crops in order to monitor possible environmental and health effects (Vaasen, Gathmann and Bartsch 2006) and is divided into a public part, which is freely accessible over the internet, and a non-public part. The public part contains information on field location and type of the GM crop. The non-public part comprises personal data of the GM farmer. For reasons of data privacy, information from this part is only given upon request and only to neighbouring farmers or other persons with legitimate interests. Cultivation of GM crops must be registered 90 days in advance to planting (§16a GenTG).

Another element is the compliance with the general code of GAP (§16b GenTG). The GM farmer is obliged to meet general safety arrangements, for instance minimum distances to neighbouring fields, the use of different varieties, or pollen barriers to prevent damage to third parties. However, the GenTG lacks concrete specification of minimum distance requirements that are sufficient to keep outcrossing below the EU-wide labelling threshold of 0.9% for adventitious and technical inevitable GM traces in food and feed. In 2006, German GM farmers had to rely on recommendations from GM seed companies which recommended buffer zones of 20 m to keep outcrossing below the labelling threshold (Weber et al. 2006).

In the case of ex-post liability, Bt-maize growing farmers in a region are jointly and severally liable for damages caused by, e.g., gene outcrossing to neighbouring maize plants (§32 GenTG). Furthermore, GM farmers are strictly liable, i.e., even if they have met all requirements of the GAP, they are not exempt from third party liability claims.

B. Costs arising from ex ante regulations and ex post liability

The legal framework of ex-ante regulations and ex-post liability can cause additional costs to the farmer who decides to grow GM crops. These costs can be classified as follows:

1. Administration and publication costs
2. Damage prevention and coexistence measure costs
3. Damage and liability costs

Administration and publication costs: The cultivation of Bt-maize must be announced in the national public site register of the BVL. This can cause direct as well as indirect costs:

- The act of registration itself is closely connected with additional work and expense for the GM farmer.
- Free data availability through the internet: Certain data from the public site register is easily accessible via the internet, such as the exact location of the GM field. In the past, this has favoured field destructions by fierce opponents of the GM technology.

Damage prevention costs: In order to avoid possible damage, e.g., through gene outcrossing, the farmer is obliged to meet the standards of GAP.

Apart from the direct costs due to distance requirements, also indirect information costs have to be taken into account:

- Searching for information concerning coexistence measures: Since the GentTG does not provide recommendations on reasonable distance requirements the GM farmer him/herself has to gather information about adequate measures to avoid damage.
- Establishment of safety measures: Measures have to be implemented on the farm level. Theoretically, the farmer can choose from a set of measures, which are able to ensure the labelling threshold of 0.9% on neighbouring fields.

Damage and liability costs: Even if a farmer meets the requirements of the code of GAP s/he is still jointly and severally as well as strictly liable for possible damages. The damage and liability costs depend on a) the expected damage, b) the probability of damage occurrence, and c) the probability that the farmer is actually held liable for the damage. Apart from theses direct costs, also possible costs arising from lawsuits have to be taken into consideration (Beckmann and Wesseler 2007).

- The magnitude of the damage and liability costs is influenced by 1) the price difference between GM, conventional, and organic products, b) the quantity of products affected, and c) the labelling threshold.
- The probability of damage occurrence is strongly influenced by the security measures and the type of GM crop grown.
- The probability that the farmer is held liable depends on the neighbourhood relationships and the possibility/likelihood of amicable agreement.

