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COEXISTENCE OF PLANTS AND COEXISTENCE OF FARMERS: IS AN INDIVIDUAL CHOICE POSSIBLE?

(Accepted in revised form April 19, 2008)

ABSTRACT. The introduction of genetically modified organisms (GMOs) in Europe has been characterized by controversy. In 2002, the European Union introduced the concept of “coexistence” as a compromise solution that, through the establishment of science-based technical measures, should allow the market to operate freely while reducing policy conflicts on GMOs. However, the concept remains highly contested and the technical measures difficult to apply. This paper presents qualitative research on the conceptualization and implementation of the coexistence framework in two regions of Spain (Catalonia and Aragon), where 42% and 55% of maize was GM in 2006, respectively. In this context, the concept of coexistence and its proposed implementation both fail to resolve previous conflicts and actually work to generate new ones through the individualization of choice and impacts. Considerations of the social conditions in which the technology and the management measures are implemented were not taken into account. This resulted in the promotion of biotechnological agriculture over other alternatives.

KEY WORDS: Coexistence, GMOs, liability, maize, organic agriculture, Spain

1. INTRODUCTION

The use of genetically modified organisms (GMOs) in Europe has generated a variety of policy responses that are under constant development. The concept of coexistence, which was first introduced in 2002 by the European Commission, has become one of the main topics of controversy. With a double objective, this policy framework aimed, on the one hand, to deal with the emerging concerns derived from the admixture between GM, conventional, and organic crops. This issue was especially relevant for organic producers, who are committed to a worldwide consensus not to use GMOs (IFOAM, 2002; Barth et al., 2002). On the other hand, the coexistence concept intended to lift the existing “de-facto” moratorium within the European Union on new commercial agro-food biotechnology applications because, as stated by Franz Fischler, the Commissioner responsible for agriculture, “no form of agriculture should be excluded in the EU” (European Commission, 2003a). As a compromise solution, the establishment of science-based technical measures to ensure coexistence had to allow

the market to operate freely, while reducing the policy conflicts on GMOs (Levidow and Boschert, 2007; Rodgers, 2007).

Accordingly, the European Commission issued non-binding guidelines on coexistence in July 2003, to be developed and implemented by the Member States. Coexistence was then defined as “the ability of farmers to make a practical choice between conventional, organic, and GM crop productions.” Demarked in the economic sphere, “co-existence thus concerns only the economic implications of GMO admixture, the measures to achieve sufficient segregation between GM and non-GM production and the costs of such measures” (European Commission, 2003b). Germany, Denmark, Portugal, and six of the Austrian Länder have adopted the coexistence guidelines into their legislation, while in the majority of other states only draft measures have been issued (European Commission, 2006a). Meanwhile, some Member States are requesting a European legal framework on coexistence, instead of developing National rules (Assembly of European Regions, 2005).

Since the concept was coined, a corpus of literature related to the issue of coexistence has emerged, including research papers, technical reports, and various conference proceedings. On the one hand, most of the studies regarding coexistence have dealt with the technical measures to ensure it. In that sense, the first report on coexistence appeared in 2002, as a summary on a conference organized by the German Federal Environmental Agency (Barth et al., 2002). In the same year, two other official reports were published (Bock et al., 2002; Eastham and Sweet, 2002). In the first, published by the European Environment Agency, the significance of pollen-mediated gene flow from six major crops was assessed. The results of the report showed difficulties to spatially isolate maize, oilseed rape, and sugar beet, advising the implementation of barrier crops, isolation distances, and information systems. The second report, conducted by the EC-Joint Research Centre, was launched after a call in the EC communication “Life Sciences and Biotechnology – A strategy for Europe” (European Commission, 2002). One of the main conclusions of this report was that coexistence was feasible but required adjustments in the current farm practices. The results were updated with the analysis of study cases (Messéan et al., 2006). For an overview of the European research on coexistence in the 6th Framework Programme, see European Commission (2006b).

The technical measures for ensuring coexistence have also been studied at the national level by Tolstrup et al. (2003) and Christey and Woodfield (2001), among others. Besides these general reports, agronomic aspects have been covered by using both spatial simulation models (Belcher et al., 2007) and field tests (e.g., for maize, see Henry et al., 2003; Ma et al., 2004; Devos et al., 2005; Messeguier et al., 2006; Bannert and Stamp 2007; Weber et al., 2007;

Langhof et al., 2008). The feasibility of GM crop containment has been discussed by Snow (2002), Haygood et al. (2004), and Marvier and Van Acker (2005), among others. Other technical perspectives include the economic (Smyth et al., 2002; Beckmann et al., 2006) and the liability analysis of coexistence (Koch, 2007; Rodgers, 2007).

