

GMOs and Economic Development in Peru: A Myth or an Opportunity?

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Abstract

Peru has a 10-year ban on genetically modified (GM) crops and food that was approved by the Peruvian congress in 2011. Is it scientifically justified or is it a cause and effect fallacy that will make Peru fall behind in taking advantage of this technology and its potential benefits to everyone else in the economy? In order to answer this question, a literature review was carried out to examine the three most commonly used arguments against genetically modified organisms (GMOs) by farmers and all those related to the agriculture industry, reaching the conclusion that they are not one hundred percent plausible. Further research showed the multiple, potential economic benefits that GM seeds could bring about to Peru, which are related to increased labor productivity, the development of human capital, and the expansion of renewable energy sources and its implications for trade and employment – the environmental and health benefits of GMO varieties are also discussed. This paper elaborates on such matters by applying different macro and microeconomic concepts, i.e., market structures and competition, the theory of the firm, and scarcity, among others; and provides insights about the different socio-economic realities present in Peru and possible ways to improve them.

Keywords: Cause and effect fallacy, GMO, Human capital, GM seeds, Productivity, Scarcity

JEL Code: Q13; Q16

Introduction

Ever since the first genetically modified organism (GMO) was approved by The U.S. Food and Drug Administration (FDA) back in 1982, there has been large disagreement in both developed and developing countries with regards to the implementation of this type of biotech advancements in the global agriculture industry. For example, in Peru, various politicians have been weighing in on this issue for quite some time. In 2016, during the presidential campaign, Pedro Pablo Kuczynski – former president of Peru – and Keiko Sofía Fujimori publicly rejected genetic engineering practices in crops by classifying them as dangerous threats to Peru’s economic and biodiverse interests, therefore, recharging the debate over the future of GMOs in this country and around the world. In November 2019 is going to be exactly nine years since the Peruvian congress decided to place a 10-year moratorium on GM seeds (Bustamante, 2016), which legally prevents them from entering the Peruvian market.¹

In light of this information, the following question emerges: is such a measure scientifically justified or is it a cause and effect fallacy that will make Peru fall behind in taking advantage of this technology and its potential benefits to everyone else in the economy? This paper revisits the three main objections made to the adoption of genetically modified seeds – related to biodiversity, health, and market power concerns. Similarly, we discuss how their adoption could help Peru spur economic growth by booming productivity in the agriculture industry and the development of a green revolution through

1 Along with Peru, several other countries like Ecuador, Venezuela, France, the Netherlands, Denmark, and Russia, among others have prevented GMOs from entering their markets. All of these bans obey one or more of the three objections to GM seeds presented in this paper.

sustainable biofuel energy. This last part is done by taking insights from the experiences of other countries with GM crops like China, India, and more importantly Argentina, a nation that, historically, has had fairly similar socio-economic conditions to those found in Peru.

2. Literature Review

2.1. Science does not support the claim that GMOs hurt biodiversity

Certainly, the first objection made against genetically modified crops is that they put Peru’s extremely rich biodiversity at risk since the genes inserted into living organisms could potentially end up in non-targeted areas through cross-pollination.

Figure 1. Different varieties of corn in Peru.

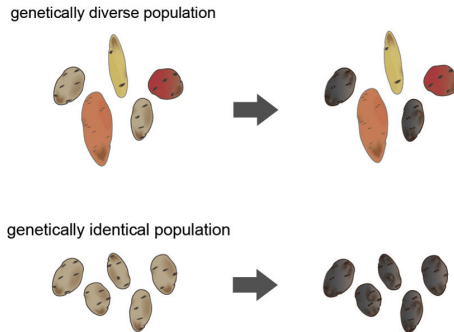


Source: Pulgar-Vidal, M. (2016). Moratoria al Ingreso de Transgénicos – OVM – en el Perú. *Ministerio del Ambiente Dirección General del Diversidad Biológica.*

Assouline and Stockelova (2005) explain an implication of this occurrence: “the world’s most widely grown genetically engineered crops [like] soybeans, cotton and corn developed to be impervious to glyphosate – are facing a new problem in their continued long-term use. The herbicide is beginning to lose its effectiveness in controlling weeds” (p. 40).² According to their research, *Bacillus thuringiensis* (Bt) and various other genes were in effect designed to help make crops resistant to pests, diseases, and herbicides – just like glyphosate; however, an increasing number of people claim that those techniques are also making weeds immune to toxic substances because their genetically improved characteristics are transferring to them. The fear lies on the fact that weeds compete against and endanger organically grown crops and; hence, negatively impact both the productivity and exports of farmers; a situation that could in turn push them to use more and stronger pesticides that are totally noxious to the environment. Additionally, in a statement released to the public in 2015, the former head of The Ministry of the Environment in Peru Manuel Pulgar-Vidal expresses his thoughts about the possibility that different plant and animal species for which Peru is internationally known such as quinoa and kiwicha might disappear if GMOs are allowed to enter the market (p. 15). Undoubtedly, this argument obeys the same cross-pollination principle described above since the transfer of Bt genes among different species is thought to limit their degree of variability, making them vulnerable to always-changing environmental conditions.