C. Coexistence measures on the farm level

According to 2003/556/EC, coexistence refers to the ability of farmers to make a practical choice between conventional, organic and GM-crop production, in compliance with the legal obligations for labelling and/or purity standards. Since maize is an anemophilous species, pollen movement from transgenic maize can take place over short distances and bear the possibility of subsequent gene outcrossing to conventionally or organically grown maize plants. Furthermore, admixture of GM harvest with conventional harvest can occur on the farm level but will not be analysed in this article. Messean et al. (2006), provide a set of on-farm measures to reduce the above mentioned risks and to guarantee coexistence:

1. Isolation distances between GM and non GM field of the same species (different crop)
2. Use of GM and non-GM crops with different flowering times (time isolation)

3. Installation of non-GM buffer zones of the same crop around the GM field

It has to be kept in mind that these coexistence measures are also a source of additional costs. In Germany, the legal framework imposes these costs on the GM farmer exclusively. Messean et al. (2006) review some additional on-farm costs arising from individual coexistence measures. For instance, the sowing of different varieties for time isolation results in notable additional costs ranging from 46 €/ha to 201 €/ha which can be explained by significant variety-based yield reduction. Additional costs of buffer zones vary from 60.54 to 78.07 €/ha depending on the size of the GM field, the width of the buffer zone, and the adoption rate of GM crops in the region. Messean et al. (2006) denote that the smaller the GM fields (<1 ha) the higher are the on-farm costs caused by the establishment of buffer zones. Furthermore, also strict ex-post liability rules can bear significant costs for small farms (Soregaroli and Wesseler, 2005). Economic losses due to coexistence measures can be minimized by clustering GM fields and by the establishment of non-GM buffer zones around whole clusters only. Yet, the economic analysis of Messean et al. (2006) does not take into account additional administrative costs or costs of cooperation to achieve these measures.

D. Forms of coordination and cooperation

According to the legal framework in Germany the GM-farmer carries the burden of ensuring coexistence exclusively. However, we argue that both the GM-farmer and his non-GM neighbours could contribute to coexistence by coordination or cooperation. Coordination can take place within a single farm (intra-farm coordination) or among two adjacent farmers (inter-farm coordination). For intra-farm coordination, a GM-farmer can arrange his own fields to keep maximum distances to his neighbours, adjust field size to reduce the risk of gene outcrossing and the costs of additional buffer zones or install isolation distances. Inter-farm coordination involves the GM-farmer as well as the non-GM neighbour. The GM-farmer can inform his neighbour on the exact location of the GM-field. This information can also be obtained by the public site register. Both farmers can agree on planting different varieties or adjusting their cultivation plans in order to prevent short distances between GM- and non-GM maize fields.

Cooperation itself can be defined as a special form of inter-farm coordination. Beckmann and Schleyer (2007) observe three new forms agricultural cooperation as a result of the approval of transgenic varieties for commercial cultivation in the EU: (1) the development of so-called GMO free zones, (2) the creation of potential GMO-zones or (3) cooperation for coexistence.

Data on the development of GMO-free zones in Germany indicate that the most common form of explicit cooperation to cope with agro-biotechnology is avoidance where adjoining farms sign contracts to refrain from growing or feeding GM crops.

We assume, that in the special case of Bt-maize it is very easy to join a GMO-free zone if a) little or no maize at all is grown in the region, b) the ECB is of minor importance or can be controlled easily by other means than Bt, or c) the region is characterised by a high density of organic farms which are not permitted to make use of the GM technology. Furtan et al. (2007) reported positive welfare effects through the formation of an organic club (a GMO-free zone).

Alternatively, neighbouring farmers could cooperate to form a GMO-zone, where only GM crops are grown. This is the case if at least two adjacent farmers rank the value of GM-production higher than the value of non-GM production.

In the case of cooperation for coexistence, one farmer attaches a higher benefit to the non-GM production whereas her/his neighbour ranks the value of GM-production higher. Especially in areas with small-structured agricultural production, adjacent farmers can cooperate for coexistence by changing fields to keep safe distances.

In a region with GM farms as well as conventional or organic farms coexistence can cause additional costs. We argue that cooperation between neighbouring farmers becomes the more beneficial the higher the costs of on-farm coexistence measures are perceived and if cooperation can reduce the costs of ex-ante regulation and ex-post liability significantly. One still has to keep in mind that also coordination and cooperation themselves are a new source of additional costs since agreements have to be made, monitored, and enforced.