On the other hand, a series of authors have highlighted the difficulties – or impossibility – of coexistence between organic and GM-based agriculture due to environmental, food safety, socio-economic, and ethical concerns. A clash of rationales at the technical (Müller, 2003; Altieri, 2005; Ponti, 2005) or conceptual level (Lyson, 2002; Levidow and Boschert, 2007; Verhoog, 2007; McAfee, 2008) is alleged, arguing for the declaration of GMO-free regions (Schermer and Hoppichler, 2004; Jank et al., 2007). In these studies, organic agriculture is usually understood not only in terms of input substitution, but also as a de-intensified and re-localized sustainable development model associated with a peasant and family farming view. This conceptualization has also been named “agroecology,” “civic agriculture,” or “alternative agriculture,” depending on the emphasis or cultural context.

Most of these studies were conducted *ex-ante*, based on modeling and experimental cases, or were done at the theoretical level due to the lack of commercial fields in most European countries. The objective of this paper is to discuss the concept of coexistence in regard to its objectives: as a policy frame that aims to avoid conflicts by allowing the free market to operate. This is done by analyzing the conceptualization and implementation of “coexistence” in Catalonia and Aragon (NE of Spain) where 23,000 and 35,900 ha of GM maize were planted respectively, during 2007. The results of this unique experience in Europe are especially relevant for the European Commission’s assessment of the implementation of coexistence, which will be reviewed during 2008.

The paper is organized as follows. First, I shall explain the methodology used for conducting the study. Next, the research is contextualized by introducing the dynamics of the maize sector in the areas of study. An overview on the legislative proposals at the Spanish and Catalan level to manage the coexistence is also done. The following section analyses how the concept of coexistence is conceived by different stakeholders, and discusses the feasibility and implications of these different conceptualizations, focusing on the technical measures to ensure coexistence and the liability scheme. Finally, the objectives of the coexistence framework are discussed in light of these results.

2. METHODOLOGY

The results presented in this paper are part of on-going research that started in 2002, using discourse analysis and qualitative techniques to elicit

stakeholders' points of view and practices. The choice of topic is due to the author's pre-existing interest in the debate on the introduction of agrobiotechnology in Spain, where I have taken part as a research scholar and as a member of the agroecological movement in Catalonia. This involvement, both as an activist and an academic, has allowed me to gain better access to the informants and the information through the fieldwork and literature review. At the same time, this has given me the opportunity to discuss the progress and results of the research in both arenas, and personal involvement has not been too strong to allow fruitful discussions and interviews with stakeholders on all sides of the political lines of conflict. My investigations have been conducted using an action research approach, trying to articulate practical and action-oriented outcomes with reflection on participative, inclusive, and grounded in experience forms of understanding (Reason and Bradbury, 2001). They have been driven by the intention to make visible a situation that is not fully recognized. The research is, on one hand, focused on the analysis of how the admixture of GM with non-GM crops is framed by the different groups of stakeholders. In order to draw out the different frames, I use a discourse analysis approach. This approach has been widely used for analyzing environmental conflicts in general (Hajer, 1995) and also for controversies over biotechnology (Heller, 2002, 2006; Levidow and Boschert, 2007; Levidow and Carr, 2007). Discourse is here defined as a way to understand a shared system of knowledge or belief and the social practices in which it is produced through which meaning is given to the world (Hajer, 1995, p. 44).

On the other hand, the stakeholders' practices and experiences in their daily life are highlighted, not only focusing on their world as "thought," but also as "lived." For doing so, qualitative research techniques were used, by means of group and individual in-depth interviews and participant observation, which also included the attendance at workshops and local and international conferences. Interviews targeted two groups of stakeholders. The first group included 22 farmers (eight farmers sowing both GM and conventional maize, nine cultivating conventional maize, and eight organic farmers), eight technicians or managers of cooperatives in the maize sector and two purchasing managers for starch and glucose companies, which establish their own segregation systems in order to be provided with non-GM maize. The second group was composed of stakeholders related to the debate on coexistence at the policy level. It included 19 semi-structured and three in-depth interviews. Stakeholders were selected among politicians and public administrators, representatives from agricultural unions, consumers' organizations, environmental and development NGOs, biotechnologists and experts on the organic agriculture sector. Thirty-one of the interviews were recorded (with audio or video), transcribed and sent back to participants for

review. The rest, 23, were recorded with field notes, as the informants did not wish to be audio recorded. All informants were interviewed in their workplace or house, which included visits to the farmers' fields and cooperatives. The objective was to contextualize the research activities while providing a comfortable environment for those participating in the interviews (Kvale, 1996).

