MORAL AND ECONOMIC THEMES OF SCIENTIFIC RESEARCH AND GENETIC MANIPULATION OF FOOD

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ABSTRACT

It starts from the premise that the relationship between ethics and genetics is summarized in the assertion that science should not say what is right and what is wrong, but should only aim to achieve the discoveries related to understanding, explanation and -is worth to say- the subsequent control of the phenomena. Based on this, the following essay intends, on the one hand, the intricate disjunctive present in the relationship *moral-scientific researc*h (in general), and on the other hand, the socioeconomic aspects associated with the production and use of transgenic foods (in particular), as well as the ethical problems in which services are immersed, such as those arising from the interests that promote this new technology and the associated ecological and human health risks. The aforementioned includes a cost-benefit analysis that considers the opportunity cost -from the economic and moral point of view- of the application of innovations in the field of genetically modified foods, as well as a study on the usefulness of the regulatory framework, from a perspective that considers it a precautionary element in the face of imminent risks and as a promoter of the flowering of biotech crops, all in the interest of arriving at final reflections on the issues addressed.

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INTRODUCTION. ON THE PURPOSE OF SCIENCE AND MORALITY

The relationship between ethics and genetics is summarized in the assertion that science should not say what is good and what is wrong, but only -through the rigorous application of the scientific method- should claim the attainment of discoveries related to the understanding, explanation and -is worth to say- the subsequent control of certain phenomena. In turn, judgmental evaluation, which exceeds the purpose of science and which responds to considerations and is reflected in the strictly human interactions on which moral standards are decreed, constitutes the object of study of ethics.

What is mentioned in the previous paragraph reflects on the fact that scientific research must not respond to the moral implications of the results obtained, they will be judged as "applicable or inapplicable" in comparison with the set of precepts, values and ideals with which a certain human group is guided in a certain historical epoch, that is, based on what is considered morally correct and incorrect at a certain moment, and then it will be the Moral Philosophy -Ethics- that deals with reflecting on mentioned moral codes.

A conflict arises when the moral debate is not about the "right or wrong" of the application of certain scientific discoveries in life, but it is the advancement of the scientific research itself that is imbued in that dilemma, how it can happen in the case of the patenting of genetically modified organisms.

The following essay intends to analyze, on the one hand, the intricate disjunctive present in the relationship *moral-scientific research* (in general), and on the other hand, the socioeconomic scope associated with the production and use of transgenic foods (in particular), as well as well as the ethical problems in which the aforementioned processes are immersed, such as those arising from the interests that promote this new technology and the potential ecological and human health risks. In addition, the usefulness of the regulatory framework will be studied as a precautionary approach to imminent risks and also as a promoter of the flowering of biotech crops, all in order to arrive at final reflections on the issues addressed.

THE MORAL DISCUSSION IN SCIENTIFIC RESEARCH

1. About the moral and immoral of scientific discovery and the objectives that promote them

Throughout the history of thought there have been few apologies to ignorance as important as those based on the argument that the human being *should not play at being God*, which would be analogous to thinking that man *has to respect certain limits*. The disobedience to this principle is what has driven the people to move mountains, change the course of rivers, build buildings that dare to caress the sky, design aircraft that today exceed the flight of any bird and submarines that dive into the depths of the ocean, undertake journeys, invent defibrillators, all kinds of medicaments and medicines, vaccines, organ transplants and in vitro insemination. In short, the man who was weak and physically inferior to most of the animals, became the ruler of the earth and the creator of the wonders of the technique due to his insatiable curiosity; if it had been limited - successfully - today it would not surpass from any point of view its progenitors from a thousand or ten thousand years ago.

