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OPINION PIECE

Counterproductive consequences of 'anti-GMO' activism

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ABSTRACT: Activist groups which oppose so-called 'genetically modified organisms' (GMOs) frequently affirm that they want to fight corporations and capitalism. While I do not discuss whether this legitimate ideological-political attitude is good or bad, right or wrong, I try to show that such avowed anti-industrial struggle in the field of green biotechnologies not only fails to hit the supposed target, but benefits and supports a sector of the industry whose products have a greater environmental impact than recombinant DNA (rDNA) cultivars. Therefore, GMO opponents are exploited by a part of the capitalistic front they are combating. In the meantime, steadfast resistance to GMOs as an indiscriminate whole creates heavy collateral damage, impeding the development of public and philanthropic biotech outcomes; such crops would help those whom activists declaredly want to protect: the poor. This detrimental action is based on one counterproductive and enormous mistake: the indiscriminate rejection of GMOs takes away precious energies from productive environmental and social battles.

KEY WORDS: GMOs · Anti-capitalism · Environmentalism · Machiavelli · Lenin

'GMO' IS SCIENTIFICALLY MEANINGLESS AND SEMANTICALLY DUBIOUS

The expression 'genetically modified organism' or 'GMO' is commonly used. It was coined[1] as a shortcut to indicate a number of agri-food products (mostly crops), which are created using different methods to 'recombine' or 'splice' one or several sequences of their DNA), often 'copying-and-pasting' genes taken from other species (transgenesis). Various techniques are applied to cancel undesirable characteristics (e.g. allergenicity or toxicity) or to add useful traits (e.g. resistance to pests, herbicide tolerance, improved nutritional properties, better performance under abiotic stress such as flooding, drought, heat and climate change). The resulting recombinant DNA (rDNA) processes and products belong to the agri-food, or 'green', area of biotechnologies (WHO 2014, Diaz & Fridovich-Keil 2018)

The problem is that the term 'GMO' is both scientifically meaningless and semantically dubious, for several reasons. (The following number of incongruities and contradictions has also been listed in Tagliabue 2016a and Tagliabue & Ammann 2018)

(1) It is arbitrary: it does not comprise many rDNA products in the areas of 'red' (pharmaceutical) or 'white' (industrial) biotechnologies, e.g. insulin (www.

[1]Apparently, the expression appeared for the first time in The New York Times Editorial Desk (1984). At the beginning, the intended use of the term was probably 'innocent', i.e. there was no intention of underlining a hidden danger of these novelties (some bacterial strains and a few crops); however, a negative halo was soon imposed by critics of rDNA operations and products

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nlm.nih.gov/exhibition/fromdnatobeer/exhibition-interactive/recombinant-DNA/recombinant-dna-technology-alternative.html, accessed 24 May 2018), or enzymes for detergents, produced by genetically engineered bacteria. Even 'green' products such as some food ingredients, e.g. chymosin for making cheese (http://blogs.scientificamerican.com/food-matters/2014/06/09/genetically-modified-cheese, accessed 24 May 2018), are not included in the dubious GMO perimeter.

(2) It is illogical: the same traits (e.g. herbicide tolerance) can often be created via techniques of genome management (e.g. tissue culture, wide crosses, mutagenesis) which are not under the GMO umbrella (Reddy & Nandula 2012).

(3) It is inconsistent: the boundary between what is a GMO and what is not is indistinct and shifting, because new advances are breaking through: the latest group of applications, which is already proving to be revolutionary, is loosely labeled 'New Breeding Techniques' (NBTs: see European Commission, Scientific Advice Mechanism 2017, p. 56-75. For a less technical explanation, see EASAC 2015); it includes Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR; for its possible agri-food applications, see Hall 2016).

(4) A genetic modification may be purposely provisional (Storici &Resnick 2006).

(5) When fruits and grains from GMO plants are processed, no difference can be detected in comparison with the same 'non-GMO' products: e.g. syrup, oil, starch from maize or sugar from sugar beets do not contain DNA (see e.g. Oguchi et al. 2009).

(6) Transgenesis may be seen by non-specialists as 'unnatural', but horizontal gene transfer happens in nature: for example, a variety of sweet potato contains sequences of microbial DNA. Ironically, the evolutionary origin of such genetic material has been traced in species of the genus *Agrobacterium*; indeed, *A. tumefaciens* is frequently used by biotechnologists to attempt the transfection of transgenes into the genome of the target plant (Kyndt et al. 2015, Otten 2018). To date, Tribe (2018) has compiled nearly 300 examples of 'natural GMOs', and the collection continues to grow. There is no common denominator for so many different products and biotechnological processes: we can often speak of single GMOs (i.e. transgenic cultivars), but 'GMOness' is a void notion.