2 Gerald Assouline holds a Ph.D. in development economics and Tereza Stockelova a Ph.D. in sociology.

Figure 2. Impact of GMOs on the vulnerability of species to

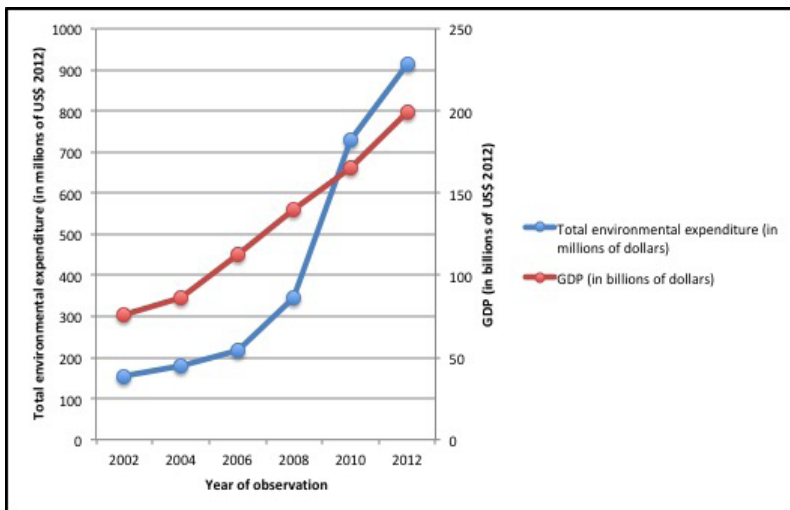


Source: Landry, H. (2015, Aug. 10). Challenging Evolution: How GMOs Can Influence Genetic Diversity. *Harvard University The Graduate School of Arts and Sciences via Science in the News*.

Can such views be defended? Not exactly. The literature review seems to indicate that those assertions are based on a strange combination of a cause and effect fallacy and a baseless precautionary attitude. A cause and effect fallacy consists of deriving a non-existing relationship about the effect of one variable or event on another without having any sort of concrete or scientific evidence to support it. Indeed, to date, there is no proof of any statistically significant correlation between genetically modified seeds and increased herbicide and/or pest-resistance capabilities in weeds. In a recent study done by The National Academies of Sciences, Engineering, and Medicine (2016); researchers found that gene flow, in other words the variation in alleles or gene frequency due to intakes of genes coming from other populations, does not take place in this context given that “GE crops have few sexually compatible weed species or naturalized plant species with

which they could hybridize...” (p. 97). These are unrelated organisms and; therefore, the margin of successful cross-pollination is really small to the point where it is considered non-existent. Moreover, research shows that, as time passes by, that exact same margin is becoming even smaller thanks to frequent biotechnology-related innovations in the agriculture industry. More importantly, there seems to be no solid basis in saying that GMOs create negative externalities for ecosystems and the overall environment, quite the opposite in fact. Harris-Lovett (2015), journalist at *Los Angeles Times*, reports how growing rice amounts to a mean production of methane – a powerful greenhouse gas – of approximately 63 million metric tons per year. This situation, she narrates, led two biologists from The Swedish University of Agricultural Science to try to find a solution. Based on prior studies conducted by them, they formulated the hypothesis that transferring barley genes into the rice plant would reduce its emission of methane by making it grow smaller roots. They then tested it out and compared the results to those gathered from conventional rice. It was found that the genetically engineered rice produced around 90 percent less methane. This research can be taken as evidence that GMOs have direct positive effects on the environment; yet, there also seem to be less direct ones like decreasing the cost of government programs that seek to fight the consequences of climate change. Consider for example that, in Peru, total environmental protection expenditure is estimated to exceed US\$ 900 million (Pulgar-Vidal, 2015, p. 50). It can be argued then that embracing GMO technologies and their proven effectiveness in combating pollution could inevitably incur big savings and/or allow the government to spend that extra money in other more productive endeavors.

Figure 3. Total environmental protection expenditure and GDP in Peru.