Research involved an interactive play between the qualitative database and the background theory. A literature review compiled European Commission official press releases and communications, legislative documents, papers, and technical reports as well as other types of documents (press releases, statements, pamphlets, and web pages) produced by other stakeholders. Other secondary sources have included results of different research projects, scientific meetings, and round tables conducted at the European and national level.

3. THE MAIZE SECTOR IN CATALONIA AND ARAGON

In spite of the *de facto* moratoria in other European countries, introduction of GM maize in Spain started in 1998. The available GM varieties have grown from the initial 16 to 61 in 2007. All the current varieties derive from the GM maize event Mon810 modified to be resistant to the corn borer. The rate of farmers' adoption and hectares under GM maize cultivation have arisen according to this increasing number of registered GM maize varieties, although with a very heterogeneous distribution. Data from the Ministry of Agriculture, extrapolated from the seed companies sales, report 75,000 ha of GM maize in 2007 (MAPA, 2007), 14.5% of the total grain maize area.

Around 85% of the maize in Spain is used for feed production (Demont and Tollens, 2004). With an overall production of 5 million tones of maize, Spain also imports around 2 million tones of Brazilian, USA, and Argentinean maize, presumed to largely be GM maize (European Commission, 2005). Moreover, standard feed contains around 20% of soy, 98.7% GM following the estimates of the Ministry of Agriculture. As a consequence, almost all the manufactured feed in Spain is labeled as containing GMOs (Ortega, 2006).

This study was undertaken in Catalonia and Aragon, the areas with the highest concentration of GM maize adoption. This percentage was 55% and 42% in 2006, respectively (Ortega, 2006). In both regions, maize production and the fabrication of feed and fodder are key agricultural activities, mainly related to the meat industry (Badía Roig et al., 2001). Although the area allocated to crops remains stable, the number of holdings is decreasing due to land concentration. Despite this, the average size of farms remains small

(5.45 ha in Catalonia, while in Aragon the average is 7 ha in the case of grain and 30 ha for forage maize) and it is highly fragmented (IAEST, 2007). Prices received by maize farmers have been constant or slightly decreasing during the last 15 years (around 0.13 €/kg) (MAPA, 2007). There is no price differentiation between GM and conventional maize. In the case of organic maize, it is sold by organic farmers at a higher price, 0.21 €/kg (interviews with organic farmers).

The maize production process is integrated in cereal cooperatives, which cover the entire production chain. This vertical integration often includes also the meat production (e.g., in the pig sector). The farmer – called “integrator” – then becomes like a wage-earning worker (Langreo Navarro and González del Barrio, 2007). Cooperatives sell the inputs (seeds, fertilizers, herbicides) and lease the machinery to the farmers and process (e.g., drying) and sell the product. Often they also grant credits to the farmers during the season, which are then subtracted from the money received after the grain is dried in the cooperative (interviews with cooperative managers). Through this process, the manager or technician of the cooperative, who also provides the technical advice, becomes a key actor in the introduction of new technologies at the local level. This structure implies the concentration of infrastructures, which also makes it difficult and expensive to segregate GM production from organic and conventional during the production chain. There are no specific silos for organic maize while only a minority of the cooperatives in the region restrict the use of GMOs.

At the same time, organic agriculture is also in expansion, increasing in the number of producers, manufacturers, and hectares (926,400 ha were reported in 2006 by the Spanish Ministry of Agriculture). Most of the production is exported to other European countries. There are no official data on the surface planted with organic maize. However, a frequently used approximation was made by Brookes and Barfoot (2003), who estimated the area of organic maize in Spain to 1,000 ha. In 2002, the area sown with organic maize in Catalonia and Aragon was 90 and 120 ha, respectively. This area has not grown, for reasons explained in this paper.

