Economics of the alive one: technology adoption versus technology acceptance

The case of agricultural biotechnology

(Project proposal)

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Why does an innovation succeed or fail? How does this innovation diffuse? By which channels and under which conditions? The comprehension of the innovation process appears like a nodal and significant question in a double way: innovation is considered by economists as the main source of growth and the comprehension of its mechanisms as the mean to increase the rate of it; moreover, it is a rather mysterious process whose knowledge must allow its rationalization and its full adequacy to social needs. Another problem emerge in the case of biotechnology, as a major innovation on the end of past century, more specific with the purpose of the study: to what extent the control and use to economic ends of genetic resources alters the relationship between Human and Nature on one side and between humans in an other side? The case of agricultural biotechnology is significant here because it crystallizes these two fundamental questions in economics of innovation as much as in environmental economics.

The facts are as follows: genetic engineering with agricultural and food use is rejected by a growing number of individuals or groups, particularly in Europe while at the same time its use by farmers or retailers can improve broad benefits on environmental protection (reduction on pesticide use and other chemicals), on agricultural yields essentials to feed a growing world population, on a better crops adaptation to climatic conditions or on the improvement of products' agronomic qualities (e.g., taste, conservation...). Why this new technology is rejected? What are the economic effects of this rejection? Are they measurable? Two theoretical frameworks can be considered.

Uncertainty on risks for human health and the environment seems to constitute the determining element of this non-acceptance of agricultural biotechnology. However, numerous studies undertaken to assess the nature and extent of this risk show that it is unlikely and widely controllable by means, certainly expensive, but easy to implement. Thus, the low public acceptance of agricultural biotechnology is assumed to be due to a bad information on risks associated with genetic engineering. And this lack of information creates an information asymmetry between producer and consumer of genetically modified food; Public information on scientific and technical characteristics of these products seems to be the mean to reduce this asymmetry. Indeed, the literature on information economics results in thinking Genetically Modified Organisms (GMO) as credence goods (Darby and Karni, 1973), whose consumption depends on consumer confidence in its characteristics. To ensure effective consumption of these products, firms and governments have to restore public confidence on it. And the consumption of these products leads to the full diffusion of the innovation. However, if we discuss this theory, it does not appear sufficient to understand the sense of the phenomenon, for at least two reasons. First, consumers are not main users and do

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not benefit of the genetic engineering technology[2]. They consume products, which incorporate technology but are regarded as " equivalents in substance " with conventional products. The relation between the consumer and technology is not a direct one. The negative response to GM products is not a refusal of the product itself but the rejection of the process used to produce it. Then, even if we consider that these products incorporate genetic engineering technology and are therefore genetically modified products, the rejection of such products is addressed primarily by individuals or groups witch are sufficiently informed on their characteristics and the risk that their diffusion on a large scale could present for human health and environment. The case of Bt corn in Europe is meaningful of individuals and organizations' mobilization by using uncertainty on GMO risks to reject the technology. It shows that the GMO moratorium is not primarily related to a lack of information on the nature and effects of these products.

The second way to think about this facts, more related to economics of innovation, consists in questioning the adoption and diffusion's conditions of an innovation and establishing which of its conditions are not fulfilled in the case studied. Few theoretical elements make it possible to suitably capture the phenomenon. Indeed, a wide majority of technology diffusion models[3] only consider individual technology adoption variables and analyze the replacement of an old technology by a new standard one[4]. By focusing on these variables, technological and economic superiority of genetic engineering appears obvious, and its diffusion on a large scale impending. More complex models (e. g., Janszen and Degenaars, 1998, in reference to National Systems of Innovation), suggest a multi-variable analyzes, with particularly institutional variables (public and private research structure, venture capital, patent system, level of public acceptance...) in order to explain differences in the adoption and diffusion rate of a new technology. One of its is the rate of public acceptance. The higher it is and the quicker technology will diffuse. Simulations show the existence of a threshold beyond whose acceptance will have drastic consequences on the innovation process. Although tempting, this model does not allow to isolate completely public acceptance among other variables and to study its determinants, while it appears as fundamental in the diffusion of agricultural biotechnology. Moreover, acceptance is regarded as exogenous with the innovation and diffusion process, whereas it can be seen like a central piece of it. Then, the question becomes: what elements shape public technology acceptance of genetic engineering and how to measure these factors?

The measurement of this variable is not easy because of its qualitative and subjective character. Indeed, acceptance refers here to a set of values and cultures which is not straightforwardly quantifiable and reducible to economic variables. One can approach it by the consumer decision to purchase a genetically modified product, or, without such information, by the intention to buy or not these products. In this framework, consumption act is assimilated to the acceptance of the technology and the refusal to buy to a rejection. However, primarily for technical reasons, it is difficult to calculate accurately the volume of product purchases incorporating the genetic engineering technology. As long as identity preservation and the separation between GM and conventional products have not been fulfilled, it will not be possible to measure the share of GM products on whole sales. This separation should occur rather quickly following the labelling regulation on genetically modified products recently initiated in Europe. But discussions on mandatory or voluntary

[2] First and second generations of GMO are input oriented and only benefit to producers in reducing costs of pesticide use and increasing crop yields.
[3] For a review of literature on technology diffusion models, see for example Geroski, 2000.
[4] In the tradition initiated by Zvi Griliches, 1957, which consist in representing the technology diffusion process as a S-shape curve.

labelling will not make it possible to give an exact measurement of this element. An approximation of it can be the sale of seeds to food processors and retailers, but such a variable moves us away the consumer and does not make clear the relation between the purchase of a product and technology acceptance. Without a reliable data set consistent with the purchase and acceptance of genetically modified products, one way to assess the public acceptance can be the estimate of willingness to pay for such products. If they are willing to pay, they accept the technology, otherwise, they reject it. However, the method is not able to grasp the phenomenon rightly. On the one hand, it focuses on individual decisions whereas GMO rejection results in the emergence of collective and representative organizations, which produce economic effects, in reducing sowing acreage or sales shares of these products. In addition, the approval of the consumer is skewed by the strong demand sensitivity to changes in price, unavoidable if identity preservation is decided. Moreover, the refusal to pay for GMO-free products does not mean agreement to buy products, which contain some.

If the explained variable (GMO public acceptance) is not easy to understand and gauge, the measurement of the explanatory ones raise to as much difficulties. Between 1980 and 1998, more than fifty qualitative and quantitative surveys have been carried out all around the world to assess public perception and acceptance of biotechnology, genetic engineering and some of their applications, particularly on agriculture. The results defer according to countries, variables, and method making all comparison risky. However, some great results, handled with precaution, seem acquired. Among these results, majority of surveys shows that biotechnology applications on therapeutic use grant a more significant credit than the agricultural or the animal uses. It also appears that perceived utility of these applications is stronger for the pharmaceutical ones and less for agricultural and food fields. Finally, public acceptance seems strongly related to ethical and moral values as much if not more than with an information lack on technology characteristics of genetic engineering. Even not being directly workable, these results can constitute good foundations to built and define significant issues to understand public acceptance on agricultural biotechnology, and to a large extent the low diffusion rate of GMO in Europe.

In short, the public acceptance problem, as an economic one, exceeds its own bounds and refers to social and political structures in witch agricultural and food markets are embedded. Control by citizens of science and technology decision making; more widely their power on their own destiny and the evolution of society: all of these questions go beyond economic analyzes but have to be answered because of their connection with market structures and individual behaviors. GMO rejection is only a part of a broader and collective social movement of mobilization to make the world like citizens think it would be.

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