On the other hand, it is true that the scientific incursion has also made possible the invention of nuclear bombs and all kinds of weapons of mass destruction, among other objects and techniques that in no way improve the tenor of man's life; but science must respond with indifference when it is attributed responsibility for the misuse of its discoveries. The benevolent man by ignorance is not benevolent, but ignorant and even then that has never been a valid argument to attack the search for the truth. There is no such thing as a moral act in knowing how to cause the fission of a fissile atom by means of a neutron, just as there is no way of knowing how to transfer genes from one organism to another (transgenesis). When science transgresses nothing, in terms of the development of its research and the attainment of its discoveries, the moral order disposed, the debate about the proper or improper of its results should not take place. Even if the discoveries of scientific work are used in a way that is considered immoral, science should never pay for the cost of such acts.

For some the attack on science from the ethical point of view not only finds justification in the immoral use of their discoveries. The motivation to demand restrictions on research has also been based on the immorality of the objectives desired by the man of science. Again the argument is based on extremely fragile bases, the knowledge in this case is not the one that corrupts the man, so the motives that make it possible must be indifferent to him. Eventually the promotion of such work may not take place, so inappropriate of its ultimate ends, but its restriction can not but reach those who seek to know by knowledge itself, thus depriving the entire society of a new finding. In addition, the inappropriate in such circumstances reflects on the possibility of consummating an act considered improper subsequent to the work done or on the corrupt and greedy of the promoter interests, but never on the knowledge or the investigation itself, so that ultimately the Moral justification to the limitations of such projects implies implicitly knowledge of the intentionality that promotes them, which is impossible in all cases.

2. **When science and morals collide**

There are certain situations in which the scientific research itself is the one that is involved in a moral crossroads. In this case, it is no longer specifically about the use of potential discoveries or the purposes that promote the analysis of certain phenomena, but rather of those circumstances where necessarily the advance or continuity of the scientific investigation represents a controversy as far as the disposed morality.

On the basis of these two axes will address the ethical issue of genetic engineering in food, after analyzing the socio-economic scope of this technology throughout history and today.

GENETIC ENGINEERING IN FOOD. CURRENT AND PAST

1. **Conceptual framework**

Genes of plants or animals can function when they are transferred to another organism, basing the possibility of generating Genetically Modified Organisms (GMOs). The inserted genes determine the specific presence of new proteins, giving the organism a new function or trait alien to its nature.

Therefore, a GMOs or transgenic[2] is defined as one whose genetic material has been altered using genetic engineering techniques (INRA, 2013). That is, through scientific techniques that manipulate DNA sequences directly, enabling the extraction of a given biological taxon and its inclusion in another, as well as the modification or elimination of these genes. While the classic genetic improvement -*artificial choice*- modifies the genes of a population indirectly, through directed crosses (Watson, 2004). In the USA the term GMOs includes both types of genetic modifications (USDA, 2005).

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[2] Rigorously speaking a transgenic is just a kind of GMOs

Within this scope and in accordance with the United Nations Convention on Biological Diversity, biotechnology refers to any technological application that uses biological systems and living organisms or their derivatives, for the creation or modification of products or processes for specific uses (UN, 1992). The use of biotechnology in the agricultural sector is what gives rise to transgenic foods.

2. Historical development

Until the advent of genetic engineering there was no mechanism available that allowed (re)designing organisms to adapt them quickly and in a controlled manner - the latter subject to controversy. Food biotechnology today applies the tools of modern genetics to the improvement of the locality of products derived from plants, animals and microorganisms. But since ancient times, man has selected, planted and harvested seeds in order to increase their yield and quality, so that the improvement of the species used as food has been a recurrent process in the history of mankind.

Between the year 12,000 and 4,000 a. C. modifications were already made by the artificial selection of plants. In 1876, the first intergeneric crossing was made, that is, between species of different genera (Moctezuma, 2011). In 1909 the first fusion of protoplasts was carried out (Küster, 1909), and in 1927 *"mutants"* of higher productivity were obtained by irradiation of X-rays to seeds. The first genetically modified plant[3] was created in 1986 and finally in 1994 the marketing of the first genetically modified food, the Flavr Savr tomatoes, was approved (La Información, 2016).