4. LEGISLATIVE PROPOSALS FOR COEXISTENCE

Up to four preliminary documents on the implementation of coexistence have been released by the Spanish administrations since 2004. However, they have been highly contested by agrarian and environmental organizations. No agreement has been reached so far. Instead, some guidelines on good practices for cultivating GM maize have been promoted by the seed producers association (APROSE, 2006). In parallel, Catalonia, one of the

Spanish regions with a high degree of autonomy, is developing its own coexistence legislation, although the proposals have yet to be approved. Together with the call to regulate coexistence, the Catalan Parliament (2004) urged the creation of a “GMO-free” quality trademark, but neither has been implemented.

While in some European countries, participatory processes were held before GM crops introduction (Gaskell et al., 2003; Schlöpfer, 2007), in Spain the situation was different, and public participation was almost non-existent during their sow in the fields. This could be grounded in the low level of public awareness in relation to environmental problems in Spain, a short tradition of participation and a high scientific and technical optimism (Todt, 1999). However, the discussion has been opened within the framework of negotiations on coexistence legislations. This development was mainly due to environmentalists, farmer associations, and activist groups, with a highly confronting discourse. It seems fair to say that it has been difficult to establish a real, transparent dialogue between the stakeholders.

5. HOW IS COEXISTENCE CONCEIVED AND IMPLEMENTED?

In this section, the conceptualization and implementation of the coexistence framework is analyzed for the case of Catalonia and Aragon. I shall first discuss how the concept of coexistence is conceived by different stakeholders. This is connected to a dissimilar assessment of the potential impacts that should be incorporated in the framework. Following this, the proposed technical measures for coexistence and for the liability and redress scheme are analyzed in terms of feasibility and implications.

5.1. *The Concept of Coexistence*

The analysis of the existing approaches for coexistence in the case study reveals two conflicting rationales. One group of actors attach themselves to the Commissions’ definition of coexistence, as the farmers’ right to choose the type of crop production (European Commission, 2003a; 2003b). A clear distinction is made between the economic aspects of coexistence and the environmental and health aspects, assuming the latter to be sufficiently addressed by Directive 2001/18/EC. Coexistence is framed as the requirement of some economic agents for maintaining the economic added value of their production (AGPME and EFEagro, 2006). The object of the discussion is then how to design the science-based technical measures to minimize the derived costs of segregation in a proportionate manner at the farm level.

For another group of stakeholders, the concept of coexistence was introduced to force the end of the moratoria, following the exigencies of the

World Trade Organization. This was done by developing a series of technical measures to deal with the introduction of GMOs as a matter of fact, without a discussion of the underlying purpose and bypassing the political conflicts around it. This perspective, shifting the focus from farmers' right to choose to consumers' rights (e.g., European Parliament, 2003), challenges the compatibility of GM with organic agricultural systems and promotes, for instance, the creation of European GMO-free zones or regions. Delimitations between economic, social, environmental, safety, and ethical aspects are blurred. As it will be discussed in the next section, different conceptions of biotechnology and its implications lie behind the two described frames.

5.2. *What is at Stake? The Notion of Genetic Contamination*

The opponents of GM technology consider so-called genetic contamination as a major threat to organic agricultural systems and biodiversity. "Contamination" here refers to the unwanted process that transgenes from GM crops move to other organisms and become established in natural or agricultural ecosystems (McAfee, 2003; Walters, 2004; Binimelis, 2005; Verhoog, 2007). It is argued that this admixture has agronomic, environmental, and socio-economic implications, raising concerns for food safety, consumers' rights or the integrity of organic and conventional agriculture and the seed system. Appealing to the irreversibility of the process, the technology is described as involving a high level of uncertainty.

Although the concept can be applied to admixtures both with organic and conventional crops, the discussion is more vivid regarding organic agriculture, as most organic farmers and consumers reject the presence of GM traces in organic products. There are several reasons behind this. As stated by organic farmers, for many of them, organic agriculture is not only a way of producing, but a way of living, in contrast to intensive agriculture. GM technology is judged as uncertain, and a step forward in the intensification of the agricultural industrial model to the detriment of small farmers and the local control of resources. For instance, an organic farmer in the north of Catalonia decided to burn his harvest after it was found to contain GMOs, refusing to place in the market a product that he considered risky and damaging to local agriculture (organic maize farmer, interview). Another central point of the discussion has been the role played by GMOs in the erosion of agrobiodiversity, especially linked with the non-hybrid varieties. The issue became essential after GM contamination was found in the red-colored non-hybrid variety "embrilla," which had been conserved by an organic farmer in Aragon for 15 years, after it had almost disappeared (Asamblea Pagesa et al., 2006). In Catalonia, contamination was also found in the variety "queixal" in the private Center of Biodiversity