Further, cooperation can not only be observed among farmers but also between farmers and downstream enterprises, such as seed companies. In 2005, the seed and grain trading company Märkische Kraftfutter GmbH (Märka) implemented a practical quality assurance system. Together with Monsanto and Pioneer the company allowed GM grain maize to be commercialized while at the same time it guaranteed farmers that their conventional grain maize grown adjacent to Bt-maize was being bought regardless of possible GMO traces and without any price reduction as long as the labelling threshold was not exceeded (Pohl et al., 2005; Weber et al. 2006). GM farmers participating in this project, voluntarily implemented GAP to keep GMO traces below the labelling threshold. In turn, the trader was responsible for further segregation and labelling. By defining a 20 m separation distance for secure compliance with the 0.9% threshold, the Märka system relied on the outcomes of several studies on pollen movement and cross-pollination. Additionally, the GM farmer was asked to inform adjacent neighbours within a 100 m range from the Bt-maize field and to harvest, store and transport GM-maize and non-GM-maize separately as well as to clean machinery adequately (Pohl et al., 2005).

III. A CASE STUDY OF BT-MAIZE CULTIVATION IN BRANDENBURG – GERMANY

A. The case study region

As a case study region, the administrative district Märkisch-Oderland in German federal state of Brandenburg has been selected. Within this region, the Oderbruch region is located, which shows an increasing incidence of the ECB (European Corn Borer; *Ostrinia nubilais* HÜBNER) since its first report in 1986 (Schroeder, Goetzke and Kuntzke 2006). Especially in grain maize production the ECB can cause yearly on-farm losses up to 30% (Piprek 2005). The insect can be controlled by a set of measures, including tilling operations, chemical and biological pest control, and – since 2006 – the cultivation of Bt-maize. These measures, however, differ significantly in their effectiveness. Although tilling is reported to be powerful against the ECB, it can not be recommended for many parts of the Oderbruch region because of soil characteristics. Chemical control has an efficiency factor of 70 to 90 % but is also connected with two major disadvantages: Firstly, in 2006 only one pesticide is approved for the chemical control of the ECB in maize in Germany (BVL 2007b) which deprives the farmer of useful alternatives, e.g. for resistance management. Secondly, control is technically difficult because at the time of spraying the maize plants have already reached a height of 1.5 m and special machinery is needed. Furthermore, the farmer has to adhere to a narrow time frame for insecticide application since as soon as the ECB larvae have once entered the maize stem, surface spraying is no longer useful.

Biological control with the natural antagonist *Trichogramma brassicae* is reported to be less effective than chemical control in the Oderbruch region and application is time and cost-intensive. Government aid is given for *Trichogramma*-control in some parts of Germany, but this does not apply to Brandenburg (Winkler 2005).

Bt-maize MON810 which is the only GM crop approved for commercial production in Germany contains a δ-endotoxin of the soil bacterium *Bacillus thuringiensis* which is lethal to the larvae of lepidopteran species, such as the ECB. The efficiency factor is reported to be nearly 100% (Degenhardt, Horstmann and Mülleder 2006). Since its first approval for field trials in 1998, Bt-maize MON 810 has been tested on-farm in Brandenburg. Some of the farmers who engaged in former field trails switched to commercial Bt-maize cultivation in 2006.

B. Sample selection and farm characteristics

From the public site register, eight Bt-maize growing farmers could be identified in the rural district of Märkisch-Oderland in 2006. All of them were interviewed using a standardised questionnaire which comprised questions regarding on-farm Bt-maize cultivation and the perception of ex-ante regulation and ex-post liability rules. Some of the Bt-maize growing farmers passed on the names of their adjacent neighbours who could be interviewed subsequently. Since maize pollen can spread over short distances, the GM farmers were asked to provide information on those of their adjacent neighbours who were also growing maize. It was of major interest whether adjacent farmers were informed about the Bt-maize cultivation or if any coordination or even cooperation took place to avoid outcrossing. Furthermore, we asked if the farmers were (still) on friendly terms with their neighbours, or if the relationship had changed due to Bt-maize cultivation.

