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## **Problems in the analysis of the public's perception of Biotechnology: Europe and its contradictions**

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***“To Rafael Calvo, more than a family member, a true friend, as a tribute to his autodidact and iconoclastic effort for being deeply cultured”***

### **Summary**

The problems of the public's perception of science and technology cannot be separated from the new socio-political context in which science and technology is developing. These new “environments” demand new conditions and qualifications from experts.

The measurement of society's understanding of science and technology has been tackled with questionnaires which stumble on evident problems when they have to face the complexity of scientific activity and its reflection on what can be understood as “scientific culture”. A critical review on the different facets in the analysis of the public's perception of science reveals the need to propose new schemes and techniques in order to advance in this area of knowledge.

Biotechnology is a clear example of all these issues, with results which emphasize the heterogeneous nature and ambivalence of the European positions. The interpretation of these results encounters a lot of difficulties.

The dissection of the transgenic food controversy, chosen as an example, has allowed the identification of five blocks of comparison and controversy: confidence, risk and benefits, interests, rationalities and values.

### ***Science and technology in a new social context***

Current society, post-modern society, is characterized by its globalized nature, in which products and processes are subject to the market game, where consumers appear to have assured themselves the role of decisive judges in valuing the quality (and acceptability) of these products.

From an apologetic position, this type of society appears to be greased by the good functioning of the market. However, from a more critical point of view, this functioning keeps posing paradoxes and contradictions, which find good examples in the problems faced by scientific-technical advances.

The enormous scientific-technical advances have driven us to a situation in which we find ourselves living in a techno-scientific society, where science and technique are elements which cannot be separated from economic and social progress, but in which, at the same time, this progress has begun to be contemplated as a probable cause of some of the problems causing greatest concern among citizens of the developed world. Among them, we should mention the environmental threats and consequent harm to humanity related to the increase in inequalities, from a sympathetic point of view. This position can be combined with the more hedonistic concern which requests greater safety in food and health issues, at the same time as protection for those goods which are closest to our individual wellbeing is claimed. It is appropriate to remember, in this respect, the well-known acronym NIMBY (Not In My BackYard) which was

coined at a time when there was greater reaction towards nuclear energy, and which we could now apply to mobile phone antennas, electromagnetic waves, or closer to the case we are discussing, certain biotechnology-derived products.

In short, we can say that we live immersed in a sea of contradictions “affected by the winds of interests”. In this enraged sea, the main issue of choosing a bearing between the conflict “trust - comprehension or understanding” is brought up. People need to develop trust in experts and institutions which allow them to adopt and follow the best solutions to conflictive situations arising from the world’s growing scientific, political, and social complexity. According to Noelle-Neumann<sup>1</sup>, Hermann Lübbe, the Swiss social philosopher, among others, has defended this position.

But, truly, the situation is different. On the one hand, there has been progress in the concept that we are living in a “risk society”<sup>2</sup>, in which there is a clear confrontation between reflection and information. Reflection is still the experts’ ground and information is that of the media’s.

The growing distrust in experts that has developed in the last two decades is being compensated by an increase in trust towards journalists and mass media, such as television<sup>3</sup>. The critical point of the issue is, in my opinion, that information is not the same as knowledge; neither is the task of informing the same as that of educating.

The very existence in a globalized society, sometimes not understood by the less favored, mobilized and information-guided? social mass, of another ambiguous concept, difficult to understand by the less advanced and less experienced, has created the immersion into a sea of paradoxes and contradictions, some of which I have already emphasized<sup>4</sup>.

### ***Science and technology in this society***

All issues related to science and technology are deeply related, and immersed in this social-political reality.

Throughout the last few years, there has been a reflection on the conditions in which both the promotion of these types of activities – organization, financing, quality selection or control – as well as the process of knowledge production and its social and

<sup>1</sup> Elisabeth Noelle-Neumann, “Foreword” en *Between Understanding and Trust. The Public, Science and Technology*, Meinolf Dierkes and Claudia von Grote, eds (Amsterdam: Harwood Academic Publishers, 2000) p. xi.

<sup>2</sup> Ulrich Beck, *Risk Society. Towards a New Modernity*, (London, Thousand Oaks, New Delhi: Sage Publications, 1992), p. 19.

<sup>3</sup> Noelle-Neumann, “Foreword” en *Between Understanding and Trust*, p. xii.

<sup>4</sup> For a list of these contradictions see Emilio Muñoz, “Percepción social de la biotecnología y el caso de España” (Social perception of biotechnology and the case of Spain), *Antropología del Mediterráneo*, Luis Álvarez Munárriz, Fina Antón Hurtado, eds. (Antropología Social/1, Universidad del Mar: Editorial Godoy, 2001), p. 411.

economic incidence is developing: growing interaction between what is public and what is private; reorientation of the way in which knowledge is spread - going from a publication in a scientific journal to obtaining news about scientific-technical advances in conventional media -; a certain trend from the initial belief that the only scientific-technical progress was oriented towards the exclusive use of the scientific community, whereas now it is being used to provide services to society, as reflected by the concern that science and technology are affecting "social or common goods".

Therefore, it seems clear, that scientific-technical development must adapt itself to "new environments"<sup>5</sup> in which the community of experts is being asked more and more to provide answers to society.

### ***Public perception and social understanding of science and technology***

The obvious need to measure and understand the degree of comprehension of society, the public, regarding science and technology in general as well as some critical technologies, such as biotechnology, has led to the development of concepts, methods and obtaining results in the area of "public understanding of science and technology" in order to create a field of social research, with clear scientific-technical implications and, therefore, multidisciplinary, which is still working in a blurred setting. The purpose of this work is not to offer an exhaustive analysis of the conceptual and analytical framework of studies about the public's understanding of science, or the degree of scientific literacy of advanced societies, but to try to outline the situation of these issues when faced by the enormous development that biology is experimenting and its possible and true applications in the productive world. Although it is not our main objective, I believe it is necessary to relate a series of references regarding the question of the relationship between science and society in such a way that it may serve as a bridge for future investigations of this relationship. In a series of essays found in the aforementioned book, "Between Understanding and Trust"<sup>6</sup>, the position of the research program on "understanding of science by society" is covered in its historic and political context. It goes into a comparative analysis in order to bring out consequences and reflections regarding the methodological instruments used for evaluating the perception and social attitudes towards science and technology. It investigates the critical approach of "cognitive deficit" as a model which tries to tie the concept of public and science to the idea of information and knowledge. Lastly, it tries to analyze the steps informing about the links between information and attitudes and which, in the last analysis, lead to the existence of processes of social evaluation or the establishment of codes of action of the different parts.

<sup>5</sup> Emilio Muñoz, "New socio-political environments and the dynamics of European public research systems Working Document CTS 02-20 <http://www.iesam.csic.es/doctrab.htm>.

<sup>6</sup> *Between Understanding and Trust*, p. 7-38, 131-156.

On the other hand, Miller, Pardo and Niwa<sup>7</sup> have published the first systematic comparative study of the knowledge, images, and attitudes towards science and technology of the populations of Europe, Japan, United States and Canada. The monograph, published in English and Spanish, is the result of research carried out jointly by the BBV Foundation and the Science Academy of Chicago, and has been published by the BBV Foundation. It has instrumental value as it creates, or at least tries to, a series of indicators to aid in statistical support and comparative research. Its conceptual basis regarding the relationship between knowledge and attitudes, and its role in the public's participation in the controversies dominated by the importance of scientific knowledge, also stands out. It is also worth mentioning the work by Miller in the last two decades, which has pointed out the importance of social attitudes in the design of educational and scientific-technical policies and the consequent decision-making related to these policies.