Even less scientific is the will to attribute a negative (or positive) connotation to the rDNA products as a whole. Not a single peer-reviewed paper has ever been published which gives credible theoretical justifications for considering the direct DNA modifications in agri-food plants, animals or microorganisms as inherently dangerous[2] (or indeed safe); yet, 'in agricultural crops, products of rDNA technology were lumped together into one ominous category, regardless of trait, genetic event, or species' (Herring 2010, p. 80). As for the most frequently raised concern, the alleged unknown long-term effects, there is no possible biomechanism to imagine that a genetic time bomb should be hidden inside GMOs — ill-defined as they must be — but not in the DNA of other biotech agricultural outcomes, such as those obtained via irradiation or chemical mutagenesis: we are talking about a few thousand (FAO & IAEA 2017) cultivars which were created, and new ones are frequently added to the list, by heavily modifying the genomes and exposing cells, seeds and seedlings to certain chemicals or irradiation (www.atomicgardening.com/2017/01/01/yes-atomic-gardens-still-exist-today). There is no epistemological indication to justify a generic and *a priori* fear of any green biotechnology process or technique (Arber 2010) while, at the same time, no attempt at genome modification can be devoid of the risk of failure: in other words, obtaining promising outcomes from breeding efforts involves many trials and errors.

THE PROCEDURE MUST BE (AND ACTUALLY IS): TRY IT AND SEE, CASE BY CASE

Theoretically, a negative impact on the environment or health may appear in one or another future product (rDNA or otherwise), even if it is very similar to its 'antecessors'. Yet, preliminary certainty about the safety of any 'green' biotechnology method is impossible; when an attempt proves to be unsatisfactory, it is discarded: in various cases, experimenters simply got rid of ill-fated GMO varieties (e.g. soybeans, barley, canola, maize, potato, rice, wheat, flax, corn, etc.) and traditional ones (e.g. squash, celery, and potato) (see Table 1 in Haslberger 2003, see Table 6 in Kuiper et al. 2001, CSU DSCS 2004). Breeders assess the results of their attempt *a posteriori*: the Codex alimentarius (an institution linked to the World Health Organization and the Food and Agriculture Organization) and similar science-based authorities provide guidelines for reliable lab tests.

[2]We need to use a different approach with 'black' biotechnologies (when dealing with pathogens in a military environment) or some objects of 'red' biotechnologies (e.g. infective viruses or noxious bacteria): in those areas, strict control is mandatory

Hence, the meaninglessness of any alleged gap, i.e. a basic difference of some (unspecified) kind, between rDNA cultivars and other similar products is fully evident, as it is replaced by a rational divide between healthy foods/feeds, individually considered, and problematic or invalid ones, which are discarded.

GMOS AS A (WRONG) PROXY TARGET

Yet, the GMO dubious meme is actually used as a target for determined opposition by many activist groups. In the USA in the early 1990s, the controversial introduction of the recombinant bovine somatotropin (rBST), an animal drug produced by a genetically engineered bacterium that is also known as bovine growth hormone, led to a widespread consolidation in the dairy industry: many small operators were swept away by the competition from bigger players. Although the new product was only one of the factors that changed the dairy sector ('The impact of information technology has been virtually unnoticed': Thompson 2014, p. 12), its role in that important socio-economic dynamic translated into an unwarranted generalization; 'biotechnology became associated with concentration and large-scale farming in the mind of many farm activists' (Thompson 2014, p. 12). In other words, an initial, then repeated and still persistent mistake was to focus on a single rDNA application, which was considered to bring about socially negative consequences, and illogically deduct that any outcome of such technologies had to be negative. The indiscriminate framing was soon embedded in any consideration of GMOs, in the plural, by anti-corporate groups, not only in the USA but in many countries. As the first, and still most important, rDNA cultivars (commercial crops such as insect-resistant maize or herbicide-tolerant soybeans) were created and produced by big seed companies,[3] GMOs soon became, and still are, a proxy for whatever is considered hideous with the agribusiness and with capitalism in general (see e.g. Karim 2013, Todhunter 2014).

