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INDUSTRY CONSOLIDATION, PUBLIC ATTITUDE AND THE FUTURE OF PLANT BIOTECHNOLOGY IN EUROPE

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In this paper, we summarize the evolution of the plant biotechnology industry in Europe and discuss relevant competitive issues. We also comment on the rise of public opposition to the use of genetically modified organisms (GMOs) in agriculture in Europe, and conclude by highlighting key aspects of the emerging European policy on GMOs, and its political economy.

Key words: genetically modified organisms (GMOs); European consolidation; public attitude

Since 1994, the seed industry has experienced major changes. With the commercialization of the first transgenic plants in the United States (U.S.), this industry has been characterized by structural changes (mergers and take-overs) which, although not new, now correspond to a profound consolidation process. A few "mega-firms", which combine capabilities in biotechnology, agrochemicals, and seeds, are emerging. These mega-firms are now competing in a new race: the race of plant genomics, which should allow them to gain rapid access to genetic information on the qualitative or agronomic traits of cultivated plants; and allow them to secure their research and development (R&D) investments through patents.

Meanwhile, the European Union (EU) member states are the scene of growing opposition to the use of genetically modified organisms (GMOs) in agriculture and food. By the end of October 1998, five of the EU member States -- Austria, France, Greece, Luxembourg, and the United Kingdom (UK) -- had imposed either specific bans, or some form of moratorium on genetically modified plants.

In this context, public authorities are trying to define a new policy to balance the economic (and competitive) stakes associated with plant biotechnology on one the hand, and public attitudes on the other. The current strategy of European policymakers is to focus on the definition of a "European way of using GMOs" which would allow them to balance public concerns with the economic development benefits associated with plant biotechnology. To some extent, such a strategy transfers the issue of plant biotechnology on to the scene of European agricultural policy.

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Plant Biotechnology And Seed Industry Consolidation: What Are The Stakes For Europe?

The recent and profound changes in the seed industry are well known. Here, we outline some of the key events that facilitate an understanding of the new trends and current strategic stakes in the seed industry[1]. The latest consolidation wave began with the decision of Monsanto to take over DeKalb in 1996. Indeed, this strategic change (i.e., having a presence in the seed industry rather than just being a "gene provider") was followed by many partnerships, mergers, and take-overs (Table 1). Some of these changes are not only specific to the seed industry but to the on-going restructuring of the pharmaceutical industry. This is obviously the case for the creation of Novartis, the new life sciences giant based in Basel, Switzerland. Two on-going mergers also correspond to this same logic. The first merger between Rhône-Poulenc (based in France) and Hoechst (based in Germany) was announced in November 1998. This merger should lead to the creation of a new industrial cluster named Aventis, although whether AgrEvo will be part of this deal is not yet clear since Schering had not given its agreement. The second combination is the take-over of Zeneca, the UK life science leader, by Astra (a pharmaceutical company based in the Netherlands), which raises questions about the future of the plant science part of this business.

Table 1. A Selection Of Mergers And Take-Overs In The Seed Industry

Monsanto		
• Agracetus	United States	(US $150 Million)
• Asgrow	United States	(US $220 Million)
• DeKalb	United States	(US $3,700 Million)
• Holdens	United States	(US $1,200 Million)
• Calgene	United States	(US $60 Million)
• Agroceres (Br)	Brazil	
• Delta & Pine Land Co.	United States	(US $1,900 Million)
• Plant Breeding Institute	United Kingdom	(US $525 Million)
Agrevo (Hoechst+Schering)		
• Plant Genetic Systems	Belgium	(US $525 Million)
• Kws (20%)	Germany	
Novartis (Sandoz+Ciba Geigy)		
• Benoist	France	
• Maisadour	France	
Dow Elanco (Dow Chemical+Eli Lilly)		
• Mycogen	United States	
Du Pont		
• Pioneer (20%)	United States	(US $1,700 Million)
Zeneca-Advanta		
• Mogen Intl	The Netherlands	
Source : INRA/SERD database.		

With these changes a new structure is now emerging in the plant science area. Mega-firms now have global targets in the seed and agrochemical markets. These firms expect to realize annual sales in the range of US$5 to US$10 billion. These sales would allow the firms to invest more than US$500

million in research and development (R&D). In comparison, Pioneer, the global leader in the seed market, has an annual turnover of US$1.7 billion and invests US$136 million in R&D.