### ***Scientific culture and its problems***

The fields of science and technology, currently marked by an environment in upheaval and globalized in nature, requires the collaboration of information. However, this demand is made difficult by a deep immersion in a sea of contradictions and paradoxes.

As we have already seen, we live in a society which is ever more influenced by scientific advances and modulated by technical progress. However, all this social bathing in scientific and technological products and components is not accompanied by a froth of scientific culture which can help appreciate what all that means.

The scientific culture problem is ever more relevant for the normal democratic development in current societies. In this section, I will try to analyze some of these problems: definition of scientific culture, factors affecting public understanding of scientific activity, characteristics of this activity, instruments for measuring this activity – the works on the public's perception of science and technology. After analyzing these problems in a general sense, the reflections will be focused on the case of biotechnology.

### ***Scientific culture: definition and measurement instruments***

I have thought about the inherent problems in the definition of culture, not in an isolated context, but in relation to the instruments used for measuring it. The assessment of scientific culture has been a constant concern within the European Community. From the moment in which Europe noticed its scientific-technical deficiencies with respect to the other two large blocks: United States and Japan, it decided to promote an active policy to foster research, development and innovation. In a parallel way, the European authorities became concerned about the development of techniques which would allow the establishment of relationships between science and the public, and began to use opinion surveys. The choice of this methodology is, in my opinion, associated with the

<sup>7</sup> Jon D. Miller, Rafael Pardo, F. Niwa, *Percepciones del público ante la ciencia y la tecnología. Estudio comparativo de la Unión Europea, Estados Unidos, Japón y Canadá*, (Bilbao: Fundación BBV, Chicago Academy of Sciences, 1998), p. 17-76.

assumption of a specific meaning of the culture concept. In the *Diccionario del Español Actual*<sup>8</sup> (*Current Spanish Dictionary*) we find three definitions of culture:

- i) Culture as knowledge as a whole acquired by a person which allows the development of a critical sense and reason;
- ii) As an instruction or non-specialized knowledge as a whole which all educated people are supposed to have;
- iii) Or as a set of lifestyles, knowledge in its entirety and degree of development of humans as a whole or during a period of time.

Obviously, these meanings differ in the dimension of the reference element used for their assessment. In the first two meanings, culture is related to the individuals, whereas in the third meaning, it is associated with a collective dimension (expression as a whole in virtue of spacial, geographic and time parameters). The choice of opinion surveys as the methodology used to measure culture, points towards the use of the first two meanings in measuring culture, clearly eliminating the third meaning.

#### *Emission and reception of knowledge*

Culture, using the chosen meanings, is determined by the degree of knowledge or things which are known about a specific subject by an individual. The next problem is to explore who gives or transmits culture and who acquires it. There are two main mechanisms for the emission and transmission of knowledge: educate and inform.

*Education*, the result of educating, consists in intellectually and morally training (essentially a person) to coexist in society. This mechanism appears essential, as we will later confirm, to develop and reach scientific culture. However, it has an opposite aspect since it is oriented towards coexistence in society so it will, therefore, be influenced by what society demands. In a society like the Spanish one, where science and technology occupy a second level of interest, therefore having scarce demands, it is difficult to believe that education will contribute or could contribute to scientific culture.

Education is transmitted, according to a strategy, in a planned fashion to all those individuals who themselves, or those who are responsible for them, wish to receive.

*Information*, the act of informing, consists in a) the transmission, through a message, of something which the receptor ignores; b) the transmission from one system to another, by means of any type of signal, of elements in order to create judgement or to solve a problem.

The limits of the first meaning in contributing to culture in complex subjects appears obvious; its effectiveness is oriented towards the transmission of news (facts) related to

<sup>8</sup> Manuel Seco, Olimpia Andrés, Gabino Ramos, *Diccionario del español actual, Volumen I (Current Spanish Dictionary, Volume I)* (Madrid: Aguilar lexicografía, 1999), p. 1377.

conventional subjects in which the receptor's attention is fixed in common sections – political, social, regional, local, sports, economic information.

The last meaning appears to be more suited to inform in a more structured manner about subjects having a certain degree of complexity, such as the case of science, technology and their products.

*Characteristics of scientific activity and its repercussions on the concept of scientific culture*

- Scientific activity which originates the production of knowledge is characterized by its constant dynamics.
- There are no absolute truths in scientific knowledge. Partial truths are generated, which are conditioned by the goal of that activity and the techniques used to solve the problems within that goal.
- Production of scientific knowledge can lead to different results which generate controversies of diverse intensities that can last for different periods of time.
- According to these characteristics, scientific culture must be related not only to the layout of knowledge (information?) regarding facts or data, but it must consider, recognize, the importance of the procedures, the processes, of the nature of the knowledge depending on the subject and the techniques applied. In this context, it seems logical to conclude that scientific culture is, above all, the result of education – with the exceptions and limits pointed out earlier -, whereas we should ask ourselves whether information can generate or lead to an acceptable degree of scientific culture. In light of the current degree of analysis, we can conclude that information, as a “transmitter, through signals or data, of elements to create a judgement or solve (understand) a problem” can manage to create “a level of education about non-specialized knowledge in cultivated people”, that is, those who have a high enough level of education to understand the characteristics of scientific activity previously mentioned.

We should not forget, at this point, the problems posed by public opinion subjects, when we are in a risk setting. We have to admit that, when there are considerable levels of uncertainty, decision-making frequently takes place in the absence of solid scientific evidence, or without a well-defined and established framework of probabilities. This is an additional element emphasizing the limitations of information in creating a basis of popular culture which is able to understand the complexity of these situations.

***Public perception of science and technology: a critical review***

The analysis and measurement of the public's perception of science and its applications is not a simple question. In this exercise we face the complexity itself of the object we are trying to analyze – of which we have previously offered some notes– and certain weaknesses in the methodologies used, supported mainly by public opinion surveys.

In previous works, I have expressed my doubts regarding the methodologies employed<sup>9</sup>, based on the complexity of the specific area under study in the survey, science and technology, or a technology as rich and varied as biotechnology is. In this case, I will try to offer a more structured and more general critical review of the problems I perceive regarding the subject of scientific culture under study.

### ***The problem of the origin***

We must search for the origins of these works in two movements, a North American one ("scientific literacy") and a British one ("public understanding of science") which present a certain degree of divergence among their goals, as can be inferred by the very headings under which they are sheltered.

The North American movement has been concerned with measuring the degree of scientific culture or literacy of the North American society ("scientific literacy"). To this end, it has designed surveys with basic scientific questions about well established facts, without bringing up the ambiguity and dynamics found in the practice of science. In this strategy, "tricks" and filters are introduced, as exemplified in two of the questions which have made history: answer "yes" or "no" to the following questions:

- ◆ The sun circles the earth.
- ◆ Antibiotics destroy viruses and bacteria.
- ◆ Electrons are smaller than atoms.

Or, in another alternative, correct statement is offered and we look for precision, such as in the following case:

- ◆ The earth circles the sun in 1 night, 1 month, 1 year. Mark the correct answer with an X.

The British movement has a broader orientation, as it seeks to evaluate the ability of the public, of society, to understand science and, eventually, its applications. It is closer to survey opinions in appreciating attitudes, and gives leeway for asking social, political and economic type questions.

<sup>9</sup> To check some of these reviews, see Emilio Muñoz, "La complejidad de la biotecnología y la percepción pública: una inevitable relación" (The complexity of biotechnology and public perception: an unavoidable relationship) *Quark* n° 12, 1998, 14-18, p. 18; Muñoz, *Biotecnología y Sociedad: encuentros y desencuentros* (Madrid: Cambridge University Press, OEI, 2001)

## **Questionnaires: a measurement instrument**

The first conflict occurs when analyzing the questionnaires used in Europe in the last 25 years. This analysis reveals a disparity in the objectives and expectations, which creates problems when trying to evaluate temporal series. On the other hand, initiatives appear to have changed, and there is no information available regarding general surveys since 1992. From 1992 onwards, the surveys appear to be focused on biotechnology.