Conservation “Esporus.” Moreover, it is argued that the right of organic agriculture to remain GMO-free and the right of organic consumers to choose are seriously compromised. Traceability and labeling are judged as impracticable as GMO contamination grows. To sum up, the arguments are made explicit by the following statement from an interview with an organic farmer: “*Why do we need to have GMOs if this technology creates uncertainties, contamination, homogenizes agrarian cultures, the consequences concerning health effects are not clear enough and there are huge questions related to ethical issues? What do we need them for? If there is a food crisis, why not opt for more sustainable approaches?*”

These arguments confront the discourse of proponents of GMOs, who argue that GMOs do not differ substantially from conventional varieties and, as GM crops undergo a risk assessment process, they have been proven to be even safer than the conventional varieties. There is also a distinction between issues evaluated by the risk assessment process (mainly environmental, human, and animal health) and those aspects that relate to social or ethical concerns, which remain outside the sphere of the decision-making. From that point of view, the concept of contamination should be rejected as tendentious, implying that GMOs are inferior. Indeed, the potential contribution of GMOs to sustainability is highlighted: “*the problem with organic agriculture, its direct confrontation with the biotechnological one is its own positioning for not accepting genetic modifications as valid for its production. However, to have a plant resistant to insects which in the future could be capable of not needing water for irrigation would be the paradigm of organic agriculture*” (biotech company representative, interview). The argument of biodiversity erosion is also challenged: “*We are opening the possibility of biodiversity, we are putting in the hands of farmers many more varieties... the only thing we are doing is, in some varieties, to add resistance to an organism that can destroy them directly. Therefore, the discourse “with the GMOs we are diminishing the biodiversity” is very difficult to explain to us, as we are seeing it, more varieties are grown all the time*” (biotech company representative). The argument of the consumer’s right to choose is also used for justifying the introduction of GMOs.

5.3. Technical Measures for Coexistence

These divergent approaches to coexistence have emerged throughout the discussion of the technical measures for ensuring it. Such measures were meant by the EC to be cost-effective and proportionate (European Commission, 2003b), but disagreement exists on what the objective is. While for one group the proposed technical measures would mean a disproportionate burden for GMOs, the other group of stakeholders faced a dilemma:

whereas these measures are seen as the ultimate instrument for imposing a non desired agricultural model, the opposition to the coexistence measures leads to a complete lack of regulation of the situation. Accordingly, strategies varied from direct opposition to the coexistence concept, to the request for the strictest measures possible.

Following Regulation (EC) no. 1830/2003, a product has to be labeled as genetically modified if the GM content, assumed to be fortuitous, exceeds 0.9% in any of its ingredients. This practical threshold is established as a convention, so that no economic loss should be suffered by the organic or conventional farmer in case of an accidental admixture. The thresholds for the presence of GM material in seeds have not been established. The labeling norm is seen by proponents of biotechnology and conventional farmers and technicians as a safety buffer to ensure coexistence and minimize derived economic costs. On the contrary, organic farmers and consumers in Spain defend the integrity of organic products as 100% GMO-free – or below the detection level – for the final consumer, even the Council of Agriculture Ministers has recently voted for allowing the same adventitious threshold in organic than conventional products (0.9%) (European Commission, 2007). In that sense, it is stated that if the norms for ensuring coexistence are designed at aiming to achieve a 0.9% threshold, this will become not an accidental threshold but a normal one. There is also a questioning of the cost and significance of this threshold. If GMOs are framed as a technology with uncertain outcomes, what is the difference between 0.9% and 1 or 0.8%?

This discussion links with the debate on the objective of the technical measures. Is it to procure an admixture as low as possible? Or is it to achieve a level that reduces economic costs of admixture? Although the admixture can be produced at the different steps of the production chain (European Commission, 2001), and the draft legislation considers a series of measures (e.g., crop planning or pollen traps) in this paper I will focus on the debate on isolation distances, as they have received most attention. Only one of the informants, a farmer who grows GMOs, negated the possibility of pollen transfer between GM and conventional and organic fields. All the rest accept that this transfer is produced in natural conditions as a matter of fact.