By 2017, 22 years after its legalization, biotech crops have expanded to 189.8 million hectares in 24 countries. With the exception of 2015, the expansion of the cultivated area has been continued, with 12 years of double-digit growth rates. It is highlighted that the average rate of adoption of biotech crops in the five main producing countries increased in 2017 until approaching saturation, with the USA at 94.5% (average for soy, corn and canola adoption), Brazil (94%), Argentina (~ 100%), Canada (95%) and India (93%). This is due to the immediate approval and commercialization of new crops and biotechnological characteristics to address the problems related to climate change and the appearance of new pests and diseases (ISAA, 2017).

[3] It was a tobacco plant to which a resistance gene for the antibiotic Kanamycin was added to its genome.

The retrospective analysis indicates that the world area of biotech crops has multiplied by 112, from 1.7 million hectares in 1996 to 189.8 million hectares in 2017, which makes biotech crops the fastest growing technology adopted in recent times. 2.3 billion hectares were achieved in 22 years (1996-2017) of commercialization of biotech crops (ISAA, 2017).

ETHICAL TOPICS IN THE USE OF TRANSGENIC FOOD. THE COST-BENEFIT ANALYSIS

1. The risks and utility behind the numbers

The impressive figures presented in the previous section, regarding the expansion and adoption of transgenic crops, highlight the need to reevaluate not only the benefits, but also the potential associated risks.

The questioning of genetic modification has led on several occasions to the point of considering such practice as immoral in itself, with a claim that the intrinsic value of living beings is affected. To this controversy may be associated various beliefs and issues of questioning, such as the role of God, the sacredness of nature and the moral implications of accepting the existence of owners of life forms through patents. In addition, concerns of a moral nature influence and strongly affect the opinion of people about the possible risks associated with the production of genetically modified foods. In this sense, some of the factors identified by Eduardo R., Yunta (2013) as risky in the production of biotech foods are:

• There is an inability to accurately insert a new gene, the current understanding of how they are controlled is extremely limited and any change in the DNA of an organism can have unexpected and impossible to predict effects.

• Marker genes used in genetic engineering confer resistance to antibiotics normally used in humans and in veterinary medicine. Therefore, a second event, although quite improbable, would be that: eating transgenic foods containing these marker genes could accelerate the appearance of antibiotic resistance in the bacteria of the intestine.

• Could generate new resistant weeds or superweeds (resistant to herbicides and pesticides) by transferring genes from crops to weeds of related species.

• New insect pests resistant to insecticides could be produced.

• In terms of negative effects on human health, the greatest potential for adverse consequences is toxicity. It is also possible the development of allergies, associated with adverse reactions of the immune system to some component of food.

• There could be indirect effects through animals that consume some part or a product of a transgenic plant.

• There could be an impact on biodiversity, decreasing native species and varieties.

• Another problem has to do with biosecurity and the possibility that terrorists release highly pathogenic organisms introduced into consumer organisms having previously developed a vaccine.

Although several of the aforementioned risks confirm real difficulties, a large part of them can be mitigated through certain precautionary measures such as those mentioned in the following sections. On the other hand, it should also be noted that some of the problems presented derive from concerns of a purely speculative nature, which usually responds mostly to unfounded fears due to the imagination, rather than to intranquities derived from the empirical analysis.

In another order of ideas, food insecurity continues to represent a major problem for the world today. The Global Report on the Food Crises of 2017 indicates that around 108 million people - in 48 affected countries - remained at risk or in serious food insecurity for 2016. Climate change is also another challenge that can cause a 23% decrease in the production of major crops (such as corn, wheat, rice and soybeans) by 2050. Estimates indicate that the protein content of the main staple crops is will reduce considerably: barley (14.6%), rice (7.6%), wheat (7.8%) and potatoes (6.4%) due to climate change (WFP, 2017). In this context, it is emphasized that improvements in modern crop technology and agronomic practices should be adopted in their entirety since they have the capacity to reduce annual fluctuations in availability and to maintain the nutritious contents of food, thereby reducing climate risk.