Since it was assumed that the seed and grain trading company Märka contributed to cooperation it was also examined if both, the GM farmers and the neighbouring farmers knew about or made use of the purchase guarantee for adjacent maize.

The data collected from the GM farmers was verified by the respective statements of the six neighbours.

We chose the case study approach for data collection and analysis because only very few farmers were growing Bt-maize in the region. Quantitative data on Bt-maize cultivation was also collected but statistical evaluation was not possible because of the small sample size. Results obtained from each farm regarding coordination and cooperation as well as neighbour relationships will be described subsequently (please also refer to Table 1):

Farm 1:

Farmer 1 had five neighbours, two of them being organic farms and the rest conventional. The organic farms were not growing maize at all. One of the conventional farmers also showed interest in growing Bt-maize but up to now, he refrained from doing so because of the public site register. In case of an increase in ECB infestation, however, he would reconsider his decision. Adjacent neighbours had been informed in time about the planting of Bt-maize and field location. The relationship to large (conventional) farmers was described as “good” and to one of the organic farmers as “difficult”. The latter one showed strong resentment about the adoption of GM crops. Farmer 1 tried to avoid unnecessary provocation by not planting Bt-maize close to the fields of the organic farm. However, the relationship did not change due to growing GM. Cooperation for coexistence could not be observed. Farmer 1 knew about the Märka system and but none of the adjacent farmers not he himself had to make use of it since sufficient safety distance were kept.

Farm 2:

Farmer 2 adopted Bt-maize cultivation in 2006 on an area of 17 ha, 15 ha being the actual Bt-maize plot size and 2 ha buffer zone around the field. The field was situated close to a neighbouring field where no maize was grown. This resulted in inter-farm coordination since the GM farmer notified his adjacent neighbour about planting Bt-maize close to his fields. Intra-farm coordination took thus place by means of keeping recommended distance requirements by installing a 25 m buffer zone around the Bt-maize plot. Farm 2 stated to have informed the adjacent farmer prior to Bt-maize plantation. Coordination for coexistence did not take place. Neither of the two neighbours saw any need for coordinating planting areas or time since they did not expect any damage. No information was exchanged about possible damages and liability issues. The relationship was described as “good” and did not change because of Bt-maize cultivation.

Farm 3:

Farmer 3 started to grow Bt-maize on a very small area for trial in 2006. The farm had six neighbours, one of them being an organic farm, which did not grow maize at all. Three neighbours were large farms, also growing maize. These farms showed much interest in the trial carried out at Farm 3 and also took into consideration to partly switch to Bt-maize in the following years. All neighbours had been informed about Bt-maize cultivation in advance. Cooperation for coexistence was not reported. The relationship between the GM-farmer and the neighbours was described as “good”, but changed to the worse with the organic farm.

Farm 4:

Farmer 4 had 10 neighbours, most of them growing conventional maize, only one producing organically. Some of the adjacent conventional farmers also considered Bt-maize cultivation. These neighbours had been informed when it was regarded as reasonable. No cooperation for coexistence could be observed. The relationship was reported as “good” and did not change over time. Farmer 4 informed his neighbours about the Märka system, but no one made use of it.