A robust fringe of the 'anti-GMO' activism openly adopts a conspiracy-theory attitude: a 'conspiratorial movement involves those opposed to genetically modified organisms (GMO), in essence a protest against the genetic engineering of food. Not everyone who opposes GMOs is a conspiracy theorist: […] But most visible and vocal members of this movement, however, are conspiracy theorists. They believe that genetically modified foods are a corporate plot, led by the giant multinational Monsanto, to profit off unhealthy food' (Uscinski & Parent 2014, p. 146). Furthermore, this supposed enormous covert operation is directed to damage the poor: 'The charge that big food interests take advantage of poverty to open new markets for GM food is restated by conspiracy theorists, who describe a deliberate macroeconomic creation of food shortage in impoverished nations in order to open the door to GM food' (Stange 2003, p. 310)

This ideological and political anti-corporate worldview, although sometimes almost paranoid, is legitimate. Yet, while I do not argue whether this attitude is good or bad, right or wrong, I maintain that the avowed anti-industrial struggle in the field of green biotechnologies not only fails to hit the supposed target, but benefits and supports a part of the industry whose products have a stronger environmental impact than rDNA cultivars; in addition, and more importantly, opposing GMOs generates heavy collateral damage to public science, agricultural progress and the poor.

In other words, I will try to offer a logical and empirical examination of the real outcomes of the 'anti-GMO' fight. Note that personally, I do not like belligerent language: I use it here to adapt words and metaphors to those which are so often put forward by GMO foes.

The questions therefore are: from a factual point of view (leaving aside political value judgements), is the unflinching blanket opposition to GMOs obtaining the desired results, i.e. weakening or damaging the power of agribusiness multinationals? Are human/animal health and the environment better protected through a complete, pre-emptive rejection of any kind of green GMOs? Are the poor, in particular the small farmers of the developing nations, helped through the frequent prohibition of raising and consuming crops which derive from certain biotech methods? I will argue that the answer to each of these queries is 'no', and, what is worse, counterproductive and unwanted effects are evident. This clear-cut statement must be articulated, but can be summarised in the sentence of an outstanding biologist-geneticist, who is also a prominent critic of industrial agriculture: 'GMOs are the wrong target' (Lewontin 2001, online). Better explained: 'Political activism in the guise of health and environmental concerns took advantage of the suspicion of GMO-crop technology as a proxy for much of the activists' discontent with globalisation' (Dubock 2014, p. 82). 'Anti-GMO move-

[3]To be precise, the first 'genetically engineered' crop was a tomato variety called 'Flavr Savr', modified in order to stay riper and be tastier: after an initial success, the product was shelved. See Winerip (2013)

ment's fixation on GE [genetic engineering] has been an enormous mistake. The principles it claims to stand for — environmental protection, public health, community agriculture — are better served by considering the facts of each case than by treating GMOs, categorically, as a proxy for all that's wrong with the world' (Saletan 2015, online).

It must be noted that genuine food safety and environmental anxieties in relation to such a new wave of agricultural applications were understandable at the very beginning of the rDNA crop developments. However, apart from the lack of epistemological reasons to be suspicious of GMOs, the mounting evidence which accrued during many years of experience should have dispelled those concerns, as I will describe further on.

A MACHIAVELLIAN-LENINIST STRATEGY

Looking in more detail at the problem, I note that environmental organizations push hard for precise, well-defined targets: slogans such as 'Save the whales' or 'Against the drilling of the Arctic' are unambiguous and immediate; on the contrary, 'No to GMOs' just shows and makes confusion. Ask activists what they mean when they call for a radical overhaul of energy policies, and the answer will be clear and specific: abandon as soon as possible fossil sources (coal, oil, methane gas), which are non-sustainable, polluting the environment, climate-altering and noxious for people, moving to clean and renewable sources (sun, wind, hydroelectric, geothermal); this can easily be understood even by those who know nothing of chemistry or biology. Many of the same advocacy groups, on the other hand, indiscriminately combat GMOs, without convincingly or clearly explaining why they attack such a target with peculiar furor: in fact, apart from the already discussed generic, and therefore inconsistent, safety suspicion, the most common criticism is that GMOs are patented, and therefore big corporations are accused of gaining too much commercial control through legal restrictions. But this important intellectual property issue also applies to most other products, agri-industrial and otherwise. On the other hand, new cultivars (including rDNA), when created by universities, public research institutes or philanthropic foundations, may be 'open source', i.e. publicly available. This is the case with the 'Scuba' rice (Ronald & Adamchak 2008), a variety that can withstand prolonged submersion. 'In 2015, 4.9 million farmers grew Sub1 [Scuba] rice, setting a record for the most rapidly adopted rice variety in the history of modern rice farming' (Ronald 2017, p. 4). In other words, the patent issue should obviously be a non-issue where patents are not enforced. Again, there is no specific characterization of GMOs that justifies its blanket ostracism.