The on-going restructuring in the seed industry is also closely linked to the technological strategies of these firms with respect to genomics. Genomics is based on new powerful tools that allow for the rapid identification of genes of high economic interest. Gene sequencing, gene mapping, molecular probes, bio-informatics, and deoxyribonucleic acid (DNA) chips are all tools that fall under the rubric of genomics. Companies like Monsanto, Du Pont de Nemours, and Novartis have set up genomic networks with academic research institutes and start-up firms. These partnerships are mainly in the plant science area, but have also been formed with human genomics start-ups. The mega-firms are investing hundreds of millions of dollars a year in these partnerships. The rapid identification of genes is already underway through technological strategies like: the sequencing of expressed sequence tags (ESTs) of complementary DNA (c-DNA), the creation of insertional mutant collections, and differential expression observation. These technological strategies allow firms to meet the necessary requirements in order to apply for patents and to protect the main genes of interest. This investment may also have major effects in the area of plant science, since such research will likely yield strategic tools and new biological material that will enhance fundamental knowledge.

If these technological developments materialize, the European research/industry system could find itself in a very bad position within the next ten years. This potential problem is more serious than the current lag in the utilization of the first generation of transgenic plants. If we take into account the cumulative effects of technological innovation, the future capabilities in plant science may well be located in the U.S.

Facing such a threat, major French players are attempting to react and federate their strengths. In 1997, the two most important French seed companies -- Limagrain and Coop de Pau -- created a joint-venture (Biogemma) thereby consolidating the potential of their R&D in biotechnology (Assouline *et al*., 1998). At the time, these firms clearly presented their initiative as the "French reaction to the global stake of plant biotechnology." Since then, the two firms have continued to lobby decision makers to implement a national program on genomics. Referring to the American "plant genome initiative" they have sought an equivalent program for France. They have continued to argue that the European seed industry is now jeopardized by the widening gap between American and European research in the field of biotechnology.

Closing the technological gap between Europe and America is the strategic mandate of the GénoPlante[1]. The scientific purpose of GénoPlante is to acquire the necessary fundamental and applied knowledge of plant functional genomics, including bio-informatics. The initial focus has been placed on rice and Arabidopsis, two plants that have been widely investigated by the Institut National de la Recherche Agronomique (INRA). Meanwhile, private laboratories will turn to research on colza, corn, and wheat; plants that are widely cultivated in France. Intellectual property rights (IPRs) to this research will need to be obtained through patents. The initiative to obtain IPRs in genomics research must be nationally speeded up.

The objective of GénoPlante is to co-ordinate the activities of the main French organizations involved in the plant sciences. These organizations are both public research institutes (INRA, CIRAD, ORSTOM, CNRS) and private actors (Biogemma and Rhône-Poulenc). The total budget of GénoPlante could be up to US$200 million for a period of five years; one third of which will come from industry. One of the conditions of the project, which has been accepted by the different partners, is that access is provided to small and medium enterprises which still have an important role in the French seed industry. If the first step (co-ordination at the French level) is a success, the next step may involve implementing the project at the European level.

The Rise Of Public Opposition To Transgenic Plants: Origins And Implications

Outside of very specialized forums, the perception of transgenic plants, their risks, and their interests, is very different. Extensive surveys document this point well. Hoban's comparative analysis shows differences between the U.S. and European public (Hoban, 1996). Furthermore, Eurobarometer clearly demonstrates two basic points (INRA, 1997) which are as follows:

- Attitudes toward biotechnology are significantly different from one type of application to another. They are positive for human therapeutics but generally negative for food applications.

- Negative attitudes are not only due to perceived risks, but also due to the perceived lack of utility from agro-biotechnology innovations.

Such survey results are also confirmed by qualitative analysis based on focus groups (Grove-White *et al*., 1997). Our own ongoing analysis leads us to propose an explanation of the opposition to transgenic plants, which, without forgetting the relevant socio-cultural factors, focuses on the following complementary elements:

- *The rise of opposition is contextual.* The commercialization of GMOs arrived in an adverse context as it followed the occurrence of two major health crises; namely, contaminated blood, and mad cow disease outbreaks. Such crises have had three types of effects. First, they have created distrust of public regulation and expertise. The distrust of public institutions is key to the observed difference in public attitudes between the U.S. and Europe. Second, at the heels of these crises, the media have been receptive to information on public health or environmental problems. Third, because of the first two effects, GMOs have become a very risky issue for policy makers which, at least in France in early 1997, led to a sense that decisions were guided by the "nimtoo" (not in my term of office) rationale. This approach to decision making has led to unclear, even incoherent, decision processes. These contextual factors explain why France and the UK, despite a traditionally positive attitude towards GMOs, are now the first countries to argue for a partial moratorium. Public authorities and the regulatory system have been seriously affected by the health crises.