Biotech crops are being adopted globally because of the enormous benefits for the environment, the health of humans and animals, and contributions to improving the socio-economic conditions of farmers and the public in general. In opposition to the environmental risk argument, it is worth noting that (between 1996 and 2016) transgenic crops contributed to the conservation of biodiversity and a better environment by: saving 183 million hectares of land, reducing the use of pesticides by 8.2%, reducing the EIQ (coefficient of environmental impact) by 18.4% and -only in 2016- CO^2 emissions by 27.100 million kg, which would be equivalent to removing 16.7 million highway cars for one year; and -from the socioeconomic point of view- the global contribution of biotech crops in the last 21 years (1996-2016) has meant a benefit of US$ 186.100 million, helping to alleviate poverty by raising the economic situation of more than 65 million of people (ISAA, 2017).

As mentioned above, the advantages of biotech crops mean less use of insecticides in the fields planted by developing resistance to one or more orders of insects (Morse, et al., 2004), which results in a lower impact of the ecosystem that harbors the crop and in the health of the workers who manipulate phytosanitary products (Pray, et al., 2002). In addition, pollution in aquifers and soil has decreased (Devos, et al., 2008). The adhesion of producers to smart farming has been testimony to the greater resistance to insects and tolerance to herbicides of the new GMOs.

2. The opportunity cost

Despite all the benefits documented and discussed above, the rebuttal to those critical of biotech crops, which raise unscientific accusations, must include an analysis of the benefits that could potentially be obtained -cost of opportunity- if the regulations of the countries and the approvals of the transgenic crops were not affected by fictional accusations.

A report from the Information and Innovation Technology Foundation (ITIF) indicates that the current regulatory climate, highly restrictive for agricultural biotechnological innovations, could cost low and middle income nations up to US$ 1.5 trillion in economic benefits up to 2050. It has also been calculated that only for African agricultural economies, the continuous suppression of biotechnological innovations in agriculture had cost at least US$ 2.500 million between 2008 and 2013. In the same order of ideas, it is estimated that in Australia the loss of opportunities due to the delay in the adoption of biotech canola between 2004 and 2014 include an additional 6.5 million kg of active ingredients applied to the canola farm; 8.7 million liters of diesel fuel burned and an additional 24.2 million kg of greenhouse gases (GHG) and compound emissions released (ISAA, 2017).

It is based on the aforementioned observations that it can be argued that the true socioeconomic and moral disaster is found in the barriers, erected by the critics of GMOs, to the development of the poorest nations of the planet, which depend mainly on agriculture for subsistence.

3. Motivations to the investigation. Intellectual property and ethical reflections

It has been identified the coexistence of two discourses that turn out to be critical, on the one hand to the motivations that drive the scientific research of GMOs and on the other hand to the scientific research itself. On these guidelines, a first group sees as positive the incentive for research and innovation generated by GMOs patents, but at the same time questions whether commercial interests are sought through intellectual property rights. That is to say, the philosophy that bases the production of transgenics -they say- is based fundamentally on economic interests rather than on producing social benefits, while there are social sectors that believe that the main objective should be: to reduce the use of chemical inputs, increase productivity, reduce costs, preserve the environment and alleviate hunger in regions where malnutrition exists. The second group fuels the controversy related to the questioning of the value of transgenics due to their potential risks, in addition to considering that the intrinsic value of a living being can be affected by being subject to genetic modification. Under this last argument, it is questioned - from the ethical point of view - that private entities can take over the quality of reproduction of certain organisms, through intellectual property rights (Yunta, 2013).