Thus, we note an unwarranted ambivalence. Proposals and projects to defend nature have aims that anybody can see and understand, whereas GMOs are a subject of acrimony without being a coherent object. Let me form a hypothesis: the aversion to GMOs, these various agricultural applications that sometimes cannot even be clearly defined, is instrumental, i.e. a means to an end: the real targets are the multinational companies which produce and sell rDNA seeds, their excessive power, their business practices that tend to create oligopolies and the mega-profits they enjoy.

Why do anti-corporate activists not put forward these exhaustive, significant criticisms without firing away at GMOs? They expose cases of embezzlement which giant companies are accused of, but they feel the added need to heap the blame on GMOs. Radical protesters fiercely criticize states that have not yet banned the hunting of endangered species; they are implacable in opposing the big energy and mining companies, responsible for environmental degradation and widespread pollution; they constantly press for the activation of measures to limit planetary warming and the consequent harmful climatic and meteorological changes. Among the public to which their communication efforts are directed, nobody can have any doubt what they are talking about; one may appreciate these aims more or less, may support or not support environmental programmes and the ways in which activists try to realise them, but anybody can understand what the issues are. It is not like that for GMOs, as surveys regularly show (see e.g. Jurkiewicz et al. 2014, Lusk & Murray 2015): the public's confusion is understandable, since the actual questions asked by researchers to enquire about people's stance on GMOs have no coherent sense or reference.[4] But opponents of agribusiness giants take advantage of the fears generated by GMOs, which are as vague as they are disquieting ('Frankenfood' and the like).

[4]According to science communication expert Dan Kahan, 'Survey items on GM food risks are *not valid*: these items are eliciting confusion from people who have no idea what they are being asked.' Researchers are to be blamed, because they 'had to know that the responses to their own survey reflected simple confusion on the part of their survey respondents.' www.culturalcognition.net/blog/2015/1/31/weekend-update-pews-disappointing-use-of-invalid-survey-meth.html (accessed 17 March 2018)

Such scares are irrationally inflated by the constant use of frightening images (Clancy & Clancy 2016). Anti-capitalist militants appeal to this threatening bewilderment to strike those who make huge revenues from rDNA seeds; the propaganda against GMOs throws a particularly nasty light on whoever exploits the economic potential of the biotechnology.

It has been argued that such exacerbation of the debate on the part of GMO opponents is due to the narrow approach embraced by regulators: since the legitimate criteria to authorize rDNA organisms, where they are not banned, are allegedly only related to safety and health issues, i.e. it is enough for GMOs to be assessed as safe in order to freely cultivate and trade them, 'the range of legal, political, economic, and cultural concerns raised by GM opponents as Food Regime Concerns' (Hicks 2017[5], p. 491) is unjustly marginalized or utterly disregarded. In other words, protestors seem to be somehow forced to exacerbate their claims that GMOs are unsafe because this is the only way to combat a wider battle against the supposed socio-economic negative effect from this portion of agri-food biotechnologies; thus, their wrong stances should be understood and excused: 'Even if GM opponents do not deploy evidence and logic and have misleading or incorrect beliefs and attitudes concerning GM crops, this does not justify excluding them from democratic deliberation' (Hicks 2017, p. 498).

However, this is an incorrect way to examine the anti-biotech groups' behaviour. First, they are not precluded from the debate: there are no examples of situations where their voice has been silenced. In fact, their relentless push against GMOs is one of the key factors which led to stringent regulations in many countries, and internationally through the Cartagena Biosafety Protocol; far from being ineffective, anti-GMO organizations have deeply influenced the ongoing stalemate, e.g. in Europe: 'ideologically motivated advocacy groups that dominate the GM crops area [...] have so far been able to maintain political resistance to any attempt to adapt EU GM regulations' (Mittra et al. 2014, p. 5).