Regarding surveys on general aspects of science and technology, the following course of development, in the European experience, can be observed (see Table 1).

- In 1977, the survey performed tried to find out the opinion of citizens of the 9 countries forming the European Community at that time regarding the value of science and its applications, both for its potential to contribute in a positive manner in the way of life as well as for the possible risks its applications could entail. It also contained questions which tried to find out about the future expectations of European citizens with regards to science.
- In 1979, the survey changed its focus to emphasize the scientific and technical development, with a thematic orientation aimed at detecting perception vs. risks. The questions tried to explore the relationship between scientific-technical development and society regarding decision-making. The questions could be grouped in four large blocks: i) questions with the goal of appreciating the public's distance towards science. ii) questions guided towards the detection of attitudes with respect to scientific and technical development with a double position: one of prospective nature in the line of the specific interests of the General directorate for Science and Technology of the European Commission another analytical one, with the aim of finding out the ability to distinguish between science and applications; iii) a section created to identify the public's position upon decision-making in these subjects; iv) the fourth was focused on the analysis of a highly important current issue at that time, Automation and Robotics, due to the possibility of its introduction in traditional industrial sectors – the car industry, aeronautics, construction – with its possible incidence on employment level and working conditions.
- In 1989, after a long period of time, an important change was introduced in the making and organization of the survey. Scientific-technical subjects were part of a more general survey (Omnibus), applied in 12 countries of the European Community and Northern Ireland. A complex survey was employed, a hybrid between the North American and the British orientations, to measure scientific culture, complemented by the assessment of interests and means to obtain pertinent information, as well as the “public's understanding of science”. This survey was undertaken with general questions regarding the importance of scientific-technical advances in daily life and the relevance of policies. The survey regarding scientific-technical aspects was divided into four blocks:

**Table 1. Surveys about European attitudes towards science and technology in general terms**

<b>Year</b>	<b>Basis of Survey</b>	<b>Countries</b>	<b>Objectives</b>	<b>Expectations</b>
1977	Science and the public	9	Risks	Future hopes
1979	Scientific and technical development	9	Risks- decision-making	Prospective Automation (Robotics)
1989	General Survey + specific subjects	12 + 1	Interests and trust	Policies
1992	Eurobarometer	12	Culture, interests, trust	Trust and policies

- A first block aimed to identify the interests of those surveyed in scientific-technical subjects – both in the productive sector and in the scientific and medical fields – compared to current political cultural and sport subjects, using a control to identify the instruments used – newspapers, magazines, museums – to obtain information and increase knowledge.
- A second block was directed at estimating the areas considered worthy of receiving the greatest support in research and valuing the trust in scientific-technical advances to improve our lifestyle.
- A third block tried to determine the population's opinion regarding the values of European scientific and technical potential with respect to that of the United States and Japan.
- In the last block, there were questions concerning two sectors of great social impact: cancer and radioactivity and nuclear energy, with the goal of evaluating the degree of knowledge about scientific facts and protection strategies (programs, regulations, behavior patterns) for approaching solutions to such problematic subjects. The formula used in 1992, similar to the Eurobarometer, was constructed around a questionnaire divided in blocks (four, in general terms) very similar to the blocks present in the 1989 questionnaire. The main difference was a more in depth study of the questions regarding the measurement of scientific culture when these questions are diversified and enriched, although as previously noted, there were questions about absolute scientific truths, and they are asked either directly or in a subtle manner, without revealing the richness, ambiguity and inherent complexity of the scientific method.

In this case, the specific scientific problem under examination was the environment, emphasizing the problems of contamination and the ozone hole.

### ***New critical facets in the analysis of the public's perception of science***

The political importance attributed to results from surveys about attitudes towards science, causes us to be cautious and analyze data more thoroughly. In this respect, a recent work by Pardo and Calvo<sup>10</sup> is particularly important. Rafael Pardo, who has been an important player in the creation of the Spanish phase of some Eurobarometers, used the data from the 38.1 Eurobarometer of 1992, due to its broad

<sup>10</sup> The methodologic criticism of Rafael Pardo and Félix Calvo in "Attitudes towards science among the European public: a methodological analysis", *Public Understanding of Science*, 2002, 11: 155-195, is mainly found in pages. 161 to 165; the analysis according to the new program they propose is found in pages 165-188.

and public diffusion as well as because it has been the basis of most analysis concerning the public's understanding of science, to carry out a more careful study on a main critical point. This point is drawn up in the statement that there is an absence of theory in studies regarding the public's understanding of science. In this sense, important steps have been taken to critically review the alleged direct relationship between attitudes and the degree of knowledge, as well as steps taken to try to find relationships between knowledge and attitudes with characteristics of a socio-economic and cultural context influenced by late modernism.

However, Pardo and Calvo believe there are two main problems in the most relevant analysis published to date. The first one is related to the intents of offering empirical answers to questions not considered in the design of questionnaires. I am in complete agreement with this criticism.

The second, and more important problem according to the authors mentioned, is the application of a simple algorithm, based on widespread scales and indicators which are "below the standards applied in other areas of scientific research in social science". Pardo and Calvo point out that the absence of an explicit theoretic basis shows a lack of orientation when selecting the items to be included in questionnaires. Therefore, it is not surprising that the metric properties of the scales are not very significant. Starting from this situation, analysis have suffered weaknesses which have lead to results of limited conceptual and statistical value.

In the aforementioned work, Pardo and Calvo have followed a program which tries to continue constructing scales of knowledge and attitudes, grounded on a deeper theoretic basis and which combine with a more sophisticated methodology – concerning the design of questionnaires, sampling and field work. On the other hand, the authors have tried to examine available data – despite the lack of a theoretic basis in its attainment – with a more paused view and a more in depth outlook. From this viewpoint, they have analyzed the conceptually richest areas present in the Eurobarometers, with exploratory statistical techniques, with the goal of showing the varied and interesting aspects in the perception of science and technology.

In applying this program, the authors have written a thorough work which is condensed in almost twenty five tight pages of the journal *Public Understanding of Science*, and leads them to a series of conclusions which are summarized as follows<sup>10</sup>:

- The methodological and statistical analysis of subjects found in the Eurobarometer, and the scales measuring attitudes towards science reveal that they are scarcely relevant and far from the standards found in other social research areas.
- Despite efforts to propose thought-provoking hypothesis and outlines, the weakness of the data threatens the stability and credibility of some results and interpretations.

- It is necessary to elaborate questionnaires which are able to capture the different facets of the attitudes towards science and technology which consider the degree of importance each of the facets presents for the population studied and which are supported by metrics which can be adapted to a greater variability<sup>11</sup>. This approach may allow the creation of more scales with the reliability and validity required for constructing models to explain the complex structure and dynamics of scientific culture in late modernism.
- It is reasonable to identify aspects requiring a treatment different to that normally used up to now in attitude analysis. These attitudes can be separated in different groups (“clusters”); these attitudes can be related to different types of subjects; attitudes towards science (assessment) may be related to or influenced by other “families” of attitudes and values – environmental perception, globalization, complexity, risk perception, world views.
- The diverse ways in which science and technology manifests itself nowadays, requires greater variation in approaching its assessment. This variation needs a more diverse set of scales which reflect the different dimensions of science. The superposition of science (and technology) and social institutions is a process in continuous expansion; this process may reveal that it is very difficult to find structured attitudes in most of the population which are spectators, and not actors, of scientific activity. Therefore, there may be attitudes towards certain subgroups of scientific-technical areas<sup>11</sup>; we have brought up this same possibility in the biotechnology<sup>9</sup> field.
- The assessment of attitudes towards science (and technology) requires a greater elaboration of labels than those used up to now – positive, negative or ambivalent. This direction must take into account a series of more complex, non-linear, and qualitative, relationships which, no doubt, exist among the different facets. It is important to consider the criteria accompanying the evaluation of science (and technology) by the population, such as the economic utility, moral considerations, views regarding nature and what is natural, risk perceptions concerning certain applications – the technologic stigma –, potential benefits for health, or possible impacts on intra- and inter-country social stratification. These criteria, so different among themselves as well as for the population, cannot weigh the same in a metric approach nor can we assume that all citizens which are not part of the scientific community have a single position towards science. The evidence points in the opposite direction, one in which the micro- and fragmented viewpoints are abundant, some of them in conflict, and others coexist without any apparent interaction.