Data source: Pulgar-Vidal, M., et al. (2015). Caracterización y Cuantificación del Gasto Público Ambiental Peruano. *Ministerio del Ambiente Dirección General del Diversidad Biológica.*

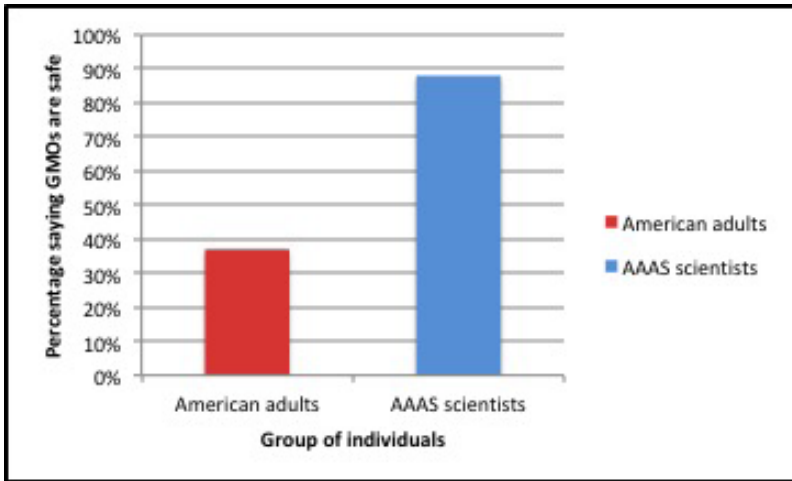
2.2. There is no concrete prove that GMOs represent a threat to human health

The second objection is more straightforward. Peruvians, just like the rest of the world, are worried that genetically improved seeds and food might have massive negative effects on their health. Brazil, one of the largest buyers of plant genetic engineering technologies in farming, is constantly referenced here. In the latter part of the 20th century, the South American country was very close to intoxicate a substantial part of its population by putting genes from nuts into soybeans with green light for consumption without realizing that a big part

of it was allergic to that precise fruit (Kruft, 2001, p. 6). During the research period of this paper, allergenicity has gained widespread approval in the public eye. People say they enjoy its so-called rationale. Genes available in some products, for instance, milk, wheat, soy, eggs, fish, and nuts, have a reputation for contributing to the development of various allergies. As follows, genetic engineering in both the agriculture and food industry puts many lives in danger because – just as it almost happened in Brazil – the wrong genes may accidentally end up being ingested by the wrong people. Furthermore, gastrointestinal problems are often brought up as a major side effect of GMOs on the human body. Ewen and Pusztai (1999) fed rats on genetically modified potatoes and then looked at their intestines to find any possible irregularities. They claim to have observed a “[rather worrying] proliferation of gastric mucosa” in the small intestines and caecum of the rats in question (p. 1353). In their study, these academics took advantage of the many physiological similarities that exist between humans and rats to make their case about the negative effects of the long-term consumption of GMO food on people’s lives look more legitimate.

However, the argument that genetically modified seeds present a risk to human health seems to have more weaknesses than strengths. Long-term data on livestock health, a proxy for human health, both before and after using GMOs in crops has shown no negative effects whatsoever (National Academies of Sciences, Engineering, and Medicine, 2016, p. 2). Moreover, around “88 percent of all scientists [in the U.S.] say GMOs are safe” (Funk & Rainie, 2015).

Figure 4. Percentage of American adults and AAAS scientists saying GMOs are safe.

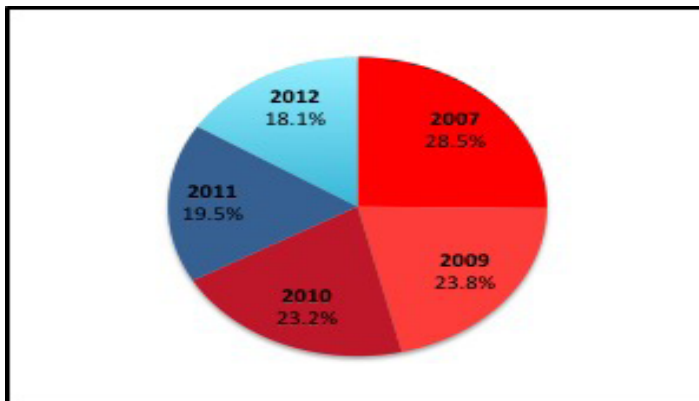


Data source: Pulgar-Vidal, M., et al. (2015). Caracterización y Cuantificación del Gasto Público Ambiental Peruano. *Ministerio del Ambiente Dirección General del Diversidad Biológica.*