The incessant focus on a limited area of genetically engineered products precludes a broader understanding of the agri-food economic sector, since the business of the seed/biotech mega-players goes well beyond the rDNA crops. Yet, other aspects of the business of seed industry multinationals do not raise hackles as the GMO bogeyman does: enemies of corporations can shoot point-blank, achieving major publicity successes. This approach seems to be dictated by a strongly ideological strategy, which is typical of many political extremists:[6] once it has been established that agri-industries are an enemy, any means is valid to combat the hated system. This behaviour can be understood through a pragmatic reading of socio-political philosophy and action, an attitude that one can find both in Machiavelli and Lenin. In fact, the expression 'the end justifies the means' is not present in the writings either of the political theorist of the Italian Renaissance or of the ideologist and leader of the October Revolution; yet, such a basic principle is apparent in the spirit, if not in the letter, of the dynamics put in place by many socio-political subjects throughout human history, in the struggle to win power.

The political analyst is not surprised by such behaviour, and does not indulge in praising or damning it, but wishes to investigate whether it is successful or not. Therefore, the main question remains the same: does this 'Realpolitik' battle, concentrated on the GMO target, reach the desired results? Sadly, the outcomes are marred, as we will now see in examining specific issues.

A TROJAN HORSE AND AN EMPTY FORTRESS

The first problem with the opposition to GMOs, since it is applied to any rDNA product, is that the openly declared anti-corporate stance does not appear to be valid where private interests are not present. This seems to be the case of the 'golden' rice, a genetically engineered cultivar which contains beta-carotene, a precursor of vitamin A; the creators of this biofortified cereal variety have obtained the authorization to freely use a number of biotech processes from the related patent owners and to distribute the product to low-income farmers in developing countries, without charging any fee (Golden Rice Humanitarian Board 2016). At first glance, this looks like a very good deal for the poor; but golden rice has been incessantly under fire from the 'anti-GMO' lobby.

The central point of the rejection is the following: opponents see in the promotion of this GMO, which

[5]This paper deals primarily with the important subject of democratic deliberation, using the debate on GMOs as a topic to discuss inclusion/exclusion of issues and actors in public debates. Here, I am only considering an aspect of that wider discussion, i.e. the attitude of the 'Antis'

[6]Note that my use of terms such as 'extremist' or 'radical' is just technical, i.e. it indicates a political collocation; it does not imply blame

is peddled as being beneficial, a manoeuvre by the multinational seed industry to raise its reputation with the public and politicians, as well as expanding its commercial dominance, by using this product as a 'Trojan horse': 'While Golden Rice will not solve vitamin A problems in India, it is a very effective strategy for corporate takeover of rice production, using the public sector as a Trojan horse' (Shiva 2000, online). The metaphor, which was applied to rDNA products at the turn of the millennium, not long after the announcement that the studies on the new rice were at a satisfactory point, has been repeated for years by anti-GMO militants (RAFI 2000; see also various activists' websites, e.g.: Pesticide Action Network North America: www.panna.org/blog/golden-rice-or-trojan-horse, and GM Watch: http://gmwatch.org/index.php/news/archive/2014/15250-golden-rice-myth-not-miracle; both accessed 17 March 2018). Now, let us assume that capitalist forces are using golden rice as a battering ram to impose their transgenic products on the entire planet. Why then combat the many 'non-patented and open-source applications of biotechnology, which have nothing to do with Monsanto, apparently without exception? This is like being against all computer software because you object to the dominant position of Microsoft Office' (Lynas 2013, online). This analogy perfectly explains how illogical it is to be 'anti-GMO' without making distinctions: if we dislike Windows, it makes no sense to hate Linux as well.

Anti-GMO protestors may consider a parallel with another industrial sector: automobiles are the typical output of large multinationals; would they object to small self-managed companies that made low-cost cars, as environmentally friendly as possible, perhaps powered by renewable energy? Any criticism which is applicable to big corporations in the automotive industry should not, rationally, vilify motorization per se. Similarly, it makes no sense to condemn and revile a (bio)technology in itself.

An important extra consideration is that some demonstrators use violence to show their opposition to GMOs by destroying crops; but they do not limit themselves to vandalizing privately owned fields, they also raid the experimental plots of universities and public or philanthropic research centres (Kuntz 2012). While the use of violence is always ethically dubious, these activists should not attack the work of charitable institutions if their action is driven by anti-capitalism. Ethical and legal considerations apart, there is no logic in destroying fields that belong to agribusiness as well as the greenhouses of universities or NGOs, simply because in both cases they cultivate GMOs. From a strictly realistic (Machiavellian-Leninist) point of view, and considering that helping the poor is a central affirmed aim of most 'anti-GMO' critics, there is nothing to be gained from trashing not-for-profit operations.