<sup>11</sup> Pardo y Calvo, “Attitudes towards science among the European public”, p. 189-195.

- As a consequence, it seems appropriate not to restrict oneself to a single approach in analyzing the viewpoints, and in the possible identification of a changing dynamics. It is convenient to carry out complementary work where the best exploitation of the data available is combined – Pardo and Calvo suggest the use of multivariate analysis techniques<sup>12</sup> such as correspondence analysis and classification and regression trees – with historiographic perspectives and qualitative methodologies. This is a proposal which I enthusiastically agree with, as it has been our research program in the CTS area for the study of biomedical sciences and life-sciences applications<sup>13</sup>.

### ***The case of biotechnology. Evolution and detection of new problems***

Biotechnology is a technology which can be included within the term “new technologies” which has been the center of social debate throughout the last 25 years.

The development of the most controversial aspects of biotechnology in relation to this social debate can be summarized as follows:

- The first critics used the metaphors of “the monster of Frankenstein” or “playing God” to show their concerns regarding the unforeseeable consequences that could derive from the intervention with the genome. In the first years genetic engineering was applied, the nineteen seventies, fears were expressed regarding the genetic modification of unicellular organisms on a laboratory scale.
- In the eighties, the criticism was directed towards actions on animals and the risk of introducing modified crops in the environment.
- In the last few years, the greatest discussions have centered around the possible effects modified foods can have on our health and environment.

The richness and diversity of biotechnology subjects under social debate are a consequence of the very nature of biotechnology itself. It can be defined as a horizontal technology – included in all areas of economic activity – of strategic nature – allowing us to choose objectives and subjects to improve products or processes -, in which advances and techniques of many different disciplines take part and are put into practice with interdisciplinary R&D programs.

<sup>12</sup> Pardo and Calvo “Attitudes towards science among the European public”, p. 190.

<sup>13</sup> The incorporation of Prof. Emilio Muñoz to the Institute of Advanced Social Studies of the CSIC in its venue in Madrid in July 1991, initiated a research line in which the objective was the analysis and evaluation of scientific and technological policies from a multidisciplinary viewpoint, with special emphasis on biotechnology and health. Throughout this course of development, the methodologic instruments used in this type of studies has broadened, as well as the theoretic approaches in the analysis of cognitive and normative aspects which influence the decisions on such policies.

- As a consequence, the analysis of the perception of biotechnology is conditioned by this complexity.
  - 1) On the one hand, it is obvious that there are problems in the need to have a high degree of knowledge (“scientific culture”) in order to understand the subjects of debate. This problem reveals the clear limitations in the criteria used for sample selection. The stratification needed to perform an opinion survey can make clear a lot of the deficiencies with respect to the degree of education of those being surveyed. Despite the risk of falling into the heterodoxy, in terms of sociologic methodology, we should emphasize the convenience of performing surveys in populations separated according to their scientific literacy level.
  - 2) Secondly, the great thematic complexity surrounding biotechnology development and application, makes it extremely difficult to prepare understandable and broad enough questionnaires. Trying to make questionnaires which include all scientific and technical aspects of biotechnology and use them in all applications, leads to the presentation of subjects in a biased manner. There are some applications, mainly those in the human and animal health area, which are presented with an emphasis on benefits, whereas the applications in the agricultural and food sectors bring up questions with negative aspects regarding risks, which may even be imaginary in nature.

On this basis, it is worth asking oneself about the suitability of creating questionnaires centered around a specific aspect of the broad range of scientific, technical and developmental possibilities offered by biotechnology.

- 3) There are various factors at the center of the debate. Some of them are: cognitive deficiencies, risk, uncertainty, religious and moral values, interests, and trust. In some cases, some of these factors are clear elements causing debate; in other cases, various factors are intermingled. As a logical consequence, many of the questionnaires prepared show this confusion, as they lack a defined framework for creating the survey’s elements.

### ***The public’s perception of biotechnology in Europe***

The performance of surveys on the public’s perception of biotechnology in Europe have taken place within the Eurobarometer’s framework. These surveys have taken place in four waves, or activities financed by the General Research Directorate of the European Commission within the different Framework Programs. Two groups have been involved in these tasks. Firstly the Task Group on Public Understanding of Biotechnology was the main player, associated to the European Biotechnology

Federation and lead by John Durant, Science Museum (London), with David J. Bennett in the Secretariat, Cambridge Biomedical Consultants. Later, the tasks have been taken over by the International Research Group on Biotechnology and the Public, lead by George Gaskell (London School of Economics, J. Durant (Science Museum) and M. Bauer (associated to both these Institutions).

- The first survey was performed in the Autumn of 1991 (Eurobarometer 35.1) preceding the last survey found in the summary of Table 1. It took place in the 12 countries which belonged to the European Community (about 12.800 people were surveyed). The goal of the study was to learn about the attitude of Europeans towards scientific developments in biotechnology, although it also tried to measure the degree of knowledge of European citizens regarding these issues and disclose the information sources which provided them greatest trust.
- The second survey was given in the Spring of 1993 (Eurobarometer 39.1) in the 12 countries which were members, with a sample of 13.032 individuals. Most questions used in this survey were the same as those used in the previous one. The new questions tried to assess the knowledge of those surveyed regarding the subjective viewpoints on the difficulty of the questions. It also presented a new view of the attitudes and opinions of European citizens.
- The third wave was put into practice in the Autumn of 1996 (Eurobarometer 46.1) in the 15-member European Community with a sample of 16.246 people surveyed. The questionnaire was significantly revised with new questions designed around the main interest areas. Only a small number of questions from the previous studies were used.
- The fourth and last, up to now, Eurobarometer on biotechnology was performed in the Autumn of 1999 (Eurobarometer 52.1) with a sample of 16.082 people. The same outline of the previous questionnaire was kept, although new questions were added. Four questions about trends and another two about modified trends, as well as a question chosen from among a set of questions from the Unit of Public Opinion Analysis of the European Union. The objective of the changes made to questions found in previous questionnaires was to simplify or eliminate tendentious terms.

#### *Some results and considerations of the Eurobarometer 1999-2000*

The last Eurobarometer on biotechnology surveyed 16.082 citizens using random sampling and normalizing the results to 1000 people per member country of the European Union. Taking note of the suggestions from the last few years regarding the suitability of centering biotechnology surveys around a

specific set of questions, the questionnaire focused on seven specific applications: *genetic diagnosis*; microorganism-produced *medicines*; *bioremediation*; *cell and human tissue cloning with therapeutic ends*; *genetically modified plants*, to increase their resistance to plagues; *animal cloning* to obtain therapeutic substances; and lastly, *food* related to genetic modification, with the application of modern biotechnology techniques to the production of food and improvement of its properties, such as an increase in its protein content, or the preservation periods, or changes in their organoleptic properties. Those surveyed were asked their opinion regarding each of these applications, their use, risk, moral acceptance and the need to support further development. These questions had four choices as answers regarding their applications: very much in agreement (+2); in partial agreement (+1); in slight disagreement (-1) and reject this application (-2). It is important to note that one of the main objectives of these studies was the possibility of comparing using temporal series. In this respect, we should indicate that four of the applications put forth in the 1999 survey – genetic diagnosis, medicines, plants and food – were also present in the 1996 survey. The other three applications – environmental correction, and cloning human and animal cells – were first introduced in the last Eurobarometer wave.