The proposed legislation for coexistence in Spain has gone through the incorporation of various different isolation distances for the case of maize. While in the first drafts, isolation distances were settled at 25 m aiming at not exceeding 0.9% of admixture, social opposition provoked the extension of the prescriptive distances up to 50 m in the last proposal in Catalonia. Meanwhile, the draft legislation for coexistence from the Spanish government suggested the isolation distance at 200 m. However, this is still disliked

by many of the stakeholders. As stated above, some push for returning to smaller isolation distances. On the other side, the opponents of GMOs approve of the increased distances, although they still believe them to be insufficient, especially if the aim is to minimize admixture. Proposals range from 500–800 m (main agrarian union) to km (organic farmers and technicians following the rules for plant breeding). Consistent with the two positions, a literature review reveals that recommended isolation distances for maize vary from 25 m up to 10 km, depending on the author and the final admixture threshold permitted (Barth et al., 2002; Müller, 2003; Devos et al., 2005; Messeguier et al., 2006; van de Wiel and Lotz, 2006; Bannert and Stamp, 2007).

The feasibility of implementing isolation distances in the regions, where the size of the plots is small, is also discussed by stakeholders, especially in Catalonia. In this respect, some of the informants see the creation of either GM or conventional and organic homogeneous regions as the only way for observing the rule. This would mean that farmers at a regional scale would need to agree and decide jointly the type of agriculture to be developed, creating a buffer zone around the area to prevent contamination [the strategy is also known as “landscape clubs” (Furtan et al., 2007)]. This is to some extent already happening, since, for instance, starch and glucose companies only buy maize in large areas, often outside the two studied regions, where farmers agree to not using GMOs. These voluntary agreements are, in fact, recommended by the EC guidelines on coexistence. The implications of these agreements, which are also necessary for other proposed measures such as crop planning to avoid flowering coincidence or segregation in later steps of production, will be discussed in the next section.

5.4. *The Social Dimensions of Liability*

Several challenges arise from a forensic view of liability in case admixture takes place, from the quantification of costs and damages to the practical aspects for claiming compensation. In this section, I will analyze the implications of the liability frame regarded in the coexistence proposals.

As discussed above, the coexistence project is constrained within the economic aspects derived from the admixture of GM and non-GM crops. In that sense, only economic damages are addressed by the framework, especially focusing on the variations in economic profit due to the impact of labeling obligation. Other socio-economic non-marketable goods, more difficult to quantify or incommensurable, such as the loss of trust among consumers [as proposed by the European Parliament (2003)] or the admixture of GM maize with a local variety, are not included. By doing so,

liability is focused on the individual economic aspects of the issue, while individual and collective concerns at a social and environmental level are left aside.¹

The trend toward individualization of the liability and redress scheme is also promoted by the coexistence framework regarding the resolution of disputes. In Spain, for instance, individual affected farmers suing for compensation would be obliged to identify the farmer responsible for the contamination and to prove their culpability and the resulting damage, following civil law. Actually, when the first cases of unwanted admixture were reported, it was seen that the whole process was hampered by technical difficulties. Pollen dispersal declines exponentially with distance from source, but often has long “tails” showing that low levels of pollen can disperse over long distances, which might be of concern in case of zero tolerance for organic growers.

Concentration of pollen is then a function of distance but dispersal is not uniform. As the figure depends on the size of the field, measurement of admixture has been heavily contested, especially in the absence of a consensus sampling protocol. Other technical difficulties for the quantification of the content of GM material in on-farm samples cannot be disregarded (Devos et al., 2005). The point can be clearly illustrated by the case that occurred in 2006 in the north of Catalonia, in which an organic maize was found to have up to 12.6% of GM material. This first analysis, performed by the organic production certification body was then contrasted by two other analyses by the Catalan agriculture department and a farmers’ union resulting in 0.9% and 6%, respectively (public administrator, interview). In view of such disparate results, some stakeholders have accused the farmer of setting up a farce (biotechnologist, interview). Other cases resulted in positive or negative results depending on the sampling and/or the analytical method. The small size of the farms brings along other technical constraints, as it is not easy to establish direct causality, especially if the rate of GM adoption is high in a region. As a consequence, the affected farmers would have to sue all the neighbors who are potentially able to cause the admixture. A prerequisite for claiming this causality is that farmers, who do not grow GMOs, have at their disposal the information on where GM crops are sown. Although legally since 2006 this information must be stated when filling the CAP declaration, the information is not publicly available. In case

¹ The European Environmental Liability Directive (2004/35/CE), includes remediation at the polluter’s expense for environmental and biodiversity damage arising from GMOs releases. However, it has several limitations for the application to cases of admixture between GM and non-GM crops. Activities that were not considered harmful when released or have been authorized are exempt from liability (Khoury and Smyth, 2007; Rodgers, 2007).

the neighbors have observed the prescribed measures, it is not clear who will bear the responsibility.