Table 1 Comparison of Bt-maize growing farms and adjacent non-GM farms

			Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8
Farm-related data	**Farm Size (area under production - AUP in ha)**		530	650	2 200	1 350	1 700	1.080	3 000	505
	Maize production in 2006	**Maize area in ha**	110	130	263	246	400	120	500	250
		% *Bt* of AUP	5.7	2.3	0.2	3.7	3.4	2.3	1.3	3.0
		% *Bt* of maize area	27.3	11.5	1.7	20.3	14.5	20.8	8.0	6.0
Information on – **Neighbouring farms**	**Number of adjacent farms**		5	2	6	10	5	6	6	6
	Production type of adjacent farms*		3 C, 2 O	2 C	5 C, 1 O	9 C, 1 O	5 C	4 C, 2 O	4 C, 2 O	6 C
	Acceptance of Bt in adjacent farms		Good, except organic farm	Not known	Good	Good	Good	Good	Good	Good
	Relationship to neighbours		Good, except organic farm	Good to very good	Good	Good	Good except one farm	Good	Very good to very bad	Good
	Change of relationship due to Bt cultivation		No	No	Only to organic farm	No	No	No	No	No
Information on – **Coordination and Coop-.**	**Field allocation****		1	3	1	1 and 3	1 and 3	2 and 5	2 and 4	1
	Buffer zone/Isolation distance		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Information about intended Bt cultivation		Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
	Cultivation plans, varieties		No	No	No	No	No	No	No	No
	Cooperation		No	No	No	No	No	No	No	No

* C: conventional; O: organic

** 1) Within own maize fields; 2) Bordering non-maize field (own); 3) Bordering non-maize field (foreign); 4) Bordering maize field (own), 5) Bordering maize field (foreign)

Farm 5:

Farmer 5 had 5 neighbours and stated to have informed all of them on intended Bt-maize cultivation. He had contacted his neighbours personally if cultivation was planned in direct neighbourhood to adjacent maize stands. Two neighbours had not been informed directly because of the great distance of several kilometres between the GM field and their conventional maize stands. Cooperation for coexistence was not regarded necessary and no information about potential damages was exchanged. The Märka system was well known but not used. The GM-farmer described the relationship to his neighbours as "good", and this description was confirmed by the neighbours.

Farm 6:

Farmer 6 had six neighbours in total, four of them farming conventionally and two organically. Three neighbours were growing maize. Farmer 6 did not grow Bt-maize close to the organic farms to avoid confrontation. In cases where fields adjoined the GM farmer claimed that he had informed all of his neighbours orally. One neighbour stated that he had not been informed, but traced this back to the huge distance between the GM field and his own (2 km). One neighbour was situated between the fields of two GM farms (Farm 6 and 7) and had not been informed either. However, the fields did not directly adjoin. Cooperation did not take place and no information about damage or liability has been exchanged. Farmer 6 knew about the Märka system, but the neighbours did not. The relationship was described as "normal" and did not change.

Farm 7:

Farmer 7 had six to seven neighbours, two of them organic farms. Only one farm was growing conventional maize at all. This neighbour was interested in also switching to Bt-maize, but was afraid of his milk being refused by the dairies and he himself becoming a target for anti-GM activists. Farmer 7 had not informed his neighbours because they seemed not to care about Bt-maize cultivation and therefore, cooperation could be not observed. The relationship ranged from "very good" to "very bad", but not due to GM. The Märka system was known, but not made use of.

Farm 8:

Farmer 8 had six neighbours, none of them farming organically. Four adjacent farmers were growing conventional maize. One of the neighbours was also a GM farmer, Farmer 7 but a clustering of GM fields was not taken into consideration. The neighbours had been informed orally. Cooperation was not regarded necessary and, thus, did not take place. The relationship to all neighbouring farmers was described as "good". Farmer 8 was acquainted with the Märka system but did not use it.

As can be seen from the interviews with the eight Bt-maize growing farmers in the Oderbruch region, coordination in terms of informing adjacent neighbours was a common practice although not prescribed under the German legislation in 2006. Also necessary distance requirements or buffer zones of conventional maize were kept around the Bt-maize stands. Many Bt-maize growing farmers even refrained from growing GM maize close to organic fields, even if these farmers did not grow any maize at all. Specific cooperation for coexistence, however, was not observed in any case.