There is still great diversity in the attitude of European societies towards these issues. In his analysis, Gaskell<sup>14</sup> still insists that the (European) public shows different appreciations depending on the type of application in question. In general, from the data of 1999, the following gradient can be established:

- Genetic diagnosis* – Useful (there is no risk)
- Medicines* – Useful (low risk)
- Bioremediation* . Useful (low risk)
- Human cell cloning* – Medium usefulness (medium risk)
- Modified plants* – Low usefulness (medium risk)
- Animal cloning* - Low usefulness (medium risk)
- Modified food* – No usefulness (medium risk)

#### *Authors' interpretations of the survey (Gaskell)*

The main author of all these works assumes the public's reactions are clearly different depending on the application, and this statement is based on a consistent structural pattern. As the perception regarding usefulness of the

<sup>14</sup> George Gaskell "Agriculture biotechnology and public attitudes in the European Union", *AgBioForum* 2000, 3: 87-96. Available on the web page [www.http://www.agbioforum.org](http://www.agbioforum.org).

application decreases, an increase in perceived risk is produced, as well as a decrease in the moral acceptance and support for its development. The main argument Gaskell comes up with from these studies for interpreting the positive attitude of the European public towards (certain) biotechnology applications, is their relationship to benefits (individual happiness). I believe this interpretation, true in a broad sense, answers mainly to utilitarian ethics, which appears to agree with a predominantly capitalist and liberal ideology. In any case, my partial agreement requires some clarification which I will try to put forward later by offering my personal interpretation in more detail.

However, the situation is not as clear when the focus is on certain applications or the analysis is performed taking into account the national dimension. Gaskell himself faces this question when observing the contrast in attitudes towards plants and food. Gaskell sets food safety against biosafety and proposes that it is the food crisis which has increased social concern regarding the possible risks associated with the consumption of some genetically modified food products. This is the reason why, according to consumer's opinions, the absence of labelling is rejected, hindering the opportunity of choosing with total freedom. However, genetically modified plants show less rejection because the environment, so often used as an element of radical opposition to agriculture biotechnology, produce less concern among citizens.

Another important contrast element arises from the conflicting situation of acceptance of cell or animal cloning. As Gaskell points out, in this case the public's opinion appears to establish judgements about techniques and their consequences. What belongs to the technique world (the laboratory as a symbol) appears to be more accepted than what occurs in nature (the farm as an emblem), especially when that nature is very close to mankind. We may even think that the issue of eugenics is present when the image of Dolly, or another animal obtained through cloning, appears.

The situation gets even more complicated when the analysis obeys national profiles. There are certain applications, such as those related to health, diagnosis and new medicines, which are appreciated in all countries of the European Union, although there may be a certain gradient in this positive attitude (genetic diagnosis is one of the applications which has greatest support, but Austria shows only a modest positive attitude). On the other hand, modified food products show the greatest rejection. Their use is seen as negative in all countries, with the exception of Finland and Spain, whose public opinions are moderately positive with respect to this application. The case of genetically modified plants or crops requires special attention. Only two countries, Austria and Luxembourg, have quite a negative opinion about this application. Another seven countries, Greece, Sweden, Denmark, Ireland, Belgium, United Kingdom and France, show a moderately negative attitude. The rest of the countries have a positive opinion regarding this biotechnology application, ranging from the slightly positive attitude of Germany to the quite positive opinions of Portugal and Spain, going through the intermediately positive attitudes of Italy, Netherlands and Finland.

Animal cloning is another critical issue. It is an application which is rejected by 12 countries and accepted by only three countries, Finland, Portugal and Spain, although all opinions, both positive and negative, are quite moderate.

The situation of all countries in time is fairly stable, with the exception of Greece which showed mostly positive attitudes in 1996 and has now become the country with the greatest negative attitudes. Netherlands has also developed an average position which is quite a lot more positive than it was in 1996, a similar situation to that seen with Germany (which has gone from a second position in the scale of negative attitudes in 1996, to the eighth position in 1999; Netherlands has gone from a seventh position in 1996 to an eleventh position in 1999). Gaskell refuses to interpret the difference between countries (national profiles), and those between certain applications, in terms of cultural or religious differences. He considers this a thought-provoking but candid interpretation. Gaskell believes the explanation of the attitudes of the different countries can be based on economic development.

He proposes that the three countries showing the more positive social attitudes with respect to biotechnology, Finland, Portugal and Spain, can be identified as those with the most modern and emerging European economies. Gaskell considers that these countries see biotechnology as a vehicle for reaching technological progress and economic development. On the other hand, countries such as Austria, Luxembourg, Sweden and Denmark already have a completely developed economy, with high per capita yield, and so are more oriented to appreciating new values and more skeptical with respect to the relationship between technology, progress and wellbeing. These societies would express a more critical attitude towards the opportunity of supporting or not new technological developments.

#### *Interpretation from my own viewpoint*

I must first note my agreement with Gaskell's general appreciations in explaining general data. I believe utility is the main factor which, depending on its relevance, may overcome risks.

However, I believe it is necessary for me to detail more precisely my agreement, in a more interpretative framework. I believe the opinions about biotechnology are being guided by a "utilitarian", selfish, extreme idea (or ethical position), marked by the interests and importance this selfish-prejudiced position gives to one or another of these goods. Health, a collective good with immediate implications for the individual, is valued more highly than the environment, a collective good but whose immediate incidence on individuals is perceived from a greater distance and with less repercussions. Here stem the differences in the appreciations between the application to agricultural products – greater incidence on the environment – and to food products, with greater repercussions on health. On the other hand, but in the same direction,

consumer interests, mainly individual, are put on top of the interests of any other group, farmers, communities, regions, states. I believe these considerations place the weight of culture and values in their true position, as far as interest modulators go, and should, therefore, not be discarded as factors which shape opinions by alluding to their candor.

Due to these factors, I also do not totally agree with the arguments used by Gaskell to explain the position of the countries occupying the extreme viewpoints regarding biotechnology. I agree that the economy and developmental stage of a country can be an explanatory factor, but not in a linear way, as we should take into account the context. Finland, Portugal and Spain are three very different countries with respect to efforts in R&D and innovation . Finland is one of the countries which, in proportion, provides greatest resources for these activities and is also one of the European countries which establishes a better link between research and economic and industrial development. On the other hand, Spain and Portugal are the European countries which make less of an effort in R&D and innovation, and establish a link between production and use of knowledge with greater difficulty. However, the three of them have in common the fact that they have based a great part of their economic and social development on natural resources, and they have not enjoyed the status of an industrialized country. However, we must insist that the differences between them are noticeable. In a direct way, we can summarize them with the following slogans: Finland, "I believe in technology and can compete with it", Portugal and Spain, "we want to believe in technology and we may be able to compete with it".

This personal interpretation finds greater support in the data provided by Gaskell himself when he tries to condense the logic behind societies' attitudes towards the most conflicting subject, which is the application of modern biotechnology to the production of food products. Grouping the opinions of those who support and tolerate risks, the situation changes, and the 15 member European Union shows quite a different panorama. Seven countries show favorable attitudes (50 per cent or more) with Netherlands in the lead (a country with great farming and food and agricultural development), followed by Spain, Finland, Ireland, Portugal, Italy, and Germany. Two countries show a neutral attitude (Belgium and United Kingdom) and only six countries (Sweden, Denmark, France, Luxembourg, Austria and Greece) show negative attitudes. None of these countries, with the surprising case of France – although it may also be explained by their interests -, present an important basis of their development in the farming and food and agricultural sector.

