Genetically Modified Organisms in Pope Francis' Conception of Integral Ecology

Organismos Geneticamente Modificados na concepção do Papa Francisco de Ecologia Integral

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Abstract

This article explores the issue of Genetically Modified Organisms (GMOs) both in the socio-ecological and the ethical-theological approaches. Concentrating on Pope Francis' view of integral ecology, it testifies that genetic manipulation by itself is not condemned, but scientific research reveals they are not a sustainable solution. Ethical considerations require deeper investigations on alternatives before any commercial decisions are made.

Keywords: Genetically Modified Organisms (GMOs); Integral Ecology; Catholic Church; Pope Francis; Encyclical Letter Laudato Si'.

Resumo

Este artigo explora a questão dos Organismos Geneticamente Modificados, tanto na abordagem sócio-ecológica quanto na ético-teológica. Concentrando-se na visão do Papa Francisco de ecologia integral, atesta que a manipulação genética por si mesma não é condenada, mas a pesquisa científica revela que pode não ser uma solução sustentável. Considerações éticas exigem investigações mais profundas sobre alternativas antes que decisões comerciais sejam tomadas.

Palavras-chave: Organismos Geneticamente Modificados (OGMs); Ecologia Integral; Igreja Católica; Papa Francisco; Carta Encíclica Laudato Si'

Introduction

In his Encyclical Letter *Laudato Si'*, Pope Francis discusses the care for our Common Home – as he defines Planet Earth. Facing global environmental deterioration, he addresses to everyone, not only religious people, to discuss common issues of urgent need. The letter introduces new concepts such as "integral ecology" (FRANCIS, 2015, p. 40-47) and "ecological conversion" (FRANCIS, 2015, p. 62-63). Francis also reviews some ecological aspects, aiming to make people conscious about "the appeal, immensity and urgency of the challenge we face" (FRANCIS, 2015, p. 5). Global warming, pollution, loss of biodiversity and Genetically Modified Organisms (GMOs) are main topics in the mass media all around the world since the last century. However, they are not always accompanied by a proper scientific discussion. The Encyclical, then, initiates a consistent approach of the theme.

GMOs are actually an explicit issue in the letter, when the Pope writes about "New biological technologies". Francis makes clear that is necessary to consider negative consequences and that indiscriminate genetic manipulation is not acceptable. He reassures that "human creativity cannot be suppressed", but highlights the considerable risks inherent to the power of human activity, which impose the need to "rethink the goals, effects, overall context and ethical limits" of such an impact (FRANCIS, 2015, p. 39).

The GMOs' solution was first presented in the seventies, when the first genetically modified animal – a mouse – was created (JAENISCH; MINTZ, 1974). In 1978, one of the first transgenic[1] bacteria was conceived to produce synthetic human insulin (STERN, 1995) and, in 1994, the first transgenic food was marked: the Flavr Savr tomato (MARTINEAU; GRESSHOFF, 1997). The genetic engineering has created thenceforth a lot of other organisms to satisfy human necessity for food and resources.

Thus, the present paper aims to discuss Pope Francis' Christian approach on GMOs expressed on the referred Encyclical. The focus will be at his conceptions of "integral ecology", which constitute a theological approximation of urgent socio-ecological questions based on scientific evidences. We are not craving for conclusions but trying to explore the options currently available at this point of humankind's development.

[1] The term "transgenic" is used in many cases as synonym to GMO; however, it means the GMO has been generated through an exogeny DNA (transgene), transferred from another organism into its genome. The GMO refers to any modification in some organism's genome, not only from an exogeny molecule.

Socio-Ecological Consideration

The last decades were crucial to genetic engineering development, which quickly made possible a large range of products, applications and medical improvements. The poverty-end discourse created a new acceptable way to produce food. However, this way has been criticized by many scientists, as discussed below.