Section 4 will now focus in detail on the assessment of costs for coexistence and the individual on-farm strategies to achieve this goal.

IV. COST ESTIMATION UND STRATEGIES FOR COEXISTENCE

After this short characterisation of the interviewed farmers, we now provide an assessment of ex-ante regulation and ex-post liability costs.

A. Administration and publication costs due to public site register

In the first place, a registration in the public site register is an additional time-consuming activity. At least three months in advance, the farmer has to decide where to plant Bt-maize and the other crops. Once registered, he can only plant Bt-maize on the areas he initially intended for this purpose and could be forced to change his cultivation plan if an adjacent farmer decided also to plant maize close to his Bt-maize field. The interview results reflect these additional costs since half of the Bt-maize growing farmers regarded the registration as "cost-intensive". Registration is also accompanied by the publication of farm-related and personal data which can be obtained upon request. Seven out of eight farmers reported personal disadvantages because of this publication. Five GM farmers became a direct target of anti-GM campaigns, such as field destructions and other hostilities. There is no doubt that anti-GM groups have a clear interest in obtaining personal data of the GM farmers to exert pressure directly. For instance, the "Bantam" Initiative (Anonymus 2007) which is supported by Greenpeace, the German Society for Nature Conservation (NABU), several church groups, and stakeholders of the organic movement aims at obtaining insight into the non-public part of the public site register by planting old varieties of sweet maize close to GM maize stands just to become legitimised to get personal data of the GM farmers in the region.

B. Damage prevention, coexistence measures and their costs

For the planting seasons 2006 and 2007, the GenTG (dated 17th March 2006) did not contain concrete measures for coexistence with respect to GAP and only seed companies provided recommendations on coexistence management, such as distance requirements or for the cleaning of machinery. Every GM farmer kept at least a 20 m buffer zone of non-GM maize around the Bt-maize stands as suggested by Monsanto Agrar Deutschland GmbH. The majority of the farmers were even willing to keep buffer zones up to 100 m and beyond. Interestingly enough, seven out of eight GM farmers linked no or only negligible costs to the establishment of buffer zones. Only one farmer described the additional costs as high. The reason can be found in the farm structure. The smallest GM farm had an area of 500 ha, the largest comprised 3,000 ha. The adjacent farms were even larger with an area up to 7,000 ha. In relation to the total area under cultivation, the percentage of Bt-maize never exceeded 6%. This indicates that Bt-maize cultivation is still confined to rather small areas and can, thus, be coordinated easily within the farm. Prevalently, we observed the cultivation of Bt-maize in the midst of conventional maize stands of the same farm which served as buffer zones. Further, since most of the maize was grown for intra-farm cattle feeding, a strict segregation of GM and non-GM harvest was not necessary on the farm level.

All farmers were very well informed about the distance requirements and kept buffer zones. Since most of the farmers already carried out field studies with GM-maize, we assume that gaining information on safety measures was not linked to high costs.