In a context greatly dominated by interests, and of an essentially selfish nature, it appears logical that the information-transmission of current, timely, clever, and subtle messages – prevails over knowledge – seeking the truth (or one of the truths) based on contrasted and evaluated facts.

In my opinion, it is within this context where the debate and political decisions which arise from it, regarding agriculture biotechnology and its application to food products, takes place. Next, I will sort out some of the data which has been generated in this debate, and try to explain it using my own opinions and comments.

One of the consequences of the situation we have outlined is that there is not one single factor which can be identified as being responsible for the opposition found in certain parts of the world, especially in Europe and some third world countries such as India, regarding genetically modified food products.

For this reason, we can name, in no specific order, a series of factors such as:

- Rejection of risks by consumers, when no direct benefits are perceived.

- Lack of trust in the agencies responsible for regulating food products in Europe and in other parts of the world.
- (Unfortunate) coincidence of marketing of genetically modified food products with food crisis (exemplified by the mad cow disease case).
- A growing perception – mobilized by certain facts and sub-debates which have taken place within the scientific community – of the lack of stringency by scientists in managing the consequences of new technologies.
- Protectionist interests of European governments which are reflected in the barriers created in marketing genetically modified crops (and food products).
- Obstinate attitude of the United States towards (European) consumers' request of labelling of such food products and the "right to know" demanded by consumers.
- Anti-American feelings.
- Biased and sensationalist treatment of these subjects by mass media.

### ***Dissection of the complex controversy regarding transgenic food products***

As we have already noted, none of these factors by themselves can explain the existence of a negative reaction towards genetically modified food products by a great part of European society – although there are important differences between countries within the European Union.

In the last ten years, we have worked on trying to separate the different elements which can be involved in shaping and modulating social attitudes towards new biotechnology in agriculture and food. We have used a mixed methodology based on the combination of an empirical and analytical approach of studies on public perception of biotechnology, with a philosophical and ethical reflection these new developments and their applications provoke. Our approach is based on experimental and descriptive works, as well as essays prepared on demand for specific events.

In these works<sup>15</sup>, we have been able to identify five blocks of comparison and controversy: trust (in the experts) and social understanding; risks and benefits; interests (types of agriculture, blocks, countries); rationalities and values. We will next present, in a schematic way, their characteristics, basis and consequences.

### *Confrontation between trust and public understanding*

The main objective of this work is not to argue about the many problems found in analyzing the public's understanding of science and social attitudes facing the use of new technologies, nor the methodological difficulties in measuring these. In the present case, I am using only those studies on public perception and biotechnology supported by the "cognitive deficit" model to point out the differences (conflicts) between the results of level of understanding (knowledge, information) of the general public regarding scientific data and facts and the use of new (bio)technologies in relation with the trust in experts.

The data is worrying and, in my opinion, justify the social conflict regarding transgenic crops and food products. There is no direct relationship between the degree of knowledge and trust in data. The data provided by the surveys performed with citizens from European Union countries and related countries (Norway, Switzerland) reveal that a greater degree of understanding (knowledge) of science and technology is reflected by a greater distrust in scientists. The trend is very pronounced in this direction, and the more recent surveys offer more conclusive data on this issue.

It appears that as the world has grown more complex with respect to the increasing importance of scientific-technical progress and its influence on social-economic development, and the increase in citizen's quality of life, we

<sup>15</sup> Emilio Muñoz, "Acción y reacción en la percepción pública de la biotecnología" (Action and reaction in the public's perception of biotechnology), *Libro Verde de la Biotecnología en la Agricultura*, (Madrid: Sociedad Española de Biotecnología (SEBIOT), 1997), p. 111-120.

Emilio Muñoz, "Nueva biotecnología y sector agropecuario: el reto de las racionalidades contrapuestas" (New biotechnology and the agriculture-fishing sector: the challenge of opposing rationalities), *Genes en el laboratorio y en la fábrica*, A. Durán y J. Riechmann coords., (Madrid: Editorial Trotta, Fundación 1º de Mayo, 1998), p. 119-140.

Emilio Muñoz, "Plantas transgénicas y sociedad: unas relaciones complejas" (Transgenic plants and society: complex relationships) *La Biotecnología Aplicada a la Agricultura*, SEBIOT, coord., (Madrid: SEBIOT, EUMEDIA, Colección Vida Rural, 1999), p. 239-255.

Emilio Muñoz "Los cultivos transgénicos y su relación con los bienes comunes" (Transgenic crops and their relationship to common goods), *Bioética 2000*, M. Palacios, coord., (Oviedo: Sociedad Internacional de Bioética (SIBI), Ediciones Nobel, 2000), p. 373-385.

Emilio Muñoz, "Ética y principios en la agricultura biotecnológica: debate sobre la precaución y la equivalencia sustancial" (Ethics and principles in agriculture biotechnology: debate on the precaution and substantial equivalence), *Revista de la Sociedad Internacional de Bioética, SIBI*, 2001, nº 6: 35-54.

have become more aware of the possible negative effects on the environment and we have started to consider the possible consequences of this progress on individual and collective health. As a consequence, advanced societies have begun losing trust in scientific authorities and institutions supporting scientific-technical activities. This lack of trust coincides with the attitude of those who, at this time are the main social messengers, journalists, and, at the same time, are gaining society's trust.

We can, therefore, conclude, with great concern, that the many years of work, preparation and training in basic knowledge production centers – universities, research centers – do not count much compared to the information provided by the media which may have learned the news (scientific or technical) instances before it was launched.

The most important conclusion of this situation is that scientific controversy in mass media – as has happened mainly in the case of genetically modified food products or their derivatives – is unavoidable, but it is a trick. Society, and mass media in general, ignore the scientific method, how science goes forward (and backwards). People are unaware of a fact which I will not tire in repeating (please excuse the autocitation): “Science does not create dogmas – absence of criticism –, it leads to truths, in the Heideggerian sense of discovery, which are subject to revisions with new discoveries”.

The case of Asilomar makes the difficulty of the situation clear. The organization of the Asilomar conference was a result of a series of movements promoted by the scientists themselves who had contributed to the discoveries, who were concerned about the potential of recombinant DNA (“genetic engineering”) experiments and the possible risks in generating dangerous organisms. Berg and various colleagues organized the Asilomar meeting, officially known as “International Congress on Recombinant DNA Molecules”, but popularly referred to as Asilomar, in a Congress center in the West coast of the United States, with a double aim: responsibility and urgency. The scientists involved in the findings were anxious to put into practice the possible applications of new technology, since a committee of the National Science Academy, presided by Berg, had established, in an unprecedented decision in the scientific and technical world, a voluntary moratorium on several types of experiments using recombinant DNA until the risks had been evaluated. The Asilomar meeting organizers had decided to leave aside the ethical aspects and concentrate on safety-related issues, an aspect they believed they could treat more effectively due to their scientific training and activity. A series of guidelines were agreed upon, and were later developed by the National Institutes of Health (NIH). This allowed research to continue and even convinced Congress of the little use in establishing restrictive laws. Since then, more than a quarter of a century later, an almost uncountable number of experiments have been performed using recombinant DNA techniques in closed environments – laboratory experiments – without having registered a single problem or incident.