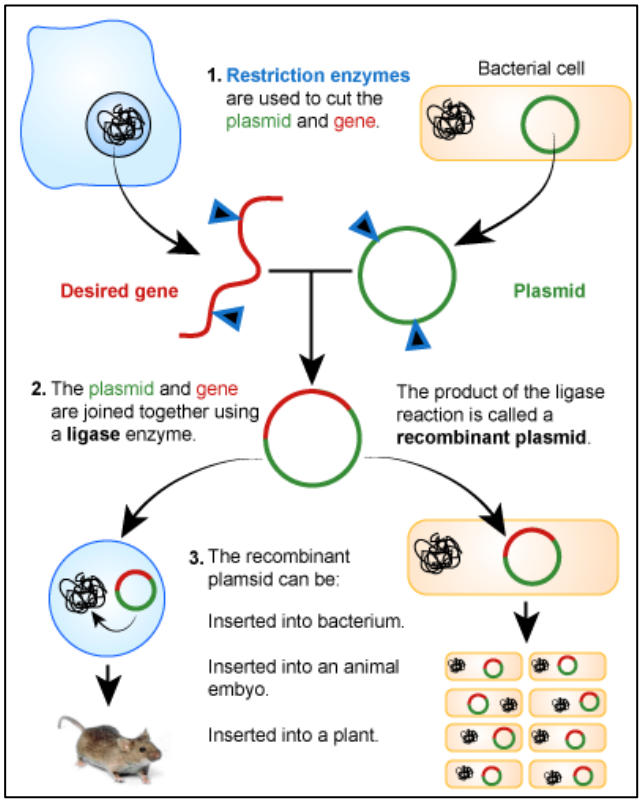

Figure 1 – (1) A restriction enzyme cuts the plasmid from a bacterium (vector) and the interested gene from a donor, in order to ligate them together (2) through a ligase enzyme. The recombinant plasmid (that includes the interested gene) is then inserted into the target organism throughout the vector. The selected vector infects the target organism (a plant, an animal or another bacterium), inserting the interested gene into target's DNA. Modified from ToKToL (2018).

A GMO is defined as an organism which DNA was modified and/or when an exogeny genetic material has been inserted into its DNA by laboratorial techniques. A gene of interest can be obtained in the laboratory from a called donor organism, in which the gene is naturally present. The extracted fragment (gene) may then be inserted into the target organism (e.g. a plant) by means of a vector, such as a bacterium or a virus. This vector transports the gene to the cell nucleus, where it is integrated into the cell's genome (GILLES *et al.*, 2017) (figure 1).

The matter is driven when risks are discussed in ecological, medical and agroecological aspects. Many papers have been written in the last years presenting conclusions about these risks, which are going to be briefly presented in the next sections, focusing on transgenic plants.

Health Approach

According to Costa and colleagues (2011), health risks caused by GMOs can be divided into four categories: immediate effects of toxic or allergenic GMO proteins; risks caused by pleiotropic[2] effects of transgenic proteins on plant metabolism; risks mediated by the accumulation of herbicides and their metabolites in resistant varieties and species; and risk of horizontal transfer[3] of transgenes into the genome of both human's and animal's symbiotic bacteria.

To mention some specific risks, we can indicate the use of Bt[4] plants – plants with an insecticide toxin in their tissues. The agroindustry argues there are no risks related to this toxin, since there is no human neither animal receptors to it, present only in the digestive system of some insects (GILLES *et al*., 2017, p. 282). However, Gilles and colleagues (2017, p. 274) introduces a list of papers that discuss this risk based on empirical evidences. The destination of Bt proteins is also a problem. For example, some studies have found that after human digestion, a considerable amount of Cry proteins may maintain their biological activities (CHOWDHURY *et al*., 2003; LUTZ *et al*., 2005; GUIMARÃES *et al*., 2010). Allergenic potential of Bt plants have yet a much longer list, that can be also found in Gilles' work (GILLES *et al*., 2017, p.285).

In addition, Herbicide-Tolerant plants (HT plants)[5] give us different challenges to struggle. While urban consumers are threatened by chronical problems associated to low herbicide doses, rural workers have direct contact with a great quantity of poisons (KLETER *et al*., 2011; GILLES *et al*., 2017). Many others potential negative effects to health can still be found in literature.