C. Evaluation of liability rules and risk of damage

The ex-post liability rules did not have any prominent influence on the decision to grow Bt-maize. The GM farmers were able to reduce the risk of gene outcrossing and, thus, economic damage to their neighbours by spatial allocation of the Bt-maize fields. Most of the GM farmers planned to increase Bt-maize cultivation in the next years regardless of a change of the liability rules. On the contrary, three of the six neighbours stated not to have grown Bt-maize due to the remaining uncertainty as to the liability in case of damage. According to Beckmann and Wesseler (2007), damage may occur if the adjacent conventional maize exceeds a pre-defined threshold level for adventitious or technically unavoidable GM traces and yields a lower market price due to labelling. In reverse, damage would not occur if the threshold was not exceeded or if GM products were marketed at the same price as non-GM products. The farms we analysed were mainly growing maize for silage which was not intended for sale. No damage is expected if silo maize with an adventitious presence beyond 0.9% is fed to livestock, since neither meet nor milk or eggs must be labelled according to EU legislation. Thus, damage can only occur in case of market sale, if the product has to be labelled and yields a lower price. In Brandenburg, GM grain maize could be sold without any problem in 2006. The same holds true for conventional grain maize exceeding the labelling threshold. Against all expectations, both conventional grain maize and GM grain maize of comparable quality yielded 120€/t when sold to Märka in 2006. We conclude that even in the case of GM traces beyond the threshold no economic damage could occur. However, this only applies to the farms we considered within our case studies and should not be generalised. It has to be stated that in 2006 none of the GM-farmers faced any damage or liability costs. This can be due to several reasons: first, all farmers kept distance requirements which were reported to be sufficient to keep outcrossing below the threshold level. Second, even in case of market sale, the threshold would have played a negligible role since for grain maize the Märka system ensured no economic damage.

However, possible damages for organic farms were not considered and have to be analysed separately. This was not attempted in this study since legally fixed threshold levels for adventitious presence of GM traces in organic maize are still missing in Germany.

D. Coordination and cooperation between neighbours

As we already pointed out, neighbouring farmers have incentives to coordinate if this reduces the costs of coexistence. Different forms of coordination for coexistence are possible, ranging from relatively easy inter-farm coordination where no external actors are involved to inter-farm coordination and cooperation where the GM-farmer closely interacts with his neighbours or downstream enterprises such as Märka.

According to our definition, intra-farm coordination consists of three general components: 1) field allocation, 2) field size and 3) isolation distances. Regarding the first two measures the GM farmer can decide freely on whether to adopt them or not whereas the last option is already prescribed by law even if legally defined safety distances are still lacking. In our case study we observed that all farmers willingly kept distance requirements mainly in the form of buffer zones. In some cases, farmers also made use of field allocation to ensure even wider safety distances to organically farming neighbours.

Inter-farm coordination always directly involves the adjacent farmers. We define four components of inter-farm coordination: 1) information of neighbours, 2) adjustment of cultivation plans, 3) use of different (maize) varieties and finally 4) cooperation. Cooperation itself can be divided into three subgroups as suggested by Beckmann and Schleyer (2007): Cooperation can take place either in the form of a GMO-free zone, a GMO-zone or cooperation for coexistence as for instance the exchange of plots to ensure safety requirements.

In most cases, the GM-farmer informed at least directly affected neighbours about his intention to plant Bt-maize and about the location of the field. This took place on a semi-official basis since the actual GenTG did not require notification of neighbours at that time. However, notification was part of the Märka system in Brandenburg. In our case study we did neither observe the adjustment of cultivation plans nor the use of different varieties. We argue that inter-farm coordination is not generally necessary for the adjustment of cultivation plans. In northern Germany, maize can not be drilled until late spring because of the soil temperature. At that time, winter grain (wheat, barley, rye, and rape seed) has already germinated. At the time when the GM farmer has to make his registration in the cadastre he already notices which crop has been sown next to his Bt-maize stand. Thus, he can coordinate his planting without contacting his neighbours.

The adjustment of varieties seems to be only a theoretical solution for coexistence. First of all, it is accompanied with additional costs, ranging from 46 to 201 €/ha according to Messean et al. (2006). In Germany, only five different varieties of MON810 are approved for commercial cultivation. Two of them are medium early varieties (DKC 3421 YG and PR 39V17) and three are late maturing varieties (Kuratus, PR 38F71 and PR 39F56) (Bundessortenamt 2007). From this, we conclude that a GM farmer can only vary the flowering time within these two groups since no early maturing varieties are yet available on the market. This provides little scope for inter-farm coordination. Otherwise, the non-GM neighbour could make use of the different varieties of conventional maize and adjust his varieties for the sake of coexistence. None of the farmers we interviewed seriously took this form of coexistence into consideration.