Based on such information, it is like Peruvians are asked to live in the past and pretend that, in the field of transgenic organisms, there are no regulations aiming to detect all kinds of allergens in them, while the reality is that there are plenty. Moreover, it asks us to forgo the promising benefits in terms of well-being that biotech innovations in the agriculture-business have to offer. Certainly, the adoption of “Frankenfood” can represent the end of hunger. In “Can GMOs Help Feed a Hot and Hungry World?” Ostrander (2014) relies on the work and experience of Eduardo Blumwald, Ph.D. in bioenergetics, to address the fact that genetic engineering practices with regards to crops comprise the only reasonable solution we have to feed an alarmingly growing population. She writes:

Blumwald means the hot future that we expect by 2050 – when a world population of 9.5 billion people will scramble to put food on the table... [and] at least thirty-seven separate countries face extreme water crises.... [He] thinks that part of the answer is to genetically engineer crops that... [are] better [able to] withstand drought, and so he and his researchers are scouring the world for varieties of fruits, vegetables and some basic staples— rice, millet, wheat, maize—that grow well without much water. (p. 24)

Scarcity of resources and global warming are the two most important challenges preventing the agriculture industry from keeping up with the always-raising demand for nourishment. That said, over the past few years, several studies investigating the impact of GM seeds on overall food production have shown a massive increase in the quantity and drought tolerance traits of crop yields, which has led experts to think of them as a compelling solution for the problem being examined. A key point here is that crop genetic engineering can provide not only more food but also a more nutritious one, contributing to both the mental and physical health of people. In third world countries like Peru, where approximately 20 percent of all children under the age of five are chronically undernourished (Velásquez et al., 2014, p. 15), elaborating GMOs with specific minerals and vitamins would help the government fight such situation and the many deaths and/or diseases that result from it every day. This would in turn be extremely positive for the economy through the development of productive talent, a major component necessary for economic growth. As a matter of fact, in Peru, it is possible to import a certain varieties of pre-approved food products that have been genetically modified, something that is inconsistent with human health worries and thus renders any criticism along those lines ultimately invalid.

Figure 5. Hunger and undernourishment in Peru.

Data source: Velásquez, A., et al. (2014). Plan Nacional para la Reducción de la Desnutrición Crónica Infantil y la Prevención de la Anemia en el País. *Instituto Nacional de Salud*.

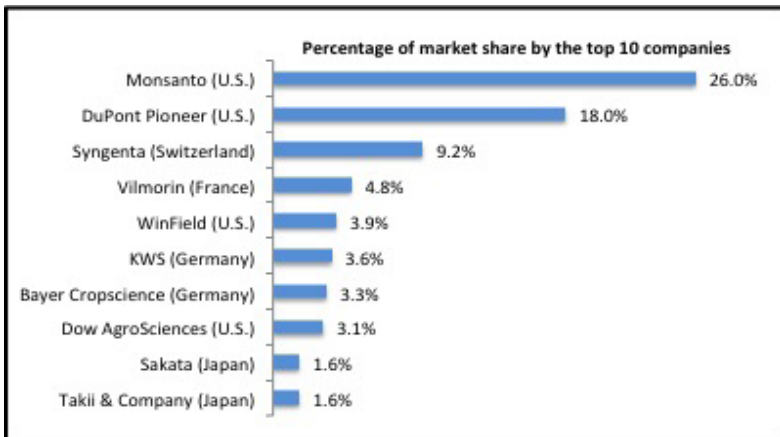
2.3. Market power is not a direct criticism to GMOs; yet the Government should intervene

Now we come to the third and final objection. The biggest reason for dislike among people with regards to genetically modified seeds is the degree of market power concentration and /or dominance that exists around them, conditions that are thought to be responsible for the price gauging initiatives that have been experienced in the global agri-biotech industry in the last twenty years. Qaim and de Janvry (2003), use the example of Argentina and its adoption of Bt cotton in order to illustrate the predatory business nature of Monsanto, the world's top producer of plant genetic engineering technologies.³ They specify that, in 1998, such company was able to put upward pressure on prices through patents and; as a result, made small

³ Matin Qaim teaches International Food Economics at The University of Gottingen and Alain de Janvry is a researcher and professor of Agricultural and Resource Economics at The University of California at Berkeley.

Argentinian farmers pay \$103 per hectare for Bt cotton seeds, something that back then represented four times the price of conventional varieties (p. 815). In effect, the explanation given by Monsanto to try to justify those increases was that R&D is lengthy and expensive. A reasonable argument according to the general consensus; however, since then, the price of GM seeds has kept going up by about 230 percent, especially in developing nations (Benbrook, 2009, p. 1), making them unaffordable for small farmers. Consequently, they fall behind in terms of competition. Concerning those who can to afford them, they are pushed to continue buying GMO seeds from Monsanto every year because the patents mentioned point out that the ones from previous years are not legally reusable.