[2] According to Merriam-Webster Dictionary, pleiotropy means producing more than one effect; especially having multiple phenotypic expressions. In this case, it means that the inserted gene can express not only the desirable characteristics, but also other characteristics not desirable, or even worse, unknown (PLEIOTROPY, 2018).

[3] Horizontal gene transfer was a concept introduced by Brown (2003), referring to the exchange of genetic material between two individuals from the same or different species.

[4] Bt means *Bacillus thuringiensis*, the insecticidal gene "donor" organism.

[5] When a metabolic pathway modification makes the plant insensitive to the lethal action of certain herbicides.

Corroborant to Pope's opinion about the necessity of more studies (FRANCIS, 2015, p. 40), Gilles and colleagues explain that even after 20 years consuming Genetically Modified (GM) plants, no epidemiological long-term studies were done by health agencies, comparing populations fed with conventional products and others with organic products. Independent scientists and laboratories, though, are trying to prove the risks, since many findings have already demonstrated potential human and animal health impacts.

Ecological Approach

Costa and colleagues (2011) have also classified ecological risks caused by GMOs, which are summarized in this topic. Firstly, diversity decrease of crop varieties can occur due to the widespread introduction of GM plants derived from a limited group of parent varieties.

Secondly, biodiversity can also decline because of the uncontrolled bioengineered gene transfer, especially those which confer resistance to pesticides, pests and diseases; by cross-pollination with wild plants of ancestors and related species. Lopez-Sanchez (2005) studied corn pollen flow and outcross in seed and grain production fields, finding out that "segregation of transgenic and non-transgenic corn cannot be achieved within the 250m distance" (p. 51), relating pollen flow to wind speed and direction.

A third risk is associated to horizontal transgene transfer in microbiota. Microorganisms living in the soil could incorporate transgene into their genome; and also highly pathogenic strains of phytoviruses (virus that infect plants) could emerge from virus interaction with the transgene, unstable in the genome of the recipient organisms – more likely targets for recombination with viral DNA (WINTERMANTEL; SCHOELZ, 1996).

Moreover, adverse effects on biodiversity due to toxic transgenic proteins, affecting non-target insects, as well as soil microbiota, could break the trophic chain. In addition, there is a risk of rapid development of resistance to toxins present into GMOs, by phytophagous insects, bacteria, fungi and other pests due to selective pressure (COSTA *et al*., 2011).

Precautionary Principle

Frequently, when one reads about GMOs, it is common to notice a reference to the precautionary principle. The Brazilian law to biosecurity (11.105/2005) in theory tries to watch this principle in case of unknown risks. According to environmental scientists (KRIEBEL *et*

al., 2001), the precautionary principle has four central components: "taking preventive action in the face of uncertainty; shifting the burden of proof to the proponents of an activity; exploring a wide range of alternatives to possibly harmful actions; and increasing public participation in decision making" (p. 871). Therefore, this principle is highlighted in our discussion, as we take deeply into account the uncertainty nature of the problem we face.

Transgenics are many times presented as the unique solution to produce food, or to adapt crops to new environments in scenarios of climate change. Even if this is true, how could we mitigate or compensate known and unknown impacts? For this purpose, there is in Brazil a Nacional Council of Biosecurity, the government agency responsible for liberation of GMOs' commercial use. Other countries (figure 2), instead, prefer to prohibit transgenic cultivation in their territory.