The establishment of buffer zones or isolation distances can also cause additional costs to the GM farmer. The costs differ according to the width of the buffer zone and the size of the fields. The smaller the field the higher are the costs for the buffer zone (cf. Messean et al., 2006). In certain areas this can render cooperation for coexistence useful by changing plots to obtain larger fields. The average GM field size in our study was 36 ha and we therefore conclude that in our cases cooperation did not provide an incentive, because additional costs were not high enough. The results from our case study lead us to the overall conclusion, that under the given circumstances in Brandenburg, GM-farmers tend to prefer intra-farms coordination rather than inter-farm coordination or even cooperation. This is mainly due to the large farms with a still low percentage of GM-maize which can guarantee coexistence by intra-farm field coordination.

We also analysed how much the seed and grain trading company Märka contributed to coexistence in Brandenburg. The GM farmers as well as most of their neighbours were well informed about the Märka system. However, in 2006 neither of the adjacent farms made use of it. It has to be stated that in 2006, Märka was the only grain trading company in Germany which also took delivery of the Bt-maize harvest in case of grain maize. When it comes to coexistence, the impact of the Märka system should not be overstated. As already mentioned, the system only applies to the production of grain maize. Most of the farms we interviewed focused on the production of silo maize. Secondly, in the case of grain maize production, the adjacent maize must be below the labelling threshold to be bought by Märka. Otherwise, the maize is exempt from this specific regulation and has to be labelled as GM. However, as orally reported from Märka, there was no price difference between Bt grain maize and conventional grain maize if quality parameters were comparable.

Thus, we come to the conclusion, that Märka reduces liability costs not because it buys unlabelled neighbouring grain maize but because it pays the same prize for GM maize as well as for conventional maize (120€/t in 2006). Gene outcrossing would thus not result in an economic damage for neighbouring conventional farms.

V. CONCLUSION

In the course of the interviews it turned out that all GM farms were large farms. In Brandenburg, the average farm size is 200 ha (MLUV 2006). The GM farms reached from 500 ha up to 3,000 ha. In contrast, the shares of GM maize in relation to the farm sizes were still very small since 2006 was the first year of commercial cultivation. By arranging their GM-fields, the GM farmers preferred intra-farm rather than inter-farm cooperation to guarantee coexistence. Intra-farm coordination could be interpreted as a costs effective manner to comply with ex-ante regulations and ex-post liability rules in force. Beyond this, perceived low additional costs of ex-ante regulation and ex-post liability are the reasons why cooperation was not necessary at present time. One could now assume that incentives for cooperation are thus more distinct in areas dominated by small-scale farms as for instance in the federal state of Bavaria (Beckmann and Schleyer 2007). However, here hardly any Bt-maize cultivation takes place at all, even if maize is affected by the ECB.

Still, coordination and cooperation is very likely to gain more importance in the future. All GM farmers planned to expand their GM-maize production area. In the long run, this probably will render intra-farm coordination more expensive. However, GM maize will never account for 100% of the maize grown on the farm. Measures for resistance management prescribed by seed producers foresee a percentage of at least 20% of non GM maize (cf. KWS 2007).

The analysis was carried out under the regulative framework of the GenTG from 2006. As stated above, the Act did neither define specific distance requirements in the course of Good Agricultural Practice, nor was there the duty to inform the non-GM neighbour nor could a GM farmer and his neighbour decide on modifying distance requirements by private agreements. At the beginning of 2008, the German Genetic Engineering Act was again amended and the new act envisions detailed rules of coexistence management for the first time. Now, the GM farmer has to inform neighbouring farmers on planned GM cultivation. Furthermore, GM farmers have to coordinate their planting with their neighbours. The minimum distance requirement for Bt-maize are set at 150 m to conventional farms and 300 m to organic farms. These requirements can though be relaxed by private agreement. Inter-farm coordination is therefore expected to gain importance in the future.

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