To remember the 25<sup>th</sup> anniversary of this historic meeting, which has received little media, social and political attention, a new multidisciplinary meeting took place in the Center of Asilomar Conferences on the 20<sup>th</sup> February 2000, with the participation of 55 people: scientists, lawyers, historians, ethics specialists<sup>16</sup>.

After 25 years, the scientists present in the “new Asilomar” agreed that the situation was quite different. Firstly, scientists agreed there was no longer a feeling of urgency to consider the technologies as safe. This optimism contrasted with the acknowledgement by scientists themselves of the strong social reactions – with Europe as a reference point, much to North America’s surprise – when talking about genetically modified crops. Ethics specialists pointed out that “the risks cannot be evaluated solely by scientists, although their contribution is very important, nor can they make decisions on their own”. The scientific community itself is also quite different from what it was 25 years ago.

Under these circumstances, the need to outline new initiatives and strategies appears necessary. These are summarized in the following paragraphs:

- Greater participation of scientists in the dissemination of scientific advances and their possible applications, with the aim of making available scientific knowledge, how it is produced and managed, which are its common and distinguishing features compared with other types of production. In a line of action which counts with several cultivated people in Spain, specifically in the case of plant biotechnology, we should mention the names of Francisco García Olmedo, who has published books such as: “*La Revolución Verde*” (The Green Revolution) (1998); “*Entre el placer y la necesidad*” (Between pleasure and need) (2001), “*La agricultura española ante los retos de la biotecnología*” (Spanish agriculture faced with biotechnology challenges) (García Olmedo and others, 2001); Daniel Ramón (“*Los genes que comemos*”, (The genes we eat) 1999); Pere Puigdomènech with continuous appearances in mass media and some narrative incursions on these issues. Personally, I have made some contributions on this subject in a book published by “Today’s Issues” in 1991, “*Genes para cenar*”, (Genes for supper) and the book “*Biotecnología y Sociedad*” (Biotechnology and Society) of Cambridge University Press.
- Development of systems and methodologies for the assessment of information provided by mass media on the issue in question (agriculture biotechnology, transgenic crops and animals) according to a series of parameters: reference framework, agenda, social-political context, type of information, quality of information, models for analyzing the understanding of science by society (linear, interactive,....).

<sup>16</sup> In the historic conference in February 1975, 140 biologists participated with a small group of doctors and lawyers and 16 media representatives (mainly press), see Marcia Barinaga, “Asilomar revisited: Lessons for today”, *Science*, 2000, vol. 287 (March 3), p. 1584-1585.

### *Comparison between risks and benefits*

This is one of the basic points underlying the social debate on genetically modified food products.

Once again, in the following paragraphs, I emphasize some of the problems I consider essential regarding this issue:

- From a methodological point of view, there are biases in the surveys which try to identify social attitudes and measure the public's perception regarding several biotechnology applications. In most general surveys performed in Europe – Eurobarometer type –, the questions on applications in the agriculture-food sector tend to concentrate more on possible risks and do not ask about potential benefits. The reverse situation occurs when asked about biotechnology applications in health: the questions are centered around the benefits, without bringing up questions about the risks involved. The questions on biotechnology applications on animals are neutral: the citizen interviewed is asked about his attitude towards animals (not about the techniques, nor their advantages and/or disadvantages).
- From a cognitive point of view, there is an emphasis on the idea that the optimistic and pessimistic positions regarding acceptance of risks in biotechnology applications, are due to the different levels of knowledge concerning the sources of risks and their possible impacts.

The assumption that in order to understand science and technology we need, at least, basic knowledge of facts and adequate information about the scientific method and its way of approaching the truth of the facts is correct. The problem lies in the fact that there is a great gap between experts and non-experts (citizens) in the different ways and models used by one or the other of them to approach technology assessment.

This gap becomes larger if we take into account the irregularity existent in information sources: trust in these sources determines the greater or lesser weight given and the use of one type or another of these sources. To summarize, we find ourselves, once again, facing the problem of “trust and credibility”.

When faced with this situation, it is difficult to find, or even propose, solutions.

I can come up with two:

- From a methodologic standpoint, it appears acceptable to insist on proposing the development of more sophisticated and focused surveys. This point has been previously analyzed in great detail by other authors. In fact, more specific surveys done in the United States or in the United Kingdom on the acceptance of genetic modification applied to the agriculture-food sector, reveal a lot more positive attitudes than those found in non-specific, general, surveys with very limited analytical sophistication in their proposal as well as their design.
- In cognitive aspects, I permit myself to recommend a greater implication of the scientific community in work related to risk analysis and research projects designed to control and follow-up experimentation and application in the agriculture biotechnology context.

Those present in the version 2000 of Asilomar followed this same line of argument: recognition of lack of research on biosafety and, what is even worse, recognition of the difficulty of this type of research being admitted in the scientific community's "excellence club".

An additional problem in this part of activity, which is so needed in order to increase social trust in science and technology and to try to once again gain credibility in the experts, is, for obvious reasons, the difficulty in transmitting information regarding these issues in mass media: boring subjects, no sensationalism, unwillingness of the media to get into the scientific logic, absence of spectacular results, scarce acknowledgement by scientific leaders of these activities.

### *Conflicts of interest*

In my opinion, conflicts of interest arise clearly in the social controversy regarding biotechnology application to agriculture. I have emphasized this in previous works<sup>17</sup>. This topic is so broad and complex that it could be, by itself, the subject of another paper. I will simply outline briefly some of the more outstanding points of this conflict:

- Conflict of interest between the different types of agriculture (organic, conventional or industrial and biotechnological).
- Conflict between the agriculture-food sector: seed producers, farmers, food-product elaborators, processors, distributors and retailers and distributors.
- Geographical-strategic conflicts with agriculture as a hostage (United States against Europe, Europe against Asia, developing countries against the whole western world and against each of the big blocks).
- Conflicts within the European Union: predominantly consumer countries against producing countries, the problem of the Common Agriculture Policy.

<sup>17</sup> See Muñoz, "Implicaciones socio-económicas de la biotecnología: nueva política científica y nuevos contextos cognitivos" (Social-Economic implications of biotechnology: new scientific policy and new cognitive contexts) in *Biotecnología y Sociedad* S. Bergel and A. Díaz, orgs. (Buenos Aires – Madrid: Ciudad Argentina, 2001) p. 365-412, and Emilio Muñoz "Percepción pública y biotecnología. Patrón de conflicto entre información, conocimiento e intereses" (Public perception and biotechnology: Pattern of conflict between information, knowledge and interests) in *Plantas Transgénicas*. E. Iañez, ed. (Granada: Editorial Comares), in press.

- Conflicts within great companies: going from fusions within agriculture-chemical companies and pharmaceutical companies which occurred a few years ago, towards separation in a small period of time. “Retracing one’s steps”.
- Possible conflicts derived from new uses of agriculture for the production of substances of great added value.

### *Contrasted rationalities*

In the book edited by A. Durán and J. Riechmann<sup>15</sup>, my article on the challenge of contrasted rationalities tackles the conflicting relationships between different ways of approaching the implications of new biotechnology in the agriculture-fishing sector.

In that analysis, I evaluate the suitability of placing the debate under a set of well established and clear definitions. I set the conceptual framework in the line of the Risk Society and the first conflict between experts and citizens, going into depth in what has previously been pointed out: the differences in trust, the different way of visualizing (and valuing) risk and the different judgements (“rival or contrasted rationalities”). Next, I present an assessment of the sector’s situation: achievements, risks, social reactions. This assessment is summarized with the presentation of a social criticism where different critical positions in the scientific-technical arguments are contrasted. The proposal tries to defend the rational debate with the integration of modern initiatives of social dialogue in Spain.