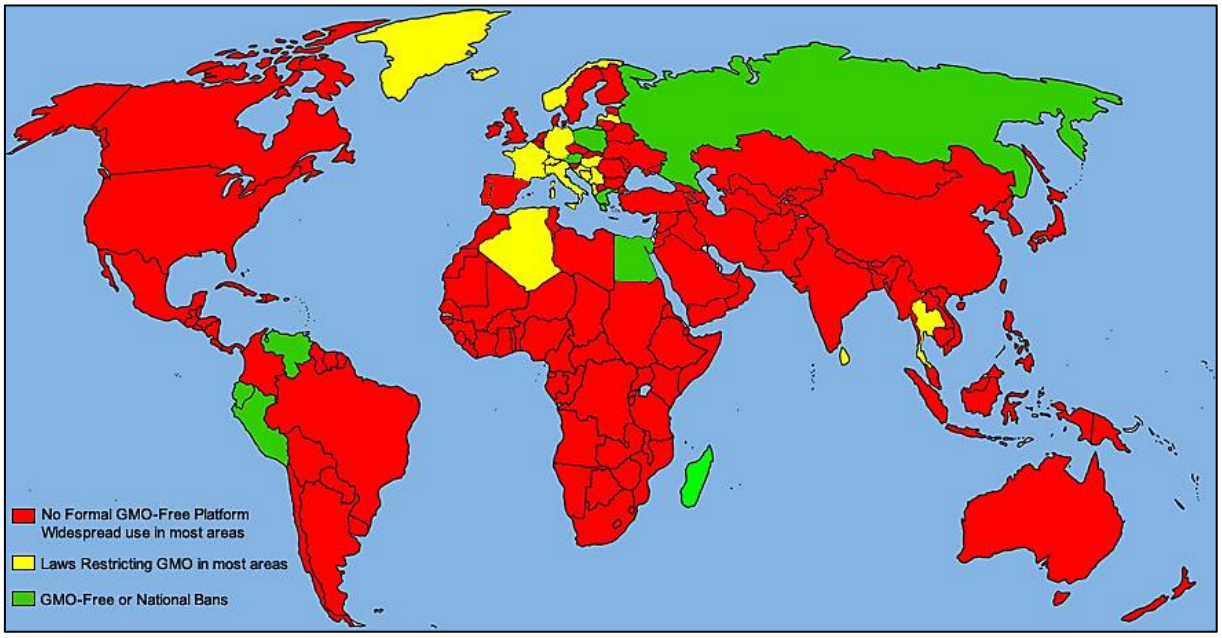

Figure 2 – Countries with GMOs prohibitions. GMO-Free means no production of GM crops. (GENETIC LITERACY PROJECT, 2018)

Countries like Argentina and China are discussing the way GMOs are legalized (PELLEGRINI, 2013; KOU; TANG; ZHANG, 2015). Perhaps the crucial question is not only about prohibiting, avoiding or allowing GM food or GM organisms production and/or importation (being in favor of or against GMOs), but about truly legislating and understating the question we face.

Commercial Use of GM Plants

Independently from the potential risks to health and the environment, which need to be intensely discussed and studied, GM plants and substances have been already available in the market for more than 20 years. Nevertheless, at least data related to socio-economy and soil health exists. In 2006, a report from AgBioForum showed the first results of GM plants after the first ten years of commercial distribution. They found net benefits of $27 billion for the period and reduction in pesticide use by 224 million Kg (BROOKES; BARFOOT, 2006). The study was performed by PG Economics Ltd, a consultancy service company to agriculture. But the fact that the study was conducted by a consultancy service raises the question of possible bias in the research.

A lot of information about GMOs as well may contain bias, since the GMO technology producer companies which want to sell their products are the main interested generating this data. It is very similar to what happens in the case of Environmental Impact Assessment (EIA). There is a conflict of interests that doubts the reliability of some studies (RODRIGUES; BRITO, 2017).

On the other hand, we have seen many projects innovating in the creation of nutritive food, such as gold rice (STEIN; SACHDEV; QAIM, 2006) and drought tolerant crops (FUNGANTI-PAGLIARINI *et al*., 2017). In the context of climate change and in situations of lack of food or diseases, some GM solutions seem to answer the problem.

Maybe we have not yet noticed, but in medicine we are widely using GMOs. As mentioned before, in 1978, one of the first transgenic bacteria was conceived to produce synthetic human insulin (STERN, 1995). However, in this last case, humans are just consuming the product of GM organisms, not ingesting the organisms, and also it is all produced in controlled laboratorial environments, not in plantation fields.