From a perspective of purely economic viability analysis, there seems to be no doubt about the usefulness and necessity of the existence of property rights in the biotechnology industry for the durability of scientific research in this area, even more taking into account that biotechnology it is probably one of the sectors where research is most intensively used. The comparison with other sectors such as the chemist and the pharmacist will reinforce the argument presented, in the first the expenditure on research and development (R & D) constitutes approximately 5% of total income, while in the second said figure does not usually exceed 13% On the other hand, biotechnology companies invest, in general, a considerably greater amount of their income in R & D (frequently between 40% and 50%).

Therefore, as in any sector that depends on research, the protection of its results for the continuity of its development are of the utmost importance (Burrone, 2006).

Now, with respect to the moral analysis of the interests that promote scientific research, it is worth clarifying that although the search for social benefits does occupy a preponderant place in the agenda of various institutions of the globe, appeal to the altruism of man in in opposition to its own economic and commercial interests, it can not but become a mistaken conception of the elements that define human action itself in an *extensive and abstract order*[4]; conception aligned with a perfect and ideal world, but that does not escape being an illusory utopia. On the other hand, about the moral questions to the rights of intellectual property on the GMOs can be extrapolated the reflection realized by Mises (1927) on the ethical legitimacy of the private property:

> Accordingly, when we reach the conclusion that an institution is beneficial to society, one can no longer object that it is immoral. There may possibly be a difference of opinion about whether a particular institution is socially beneficial or harmful. But once it has been judged beneficial, one can no longer contend that, for some inexplicable reason, it must be condemned as immoral. (p. 34)

Certainly the possibility of transferring genes from one species to another and patenting living organisms genetically modified with industrial use, has made possible the enormous growth of biotechnology and contributed in an unquantifiable way to the future welfare of society.

4. Normative prevention and final conclusions

The validity of the arguments presented is based on an economic order that, provided with an adequate regulatory framework, gives due importance to issues of environmental sustainability, the health of the population and the consent of the population on the placing on the market of mentioned products.

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[4] The terms of extensive and abstract order are used in the sense understood by the own Friedrich A. Von Hayek. To respect see http://www.anarcocapitalista.com/HayekMoral.htm

In this section, the importance of the regulatory framework as a palliative of the risks identified above is highlighted, these can be minimized and even extinguished by conducting field tests before placing a transgenic in the market. For example, in plants, once the introduction of the foreign gene is achieved, its function and stability in the greenhouse can be evaluated. Followed by small field trials on plots totaling 50 to 500 m^2 that, depending on the nature of the plant and the modification obtained, may require containment measures: physical separation between sexually compatible plants, use of crops barrier, elimination of compatible wild species, etc. As the evaluation process progresses, tests can be conducted in different environments. However, in many countries this type of measure is not yet fully specified in the transgenic production standards.

On the other hand, the principle of consumer autonomy implies that the consumer must be able to make his decisions freely and fully informed of what is offered. In this sense, the regulation of labeling for foods that contain transgenic elements is important. The labeling should be regulated, even more so considering that there are people who have adverse reactions to specific proteins present in food. Without labeling, consumers of transgenic foods may unknowingly violate their own dietary and / or religious restrictions.

The aforementioned concludes that long-term sustainability and ecological risks must be considered, using precautionary measures and responsibility towards future generations. It is necessary that there is monitoring and evaluation of the environmental and social impacts of biotechnology products, taking into account all the elements to reduce risks.

Genetic engineering in food promises to be able to overcome the restrictions of nature, crossing limits that were considered insurmountable. The fears of the emergence of *chimeras* resemble the fears that once hovered over the incursion in atomic energy and its risks, such as nuclear war. Even in that case, what encouraged the drums of war was never the discovery of a new technology. The discovery and use of fire personifies the starting point of technology in human existence. A more dangerous moment can hardly be identified. Despite this, human beings learned to live with the benefits of fire, mitigating and almost extinguishing their threats. Who illustrated us that this was possible was the science itself, faced with biotechnology, the challenge is similar.

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