Figure 6. Market power concentration in the international seed industry.



Data source: McDougall, P. ETC Group. Shown in GMO FAQ. (2017). Do Monsanto and Big Ag Control Crop Research and World Food Supply? *Science Literacy Project*.

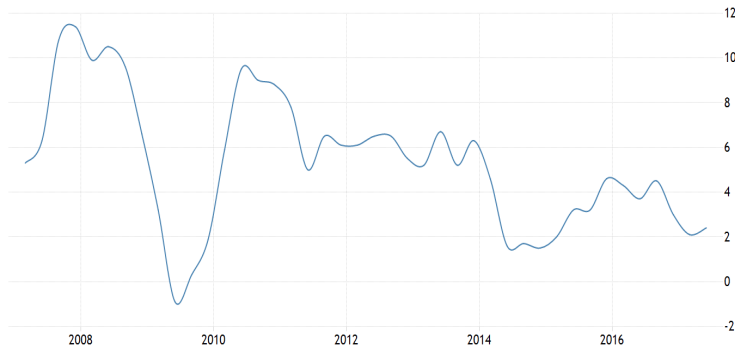
Two points should be made about imperfectly competitive market structures related to the agri-biotech industry. To begin with, it is not logical to argue that genetically modified seeds are bad for people and must be rejected due to the existence of market power. Doing so does not constitute a strong criticism made against GMOs on their own but against the way in which they are currently commercialized. A situation that can be fixed through government intervention, i.e., antitrust regulations. Applying these laws would help expand the amount of GE crop producers by promoting fair competition, thus, benefiting large and small farmers, consumers, and the economy as a whole. Still, companies like Monsanto invest millions of dollars each year in various “lobbying and public relations strategies” warns Eric Lipton, a reporter at The New York Times (2015). Given the existing inability of antitrust laws to effectively cope with special interest groups in the government then, close monitoring from outsider units seeking to improve transparency in policy-making processes would have to accompany them. The other point is that it is often not known what initiatives are taking place in the public sector to give a hand to small farmers. In a 2014 interview with the School of International Public Affairs at Columbia University, Mark Lynas, a writer who specializes in environmental activism, emphasized that he had been “working with Cornell University to launch a genetically modified eggplant... at the lowest possible cost” (as cited in *GMOs: A Solution or A Problem?*, 2014, p. 133). Providing everyone in the agricultural sector with easier and more inexpensive access to technological innovations can contribute to create competition through equal opportunities and, as follows, boost economic growth. The lack of theoretical and empirical support for the third objection is at this point clear.

3. Discussion

3.1. GM seeds, potentially higher crop productivity, and the role of the government

Over the past few paragraphs, the three most commonly made objections to the use of genetically modified organisms in the agriculture industry have been analyzed from a health, environmental, market structure, and slightly economic perspective. Let's now fully engage in the idea of GMOs as key drivers of both development and gross domestic product (GDP) growth in Peru. It is no secret that the Peruvian economy, which up to 2014 was growing at rate of almost 7 percent per year, has considerably slowed down due to the end of the boom of commodities, many struggles in the Chinese economy – Peru's biggest trading partner (Kozak, 2014), natural disasters, and corruption-related issues, among other factors.

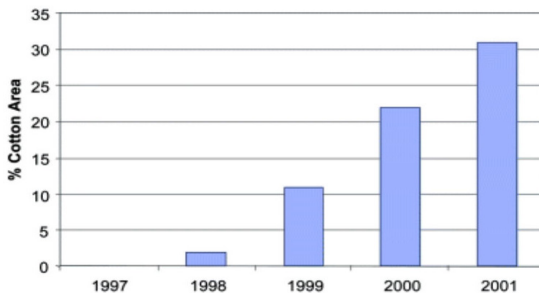
Figure 7. Annual GDP growth rate in Peru.



Source: Peru GDP Annual Growth Rate. (2016). INEI via trading Economics.

Therefore, a greater acceptance of transgenic crops can represent a really good option for getting our GDP back on track because they increase farm-level productivity. A Purdue University study reported in Science Daily estimates that, in the U.S., GM seeds help raise corn yields by about 11.2 percent, soybean yields by about 5.2 percent, and cotton ones by about 18.6 percent (as cited in Brandon, 2016, p. 8). Why does this matter? On the one hand, it matters since it is not just the United States that is taking advantage of this technology; India, China, and other countries are also doing it, which makes Peru fall behind in terms of competition and productivity. Marcel Gutierrez-Correa, Universidad Nacional Agraria La Molina's former head of research, claims that the 10-year ban on GMOS – that was approved by congress in 2011 – costs the Peruvian economy approximately \$400 million per year due to production-related inefficiencies regarding corn and cotton, two of Peru's most important agricultural goods (as cited in El Comercio, 2015), like the unnecessary use of costly pesticides, labor, and electric energy.