Furthermore, it is emergent the necessity to analyze biophysical, economic, environmental and information costs in GM seed production (RÓTOLO *et al*., 2014). GM technology has industrialized the way humans cultivate, seeking profitability to industries and farmers, but restringing biodiversity (RÓTOLO *et al*., 2014; VRČEK, 2016).

Sustainable Food Security

We may believe to have no options but ensure food for each human on Earth at all costs. However, we do not know the impacts of costs like soil disease, resistant insects and other unknown risks. We have already presented some reasons to believe that we have at least to pay more attention on the actions we take, according to the Precautionary Principle, particularly when we face disagreements between scientists.

A famous entity concerned about this issue is Rodale Institute from Pennsylvania USA. This Institute has been working on food security for more than 60 years, producing independently research results about organic agriculture, soil health, water management etc. In a report of 30 years studying farming systems, the Institute presented results that corroborates to the idea in which organic small-scale farming may feed the world population (RODALE INSTITUTE, 2011), even in scenarios with 9.8 to 10.3 billion people by 2100 (BHOSEKAR; NICHOLS; MOYER, 2017).

Rodale Institute (2011) has compared conventional farming, using chemicals and GMOs, against organic farming. Soil health has decreased in conventional farm as time passed, the main reason to decrease productivity in long-term production in comparison with organic agriculture. Then, in order to stop starvation, neither GMOs nor chemicals seem to be a sustainable solution in a long-time scale.

Rótolo and colleagues have been also demonstrating a needed rethink in agriculture (RÓTOLO *et al*., 2014). They have found better performance in low-intensity production – traditional cultivation in terms of seed selection by farmers and crop-animal rotation – than high-intensity production – using GM crops and pesticides, fertilizers etc. (RÓTOLO *et al*., 2015). Organic food is not only about production, but also about quality. A lot of studies have given some insights in this direction, creating the hypothesis that "organic food increases the capacity of living organisms towards resilience" (HUBER *et al.*, 2011).

Pope Francis and Laudato Si'

An Integral Ecology and the Ecological Traits of Christian Spirituality

The Pope starts the Encyclical resorting to consolidated scientific researches that points to many grave socio-ecological problems we face concerning our Common Home: pollution and climate change, the issue of water, loss of biodiversity, decline in the quality of human life, the breakdown of society and global inequality (FRANCIS, 2015, p. 6-16). Despite the severity of these established problems, responses so far have been weak and opinions among scientists considerably divergent. Therefore, he criticizes the "globalization of indifference" (FRANCIS, 2015, p. 16) and points out that "a true ecological approach *always* becomes a social approach", once "it must integrate questions of justice in debates on the environment, so as to hear *both the cry of the earth and the cry of the poor*" (FRANCIS, 2015, p. 14, griffins in the original).

When approach the gospel of creation, Francis states that some people view religions simply as a "subculture to be tolerated". Nevertheless, "science and religion, with their distinctive approaches to understanding reality, can enter into an intense dialogue fruitful for both" (FRANCIS, 2015, p. 18). In an hermeneutics of the biblical narratives of the creation, he underlines, on one hand, that "clearly, the Bible has no place for a tyrannical anthropocentrism unconcerned for other creatures" [6] (FRANCIS, 2015, p. 20). On the other hand, Judaeo-Christian thought demythologized nature: "while continuing to admire its grandeur and immensity, it no longer saw nature as divine". Thus, this tradition emphasizes even more "our human responsibility for nature", highlighting at the same time "the fragility of nature" and "our God-given abilities". The belief that the world is "entrusted by God to human care" signals paths that could allow us to "finally leave behind the modern myth of unlimited material progress", challenging us to "devise intelligent ways of directing, developing and limiting our power" (FRANCIS, 2015, p. 23).