### *Values*

The relevance of values arises as soon as we study the results of surveys regarding social attitudes towards new technologies in depth. A society such as the German one, which is used to appreciating the value of a technique as a basic instrument for economic and social progress, shows more tolerant attitudes towards applications than towards scientific advances which bring up the ghost of eugenics. A society such as the Spanish one, which is not very familiarized with the value of a technology as the engine of development, shows the opposite attitudes: their position towards scientific advances is more positive (the romantic imperative) than towards applications. Comparative analysis regarding this subject have shown the importance of values, or more specifically, of culture.

The limitations of the surveys, in two aspects, stem from this: a) measuring the dimension of the information we have regarding science and technology (or technoscience as some authors, such as the Spanish philosophers J. Echevarría and José Sanmartín prefer to call it)<sup>18</sup>, in accordance with social-historical roots, and that which is transmitted; b) constructing scientific culture indicators on their own or in relation to other cultural dimensions. The data from the survey are not self-explanatory. As I have repeatedly mentioned in the last few years, we need to know the context, systematically analyze the field we are

<sup>18</sup> For a more in depth reflection on the relationship between science and the act of evaluating, I refer the reader to the recent work by Javier Echevarría, *Ciencia y valores (Science and Values)* (Madrid: Destino, 2002).

exploring and the elements and factors which make it up and which condition it: for example, the myths, challenges, heroes, transformations. I believe it is important to state, with satisfaction, that the ideas I have defended agree, in a broad sense, with those of other researchers and analysts on these topics (Bauer, Durant, Sorensen<sup>19</sup>) despite not having had the chance to exchange and discuss our opinions. What has brought us together is our analytical concern for the same topic: the familiarity of the public – with the difficulties involved in identifying and suitably defining this term – with science and technology and its relationship with the degree of acceptance of new technologies; in our case, of biotechnology. We have reached a virtual consensus through our reflections.

The cultural indicators reflect the measurement of the stock of images, beliefs and values existent in the population. In the more specific case under study, this “storage” refers to science and technology. They are the result of a hybridization process, also tinted by an important mixture of popular, mythical, religious, moral images and other traditions, which is the basis for the future development of science (and technology).

As science has been proven not to be neutral, or more specifically, that scientific activity is subject to a series of determining factors, society, and as an intermediate party, mass media, has increased their distrust in experts, at the same time as they have, paradoxically, put their trust, up to the point of canonizing, in scientific facts, both to criticize as well as praise them. Both extremes are being practiced in an exaggerated manner in most cases (the hyperbole has become common practice).

#### ***Some lessons from this controversy for the perception subject***

I have tried to present an overall view of the social controversy concerning transgenic crops from a holistic approach. Bringing up the multiple factors which are involved in it, makes the difficulties existent in its understanding and its debate from a rational point of view evident. From the point of view of its complexity, the deficiencies in the methodologies used to measure the factors which shape the social debate on agriculture biotechnology are revealed.

The proposals we dare make point towards a deeper reflection, more research and better information.

- i) The analytical methodology employed needs to be improved, especially in terms of survey outline and design. The interpretation of

<sup>19</sup> *Between Understanding and Trust. The Public, Science and Technology*, p. 151-156, 157-158, 237-260.

results, which is in need of more and better efforts, will, no doubt, ameliorate with these methodological improvements.

- ii) The need for developing cultural indicators and advancing in qualitative experimentation will allow the identification and characterization of the contexts, a decisive factor for understanding public reactions.
- iii) A greater involvement of scientists in the dissemination of scientific facts, their meaning, the instruments and routes used in generating knowledge, as well as the mechanisms used for valuing its production is necessary.
- iv) Last, but not least, the development of methodologies which will allow the evaluation of the information given to society, especially by the media, appears to be essential.

### ***Perception of biotechnology: Europe and Spain. A summary.***

Research on the public's perception of biotechnology has increased in intensity and complexity during the last decade. It has become essential to go from a merely descriptive viewpoint, which offers the public's response to biotechnology as if it were a simple reaction, to one which tries to understand the construction and expression of those opinions according to surroundings of symbolic value.

The sampling and data collection methodology is well established, which allows treating the European Union as the object of the analysis, despite its complexity and diversity. At the same time, it allows the identification of different profiles for each state. Another important achievement in the methodology field is that surveys have become more focused on a series of applications, which aids in the characterization of national profiles and allows a better framework for comparison to examine the development of opinions.

The main problem lies in the cognitive elements used to shape the surveys and the explanatory factors which aid in the interpretation of results.

The first efforts taken in this sense were based on the "cognitive deficit" model. It was believed that a more or less favorable attitude towards a technology was directly related to the degree of information (or knowledge) of the citizens. For this reason, surveys were initially designed with two purposes in mind: measure the degree of scientific and technical knowledge and relate it to the opinions towards biotechnology in a general way. The first results were quite

in the opposite direction of the rational argument on which the public opinion analysis had been based. The North American society showed a lower level of scientific-technical culture than European societies, but their attitudes towards biotechnology applications were a lot more positive. Within the European Union, the countries more cultivated in scientific and technological aspects, such as Germany, the Nordic countries, and the United Kingdom, were more skeptical and negative regarding the future of biotechnology and its applications. On the other hand, countries with a lower level of scientific knowledge, such as Spain, Greece and Portugal, showed more positive attitudes. For unknown reasons, lately, Greece has changed in quite the opposite direction.

The fact that applications related to human health were considered more acceptable by European citizens led to the use of an explanatory line of the importance of interests for the end user, the final consumer, to explain the different positions towards the use of biotechnology in Member States. The identification of differences according to the object being genetically modified, - animals were less accepted than plants, and these were less accepted than bacteria – directed the national profiles' explanatory arguments towards cultural and religious differences. This interpretation gained support when the comparison was centered on applications related to modification of animals; Spain showed great acceptance, which is in accordance with the not so friendly relationship of Spaniards with animals. However, Gaskell<sup>14</sup> considers this argument to be, at least, candid, and not very sound.

Gaskell has searched for a possible explanation of the position adopted by countries in relation to their economic development. He points out that the three countries which show most favorable opinions towards modern biotechnology, Portugal, Finland, and Spain, are the new emerging and modern economies of Europe and it may be that these countries see biotechnology as an instrument to gain access to technological advances and economic development.

Independently of its certainty, this argument, in Gaskell's own opinion, is at least as candid as the one it calls upon: beliefs and cultural values.

The following are some counterarguments which can be pointed out:

1. The economies of the three countries are very different, both regarding the instruments used for their economic growth as well as the strategies employed in that objective: technology in one case, tourism and services in the others.
2. We cannot say that the economies of Portugal and Spain are more modern than that of Ireland in terms of innovation indicators.
3. The modernization element of the economies of Portugal and Spain is not a technological and innovating strategy. The biotechnology system in those countries is not well developed. There has been no explicit strategy of economic promotion in those two Southern European countries which has advocated biotechnology.

Therefore, it seems logical to admit that interpreting results concerning opinions and attitudes towards biotechnology is an arduous and difficult task, which cannot be based on an explanation in a single direction. It is reasonable to consider that a series of factors are involved in shaping these opinions, most of which, up to now, have been considered unique and context-isolated explanatory factors. It is worth mentioning a few: cognitive elements which have a positive and negative influence; trajectories in the spreading of information according to the scientific-technical development; interests, as much individual as collective and general; cultural and social values.

Within this complex context, we can argue that the Spanish case in the public's perception of biotechnology is a reflection of a series of factors: limited knowledge levels; a continued willingness to advocate modernization, - an objective which Spain has managed to reach with great effort -; ability to accept and assume risks, when those risks are seen from a distance and which, on the other hand, are considered adequate in order to obtain some benefits. Especially, if they are mainly related to the modernization process, a bet which in Spain is characterized by an improvement in the human resources' abilities and in the services field.