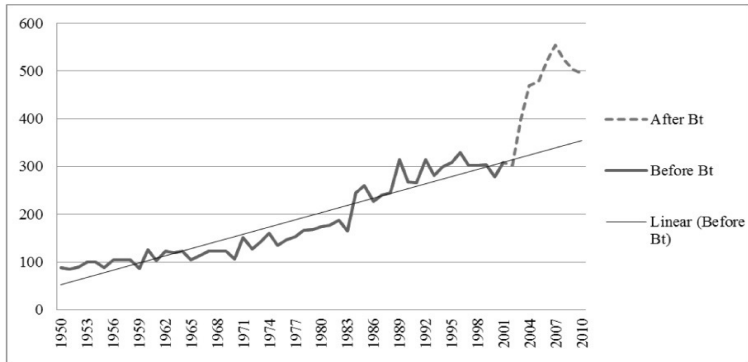
Figure 8. Increase in Chinese cotton yield due to the adoption of Bt technology.



Source: Pray, C. E., et al. (2002). Five Years of Bt Cotton in China – the Benefits Continue. *Wiley Online Library*.

Figure 9. Increase in Indian cotton yield due to the adoption of Bt technology.

Figure 2.1—Average cotton yields in India, 1950–2010



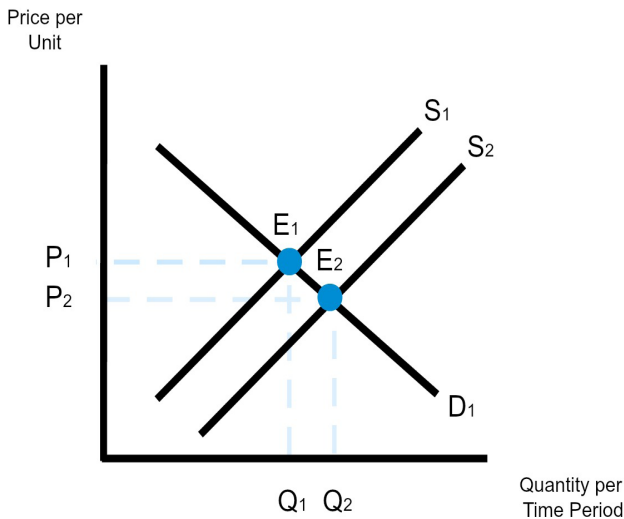
Source: Indian Cotton Advisory Board, obtained from International Cotton Advisory Committee.

Source: Naam, R. (2014). Why GMOs matter – Especially for the Developing World. *Grist Magazine*.

And on the other hand, the importance of higher crop yields, obtained as a result of the nutritious and pest-resistance attributes of genetically modified seeds, lies on their positive effects on food prices and net profits. Certainly, GMO biotech innovations have been proven to increase labor productivity, thus, shifting the market supply curve for agricultural products to the right, establishing a new equilibrium with a bigger quantity produced and lower market price. Consumers are then benefited from this given increased availability of goods and the fact that they can now purchase those exact same goods for less. Such decrease in food prices may sound like a bad thing for producers but it is not quite so. According to an article published on The American Farm Bureau Federation’s website in 2016, “farmers choosing to grow GMOs have seen net economic benefits at the farm level

amounting to \$18.8 billion in 2012 and \$116.6 billion between 1996 and 2012” (p. 1). They are able to compensate for those reductions through the multiple, bigger savings in pest control costs that GM seeds allow them to have. In a report by The National Research Council, it is claimed this is due to their effectiveness and economies of scale and scope considerations regarding the genetic modification of organisms (2000, p. 220). Another way to see this is from an output-input perspective. Undoubtedly, standard economic theory indicates that technological developments like GM seeds will displace the production function upwards thus allowing production of either the same old output using fewer resources or of more output using the same amount of inputs.

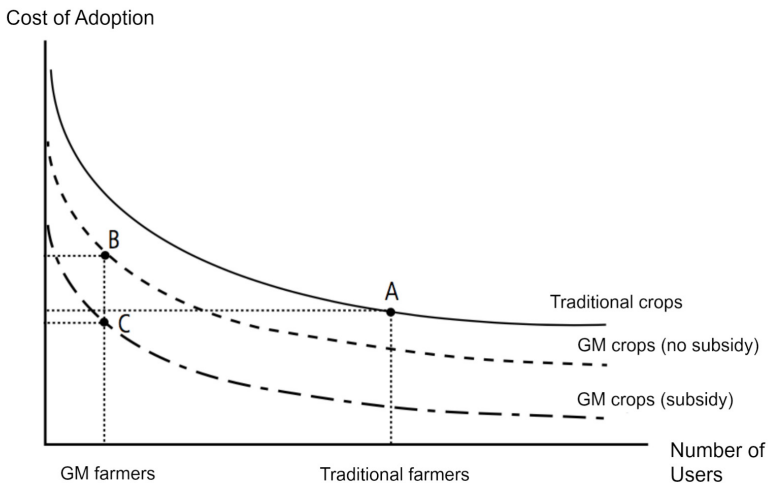
Figure 10. Theoretical increase in domestic productivity due to the adoption of GMOs under perfect competition.