The integral ecology promoted by Francis involves a wide range of aspects in human life, such as environmental, economic and social ecology, cultural ecology, ecology of daily life, justice between the generations and the principle of the common good (FRANCIS, 2015, p. 40-47). Therefore, it appeals for interdisciplinary work and a multiperspective approach, dealing

[6] See the article "Crise socioambiental e dimensão ecológica da tradição judaico-cristã" (ALBUQUERQUE, 2017). Responding to the criticism of the historian Lynn White Jr., for whom Christianity would be responsible for the current socio-environmental crisis, it highlights elements of the Encyclical Letter Laudato Si' stating that ecological dimension occupies a fundamental place in the Judeo-Christian tradition.

with three perspectives: socioeconomic, scientific, and moral/theological, all of them considered in *Laudato Si'* (VRČEK, 2016).

The Pope states that a commitment as lofty as the care for the Common Home "cannot be sustained by doctrine alone", but has to be accompanied by "a spirituality capable of inspiring us". He claims attention to the fact that some Christians "tend to ridicule expressions of concern for the environment" or "choose not to change their habits and thus become inconsistent". Thereby, he makes a clear pronouncement emphasizing the need for an "ecological conversion" so as "the effects of their encounter with Jesus Christ become evident", once this care "is not an optional or a secondary aspect of our Christian experience" (FRANCIS, 2015, p. 62).

Technology and the Ethical Issue of GMOs

This document is the first one originated from Catholic teaching that explicitly considers the use of GMOs (VRČEK, 2016). In the section "New biological technologies", Pope Francis contrasts the pros and cons of technological progress in reference to the concept of integral ecology. He clearly states that the Church is not against scientific development, nor against its technological applications. The problem is not scientific, but ethical, because when technology is linked to business interests, and presented as the only way of solving specific problems, it becomes blind to "the mysterious network of relations between things", and cannot recognize that "sometimes solves one problem only to create others" (FRANCIS, 2015, p. 6-7).

That is why the Pope underlines that "technological products are not neutral", since they "create a framework which ends up conditioning lifestyles and shaping social possibilities along the lines dictated by the interests of certain powerful groups". Their social-influencing power can be so big that they greatly diminish people's capacity to make decisions and the possibility of "each one's alternative creativity" (FRANCIS, 2015, p. 32). The technologies' specialization and the fragmentation of knowledge makes difficult to see the "broader" and "genuine ethical horizons". But actually the solutions placed by science to great issues necessarily need to "take into account the data generated by other fields of knowledge, including philosophy and social ethics" (FRANCIS, 2015, p. 33).

This doesn't implies to reject technology or deny its benefits; on the contrary, the Catholic Church understands that "developing the created world in a prudent way is the best way of caring for it, as this means that we ourselves become the instrument used by God to bring out the potential which he himself inscribed in things" (FRANCIS, 2015, p. 36). But there is a risk

of disregarding the great ethical principles and not take into account the need to limit its own power (FRANCIS, 2015, p. 40).

Approaching specifically the GMOs' issue, Francis states that "it is difficult to make a general judgement", because their different types vary greatly and require specific considerations. Their risks are not always due to the techniques itself, but to their "improper or excessive application". Genetic mutations have often and continue to be naturally caused or are due to universally accepted human intervention as old as the domestication of animals. The Pope is also aware that "scientific developments in GM cereals began with the observation of natural bacteria which spontaneously modified plant genomes". However, he highlights that in nature this process is much slower and "cannot be compared to the fast pace induced by contemporary technological advances" (FRANCIS, 2015, p. 39).

The Pope states that "no conclusive proof exists that GM cereals may be harmful to human beings" and shows a clear conscience that in some regions they have brought economic growth, but he is still concerned that "there remain a number of significant difficulties which should not be underestimated". As a matter of fact, the use of GM crops is often associated to the concentration of the productive land in the hands of a few owners, impairing the most vulnerable and many rural workers. Nevertheless, the expansion of these crops can destroy the complex network of ecosystems, diminish the diversity of production and affect regional economies. The expansion of oligopolies and the dependency generated from there can be aggravated with the production of infertile seeds (FRANCIS, 2015, p. 39).