On the other hand, fieldwork has highlighted that social conditions can become critical in order to establish working liability frameworks. For analyzing that aspect, it is important to understand the conditions in which the technology has been introduced and how it has been done. Most interviewed stakeholders agree when listing the reasons behind the introduction of GMOs in Spain, in spite of the de facto moratoria operating in the other European countries. The main explanation is the political alliance of the former right-wing Aznar government (1996–2003) with the neoliberal governments in the United States and United Kingdom by the time that GMOs were first introduced. Other related explanations are the permissive character of the Spanish administration, the power of agribusiness companies, which in fact are in charge of rural extension, and a low environmental awareness compared to other European countries, which impeded a social debate on the issue.

In regard to the adoption of GMOs, farmers growing them highlight the advantages of this technology for the farm management. It is in a way compared to having insurance, as the farmer can be sure that less grain will be left in the field because the borer will not break or bend the plants. Moreover, most of the stakeholders point out big pressures from the seed companies to introduce and promote GMOs. Public support for rural technological transfer has been diminished in recent years, leaving most of the load to private companies. Agribusiness companies are, in fact, either directly or indirectly through the cooperative technicians, recognized as the leaders of rural extension.

This social pressure for introducing biotechnology, however, does not only come from the companies. Modernization is considered a driver for economic progress and being an entrepreneur is a shared social value. It can be illustrated by a statement from a farmer growing GMOs, who was initially reluctant to do it: *“In the town most of the people say good things [about GMOS], they do not speak badly, on the contrary. They said I was stupid for not planting GMOs in the last two years.”* This preference towards modernization and technification was also shared by a cooperative technician, when explaining the change in the use of GM varieties: *“Pioneer is now selling the most because the Syngenta gene is old and people always want the latest [technology].”*

The tension between the productivist agricultural model and a more environmental farming practice is framed as a traditional confrontation between ecologists and farmers in Spain, which remains and is more polarized in areas with intensive farming, as in the area of study. A similar conclusion was reached by Hoggart and Paniagua (2001), who have documented the resistance towards a more environmentally friendly agriculture in Spain in

favor of intensification, backed by a lack of agro-environmental legislation until recently (Paniagua, 2001). Organic farming is a locally marginalized agriculture. In that sense, lack of social support becomes the main obstacle for young farmers who want to practice organic agriculture, especially those coming from a rural background (interviews with organic farmers). Organic farming is, for some farmers, a shameful practice, as can be glimpsed in the statement made by a farmer growing conventional maize when explaining his intentions to plant organic maize: *"I will sow organic maize next year but in a hidden plot where nobody sees me, otherwise they will laugh at me"* (interview). Another illustrative example links with the perception of nature and ecosystem functioning and the role played by the farmer. During the field visits, farmers growing GMOs repeatedly referred to the ones growing organic as careless, dirty, and untidy because weeds can easily be seen in their fields. A completely different position is held by organic farmers, who perceive the use of synthetic herbicides as highly polluting, and, therefore, as a negligent practice.

This situation and the way in which GM technology is introduced are critical elements shaping the cases of disagreements among farmers. On the one hand, disagreement exists in regard to the responsibilities of farmers sowing GMOs. These are presented as relying on the technicians and on a product that has been authorized. On the other hand, the liability scheme is perceived as transferring the problem to the organic farmers. As a result, many farmers are reluctant to publicly report cases of contamination in a context where there is a need for social cohesion, as in small villages. One organic farmer said: *"as a consequence of social pressure, when farmers suffer contamination, they do not want to say so. Last year there were 4 contamination cases and 2 made it public but 2 did not. For fear of confronting the people in the town... so they have to assume the economic cost, the environmental cost, and the cost of losing the organic certification but they do not say so"* (interview). Consequently, data on admixture cases are not systematically registered, although the organic certification is withdrawn in these cases. This was the situation in Aragon in 2004, when all the analyzed samples (representing around 200 ha) gave a positive result for presence of GMOs. Moreover, many organic farmers growing maize have already shifted the crop as they wish to avoid direct confrontations with their neighbors: *"I would never do this [bring a neighbor into court]. My neighbor is not my enemy. He is my colleague, from the school, we did communion together (...) We are a small community and we have a community life. He is my friend. I cannot say anything. He is trying to survive and he does what he can. I prefer to give up with agriculture than having bad relations"* (interview).