Source: Baxerias, D., & Banda, C. (2019). *Journal of Economics, Finance and International Business*.

Yet, the argument presented so far relies on the assumption that adopting new technologies – in this case related to crop varieties in the agriculture industry – is a straightforward process, which is not very realistic. Vesal (2014) points out that for any given economy, past decisions can take it into an impoverishing path of dependency on existing technologies and conditions. Hence, farmers, even if presented with GM seeds, still have to incur rather costly experimentation to learn how to use them properly, which constitutes a waste of time and money. A temporary subsidy by the government, he asserts, would shift the cost of adoption for these crops downwards to the point where the number of users increases; and this, in turn, lowers adoption costs even further so that the subsidy is not needed anymore (p. 48).

Figure 11. Shift in the cost of adoption in the presence of GM seeds-related subsidies.



Source: Baxerias, D., & Banda, C. (2019). *Journal of Economics, Finance and International Business*.

3.2. Peru and the feasibility of developing sustainable biofuel energy

In addition, GM crops can spur economic growth by booming the development of a sustainable biofuel industry. No matter how challenging global economic conditions were in previous years, or the frequent appearance of compelling studies about the dangers of climate change, for a really long time fossil fuels were thought to be energetically indispensable. To the surprise of many, things are changing for the better due to the time and money constraints they imply, and their limited availability. People have realized that renewable energy sources are the future and the demand for biomass feedstocks, which are unprocessed either plant or animal inputs used to generate ethanol and other biofuels, is constantly rising. The problem is that current agricultural practices are not productive enough to supply the amount of biomass feedstocks required in the global market, and some even fear that paying too much attention to the cultivation of green energy might make it “replace food production... [and as follows] needy people will go hungry...” (Burke, 2007, p. 52). Whatever other underlying factors, there must be no question the fear here is reasonable. Rich agricultural land is scarce and with farming methods other than genetically modified crops, the use of such land for growing fruits and vegetables is left to compete with its use for biofuels. For a country to successfully transition into a bioeconomy, its feedstocks have to meet numerous primary requirements, i.e., “yield improvement, crop adaptation to marginal lands, plant modifications to increase amenability for bio-processing; and modifications to allow multiproduct production from a single crop” (Moon & Wolt, 2007, 676).

Figure 12. Development of drought-tolerant wheat.



Source: Cho, R. (2014). The Intensifying Debate over Genetically Modified Foods. *The Earth Institute of Columbia University*.

So far only GMOs have been able to accomplish that. Peru, being a major provider of sugar cane, sorghum, and palm – three of the most well suited biomasses for producing biofuels, would profit from this by allowing genetic engineering techniques in its crops, using them to enhance its feedstocks, and getting green liquid fuels out of them in order to export renewable energy to industrialized nations just like China, India, Argentina, Brazil, and Indonesia are doing (Williams, Smyth, & Kerr, 2013, p. 1723).

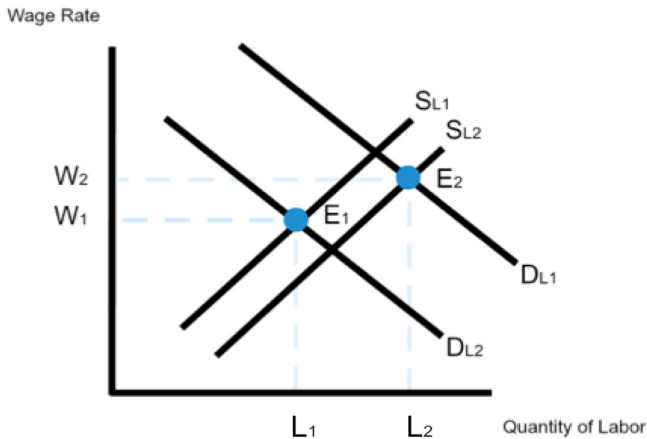
Figure 13. Top agricultural feedstocks for making biofuels.