These are the main concerns that require "constant attention and a concern for their ethical implications". Therefore, "a broad, responsible scientific and social debate needs to take place", one that is capable of "considering all the available information", wider than the results disclosed which are based on particular politico-economic or ideological interests and that makes it "difficult to reach a balanced and prudent judgement on different questions, one which takes into account all the pertinent variables". It is necessary to involve into this debate all those directly or indirectly affected, including farmers, consumers, civil authorities, scientists, seed producers, people living near fumigated fields, and others (FRANCIS, 2015, p. 40). It requires, therefore, an "intergenerational solidarity", which "is not optional, but rather a basic question of justice, since the world we have received also belongs to those who will follow us". In the last instance, "it has to do with the ultimate meaning of our earthly sojourn" (FRANCIS, 2015, p. 46-47).

Francis is aware that certain environmental issues are not easy to achieve a broad consensus and states that "the Church does not presume to settle scientific questions or to replace politics", but expresses his concern to "encourage an honest and open debate so that particular interests or ideologies will not prejudice the common good". He underlines that politics cannot be subject to economics and this to the paradigm of technocracy. On the contrary, all of these spheres must "enter into a frank dialogue in the service of life, especially human life" (FRANCIS, 2015, p. 54).

As for the critic that the raise of these questions would be an "irrationally attempting to stand in the way of progress and human development", the Pope counterposes that "a decrease in the pace of production and consumption can at times give rise to another form of progress and development". This broadening of horizons implies into an "openness to different possibilities which do not involve stifling human creativity and its ideals of progress, but rather directing that energy along new channels" (FRANCIS, 2015, p. 55).

In the light of *Laudato Si'*, then, Catholic Universities have a great challenge to face, as Josafá Siqueira (2016) underlines, signaling three missions related to integral ecology that these institutions are called to take forward: 1) contribute to overcome the culture of disposability and waste; 2) develop researches that can minimize impacts and present more sustainable alternatives; 3) give testimonial in concrete actions that express our commitment to all problems related to humankind's relationship with nature. The author summarizes the question as follows: "Catholic Universities can serve as important mediators in the process of building a world which is fairer, more inclusive, more ecologically sustainable and more theologically compatible with the Creator's design" (SIQUEIRA, 2016, p. 123).

Final Considerations

Studying Pope Francis' conception of integral ecology in the Encyclical Letter Laudato Si', we can clearly testify that genetic manipulation by itself is not condemned by the Catholic Church, since it occurs naturally during species evolution, though in a much slower speed. However, ethical considerations make clear that the effects should be deeply investigated before any commercial decisions would be made. That is, "Pope Francis is neither frightened nor delighted with the emergence of GMOs" (VRČEK, 2016, p. 218).

The gravity of the problem makes urgent that all of these interested parts can have access to "adequate and reliable information in order to make decisions for the common good, present

and future". This complex environmental issue, therefore, requires "various lines of independent, interdisciplinary research capable of shedding new light on the problem" (FRANCIS, 2015, p. 40). That is, however, precisely what we have seen that is not yet sufficient in order to take a clear and relatively secure position.

Instead, what we have seen is that, at least in the context of Food Security, GMOs are not revealing to be a solution as sustainable as small-scale farming in a long-time scale (RODALE INSTITUTE, 2011). These findings remind us of the rules within the spiritual exercises created by Saint Ignatius Loyola (2015), founder of the Society of Jesus (the congregation to which Pope Francis belongs since his vowels as Jorge Maria Bergoglio). He offers the exercisers tools for distinguishing not only between the good and the bad, but especially between the good and the better. As we are looking for the more efficient manner to solve the terrible problem of starvation, we are probably not deciding between good and bad options, but choosing among good ones to identify the better given the circumstances.

Faith and politics are intrinsically concerned, so that Christians are ready to "dare to turn what is happening to the world into our own personal suffering and thus to discover what each of us can do about it" (FRANCIS, 2015, p. 6). Therefore, the ecological traits of Christian spirituality also awaken us to the fact that "rather than a problem to be solved, the world is a joyful mystery to be contemplated with gladness and praise" (FRANCIS, 2015, p. 4). Consequently, the Pope reminds us that our struggles and concerns for this planet should "never take away the joy of our hope" (FRANCIS, 2015, p. 70).

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