As a result, from 2004 (when the first analyses were done) to 2007, the area devoted to organic maize was reduced by 75% in Aragon (organic

certification body representative, interview). For the case of Catalonia, the surface decreased by 5% from 2002 to 2005 (Morán, 2006). The trend was confirmed by the organic certification body for the following years. Informants within the organic sector have corroborated the difficulty in obtaining local organic maize. In spite of this, some other stakeholders stated that no problem has been observed after 8 years of GM agriculture (AGPME and EFEagro, 2006).²

6. DISCUSSION

The conflicts that have arisen from agricultural biotechnology in Europe can be seen as a struggle between confronting frames of interpretation. Against this background, the coexistence concept was introduced as a compromise solution to handle the introduction of GMOs in Europe by way of the implementation of technical measures based on purported scientific criteria (European Commission, 2003b). In the case of Spain, it is worth noting that this aspect was emphasized in the Catalan proposals as “strictly scientific criteria.” By doing so, the problem is demarked as a technological fix, in which the ethical, social, political, and environmental aspects are reduced to a quantitative “objective” regulatory setting, which can be managed without the participation of those primarily affected. However, quantification is also a form of making decisions (Porter, 1995). Moreover, the mainstream frame excludes other rationales and criteria, such as food quality, farmer autonomy, or the integrity of organic agriculture (Heller, 2002) that cannot be easily quantified. The specific coexistence proposals in Spain are thus favoring some agendas over others, confirming suspicions in the context of other European countries by Levidow and Boschert (2007). Moreover, science is presented as an autonomous entity of society, objective and neutral, but also as a homogeneous body. These concepts have been widely discussed for the case of agricultural biotechnology, covering issues such as the lay-expert divide in the perception and management of risks (Wynne, 2001), the failure of the science-based risk-assessment procedure to incorporate societal concerns (Carr and Levidow, 2000; McAfee, 2003; Sarewitz, 2004) and the legitimacy of science-based regulations (Levidow and Marris, 2001). A low consensus on the scientific issues and the analytical methods to be applied is also found among scientists (Busch et al., 2004; Myhr, 2005), depending for instance on their work context and background (Kvakkestad et al., 2007).

² Isabel García Tejerina, the former Agriculture General Secretary, during the presentation of the National Commission of Biovigilance, declared that “after 6 years of real experience, there has not been any case of contamination” (EFEAgro, 2004), although some official cases had been already published and discussed in the sessions of the National Biosafety Commission (2002), as it is reflected in its proceedings.

The case study shows that these concerns are handled as if they were a matter of private choice, which can be solved (compensated) by market mechanisms. In this case on the one hand, the wider debate on the acceptability or necessity of GMOs is dumped on the individual sphere as if farmers are in charge of deciding what they want to cultivate (Devos et al., 2008). On the other hand, liability based on civil law is focused on monetary compensation, it supports the individualization of the problem and leaving aside social and environmental conditions and effects (McLeod-Kilmurray, 2007). As it has been shown by the fieldwork, it seems that previously unsolved framing conflicts are pervasive in the coexistence concept, while new ones are enhanced. Considerations of the social conditions in which the technology and the management measures are implemented, and to what degree they will be observed, were not taken into account. Problems in establishing causation and dispute-solving mechanisms have resulted in the promotion of a biotechnological agriculture over an organic one.

ACKNOWLEDGMENTS

I wish to thank Roger Strand, Fern Wickson, and Kamilla Kjølberg at the Centre for the Study of the Sciences and the Humanities (SVT) in Bergen, Iliana Monterroso at FLACSO-Guatemala, and Joan Martínez Alier and Nicolas Kosoy at the Autonomous University of Barcelona for their helpful comments on a previous version of this article. The Research Council of Norway and the FP6 project ALARM (GOCECT-2003-506675) have partially funded this research. I am particularly grateful to all the stakeholders who actively collaborated in the research process.

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