Country	Current or soon to be crops
Argentina	sugar cane, soy, corn, colza, topinambur, wheat
Bolivia	Sugar cane, soy
Brasil	Sugar cane, soy, palm tree, castor oil plant, topinambur, colza
Chile	Corn, colza
Colombia	Sugar cane, cassava, palm tree, corn
Costa Rica	Sugar cane, palm tree
Cuba	Sugar cane
Domunican,	Sugar cane, palm tree
Ecuador	Sugar cane, palm tree
El Salvador	Sugar cane
Guatemala	Sugar cane, palm tree
Honduras	Sugar cane, palm tree
Mexico	Sugar cane, sorghum, corn
Nicaragua	Sugar cane
Panama	Sugar cane
Paraguay	Sugar cane, soy, palm tree, colza, corn, wheat
Uruguay	Sugar cane, soy, corn
Peru	Sugar cane, palm tree, sorghum
Venezuela	Sugar cane, palm tree

Data source: Calle, J. L. Biocombustibles en el Peru y su Importancia. *Facultad de Ingeniería Agrícola de la Universidad Nacional Agraria La Molina.*

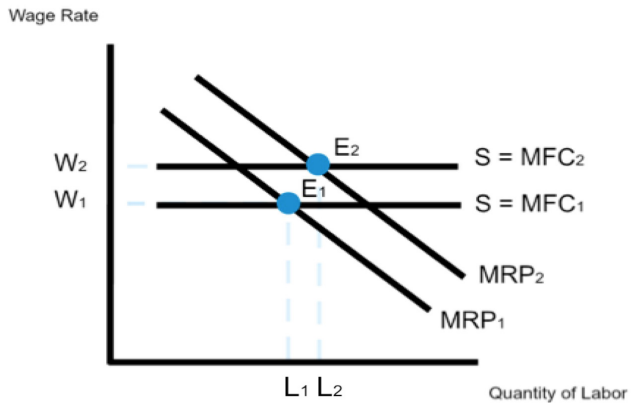
A final point to be made here is that, apart from incurring a boost in exports, the development of a sustainable biofuel industry would help create more and better-paid jobs in the country since it is unavoidably linked to the growing demand for biofuels and improvements in labor productivity – common sense dictates that the jobs resulting from the development of a whole new industry are likely to exceed those taken away by the savings incurred in agricultural production.

Figure 14. Outward shifts of the market demand curve for labor and the market supply curve of labor.



Source: Baxerias, D., & Banda, C. (2019). *Journal of Economics, Finance and International Business*.

Figure 15. Upward shift of the marginal factor cost (MFC) curve and outward shift of the marginal revenue product (MRP) curve.



Source: Baxerias, D., & Banda, C. (2019). *Journal of Economics, Finance and International Business*.

4. Conclusions and Future Study

As should be clear by now, there are three major views opposing to the adoption of genetically modified organisms in the agriculture industry. One contends that they comprise a worrisome set of ecological risks by limiting biodiversity and endangering the sustainability of organic agricultural practices. Another sees them as having multiple genes and substances with unpredictable consequences for health, which are thought to range from gastrointestinal problems to severe allergies. And lastly, critics dislike the imperfectly competitive conditions in which GMOs have developed in the past couple years. Although, some of these arguments are valid, especially those concerning allergenicity and market dominance, it has been shown that most of them are unsupported both theoretically and empirically. Bio-engineered crops have been scientifically proven to contribute to the environment by lessening the release of greenhouse gasses, and boost both the mental and physical welfare of individuals by providing them with more and better food. From a purely economic perspective, GM seeds positively jolt a nation's economy through steady growth caused by the development of productive talent, increased labor productivity, low unemployment, and the expansion of renewable energy sources.¹³

In light of all this, positions like those of Pedro Pablo Kuczynski and Keiko Fujimori of supporting the 10-year moratorium on GMO varieties in Peru seem to do more harm than good to the country. Peru is a top producer of agricultural commodities and, as such, is potentially losing a great opportunity for closing the gap with other emerging economies that have adopted them. In all likelihood, two not less important

points are: first, that despite the benefits of seeds undergoing genetic alterations, resulting agricultural products ought to be properly labeled in order for each person to freely choose whether or not to consume them. This would appease local pressure groups. And second, perhaps before jumping into premature conclusions and harsh criticisms concerning GMOs, Peruvian authorities should raise the current poor rate of expenditure on research and development (R&D) as a percentage of GDP, which as of 2015 was less than 0.2 percent (UNESCO Institute for Statistics via The World Bank, 2017). This would help substantiate the amount of knowledge and information that is out there in relation to GM seeds. The role of labeling and R&D in shifting opinions regarding GMOs, however, has not been covered in this paper and represent a solid opportunity for future research.

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