- *The rise of opposition is linked to a lack of public understanding of current agriculture.* Certainly, this statement holds in countries like France. For reasons that go beyond the present analysis, French agriculture has a dual perception. Traditional agriculture is well perceived (often associated with the preservation of nature, quality products, and small farming systems) while modern agriculture is considered to have had a negative impact on all of the above factors. The use of GMOs in agriculture is associated with modern agriculture and, thus, motivates a negative perception. This is the main reason why the public sees little utility in this new technology.

The focus on the two previous factors does not necessarily mean that current opposition is only transitory. As shown by Limoges *et al*. (1993) the dynamics of a public controversy exhibits emerging properties and irreversible effects. To some extent, the space of debate opened by a public controversy increases the interest and mobilization of various groups. The process may be cumulative, at least for a period of time. In France, the Conseil d'Etat decided on December 11, 1998 to suspend a French ministerial decree of February 5 authorizing the cultivation of Novartis's genetically modified maize. The Conseil d'Etat referred the issue to the European Court of Justice. This decision means, *de facto*, a moratorium on *Bacillus thuringiensis* (Bt) corn, after the government moratorium on sugar beet and rapeseed. Such a decision reinforces the position of

various interest groups which, in different European member states, are in favor of a global moratorium on the commercial use of GMOs. It may also influence the difficult revision of the European Regulation (Directive 90.220 on the deliberate release of GMOs) which has already lasted 2 years.

A European Way Of Using Transgenic Plants To Solve The Dilemma?

French policy makers actually have to grapple and act upon two types of conflicting issues relating to GMOs. The first is the current crisis linked to the public controversy over GMOs and the fact that in France the legality of government decisions is now being contested by the highest Administrative Court. The second issue is a potential crisis linked to the fact that if rapid decisions related to research in plant biotechnology and genomics are not taken, research capabilities and technological competencies could concentrate in the U.S., creating an irreversible gap.

Such a situation is not exceptional in the history of technological innovation, since nearly every cluster of radical innovation has generated its own network of controversy. More new, perhaps, is the context of diffusion that, as explained, gives stronger legitimacy to the actors contesting the technology. It is not, therefore, a surprise to see that the Conseil d'Etat refered to the "principe de précaution" when it decided to suspend the authorization of Novartis corn.

Observation of some key actions taken by the French government may help one to understand a possible way out of this tricky situation. The first line of action is related to a clarification and a reinforcement of risk analysis:

1. Better control the potential risk of GMOs and guarantee the independence of the scientific procedures.
2. Given that a situation of "no risk at all" does not exist, add an analysis of socio-economic opportunity before giving the authorization.
3. Monitor the effects of the GMOs after the authorization in order to quickly detect potential problems, and if necessary, suspend the authorization.

This line of action is to be coupled with guaranteeing consumers the option of a GMO-free choice through clear and reliable labeling of products containing GMOs. All these points have been reaffirmed by the "Conférence de Citoyens" organized in June 1998 at the French Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques (Le Déaut, 1998). The second line of action is more pro-active but less clear. It aims to develop a positive attitude toward GMOs using a very simple idea. The French agricultural and food systems are not the same as the U.S. systems. Hence, this technology ought to be adapted to our specific needs (possibly think European needs) and not the other way around. Our systems do not need to be adapted to GMOs made in the U.S.

What are the differences between the two systems? As far as farming systems are concerned, the new Agricultural Law, still in discussion at the French Parliament, recognizes the various complementary functions of agricultural activities: competitive production, territory occupation, landscape production, and environmental protection. In addition, the quality of food products is explicitly linked to the produce at the farm gate, to the organizations of "filières". These are some of the important features of the French system.

So where do all these arguments lead? The current doctrine provides clear and, probably, credible signals as to the future of government policy. Although the first generation of transgenic plants will experience hard times, a second generation of GMOs, which bring some environmental benefits, or

which improve the quality of products, will be most welcome. These GMOs will be welcome because these products fit well with the general objectives of French agricultural policy. And then, *ipso facto*, the dilemma previously identified disappears. If this message is credible, it is rational for the various actors to forget today in order to prepare for tomorrow. Indeed, invest in genomics now to prevent the potential economic crisis even if you currently observe a moratorium on the use of GMOs!

The conditions for such a clever and sophisticated strategy to be successful should be analyzed carefully since the problem remains tricky and the various possibilities of action are still so uncertain in the era of techno-globalization.

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End Notes

[1] For a more detailed analysis see Joly (1998).

[2] The program will likely be located close to the infrastructure and scientific knowledge provided by the Génopole in Evry (near Paris), also where the Centre National de Séquençage (CNS) and the Centre National de Génotypage (CNG) are located.