Back to golden rice: whoever opposes this product/symbol may not do so because they fear the unknown harm to the environment or health, but for those reasons of socio-political struggle that we mentioned before. This interpretation is confirmed from within the anti-biotech field: 'The former lead anti-GMO campaigner for Friends of the Earth Jens Katzek reported last year that his colleagues, who are implacably opposed to genetically modified crops stated: 'If we lose the Golden Rice battle, we lose the GMO war' (Dubock 2013, p. 10). It may be true that the long delay in the introduction of golden rice is not primarily due to the opposition, but rather to technical and agronomic problems (Stone & Glover 2016, see also Everding 2016), although opinions on this issue strongly differ (Dubock 2016). But this is not the point here: I argue that opposing a promising new crop just because it is 'a GMO' is illogical in the first place.

So we must go back to what we explained: if it is true that seed multinationals do really well out of 'traditional' products, i.e. hybridized or mutagenized crops, it would not be possible to turn people against them by trying to spread fears about the threats which arise from cultivars that consumers are more familiar with; nor — surprisingly — do anti-capitalist activists usually target mutagenized crops, which could in fact have a certain terrorising appeal (created by using noxious chemicals or atomic irradiation!). On the other hand, GMOs (including golden rice) are a juicy target, for the very reason that the public does not know what they are (or are not) and so there is the (inflated) fear of the unknown.

Furthermore, anti-biotech groups are indifferent to blatant contradictions. A particularly curious case is that of the 'Amflora' potato. It was genetically engineered in order to inhibit the production of 1 of the 2 kinds of starch which are typically present in the tuber and which, in order to favour the production of paper (a large share of potatoes is not eaten), must be traditionally eliminated using a costly process; the inactivation of a certain gene eliminates the problem. The discussions between the European Commission, the ministers of various European states and the opposition of anti-GMO organizations about the authorization of the new cultivar lasted 15 years until the producer, BASF, renounced marketing the product in Europe: yet, another German company obtained the same desired characteristic through a

method of mutagenesis, which is not considered 'GMO', and started the mass production of its 'Super potato' without any red tape burden (PotatoPRO: www.potatopro.com/news/2009/emsland-st%C3%A4rke-processed-100-tonnes-amylopectin-potatoes-fall, accessed 17 March 2018). A corporation is making profits from the very same produce that had been relentlessly combatted with no reaction from activists (See also Tagliabue 2017).

GMOS ARE SUCCESSFUL FOR SEED COMPANIES AND FARMERS, SCARCELY RELEVANT FOR CONSUMERS

From an empirical point of view, the fight against GMOs seems to be a backward battle. According to peer-reviewed papers, rDNA cultivars, wherever they are allowed, are impressively successful: in 2013, 18 million farmers, 90% of whom are smallholders in developing countries (7.3 million in China and 7.5 million in India; James 2014), raised GMO crops. It is easy to understand why, as the economic analysis shows that 'even though companies like Monsanto, Pioneer-DuPont, and Syngenta own patents and charge farmers royalty fees for use of the technology, they are only able to capture a minority portion [33% on average] of the total economic value they helped to create' (Graff et al. 2014, p. 673). The surfaces where GMOs are cultivated have been constantly increasing over time, and one of the brightest macro-areas is the Third World (Smale et al. 2009; see also Juma & Gordon 2015): 'Yield and farmer profit gains are higher in developing countries than in developed countries' (Klümper & Qaim 2014, p. 5). To summarise: 'Overall, the impact of GM crops has largely been agronomically and environmentally positive in both developed and developing world contexts. [...] yield increases per unit area, mainly due to reduced losses as a result of improved pest (i.e. insect) and weed control' (Mannion & Morse 2012, p. 747).

Some critics claim that genetically engineered crops have so far been something of a failure because, since the 1990s until today, they have spread only in a very limited number of products: on a large scale, there are in fact only a few GMO varieties, used mostly for animal food (maize, soy, and rapeseed) or industrial purposes (maize for biofuels) and one intended for textile use (cotton) (Parisi et al. 2016). Moreover, those questioning the success of agricultural GMOs argue that the improvement attained through rDNA techniques has all but focused on just 2 aspects, herbicide tolerance and pest resistance.

These considerations are true; but the criticism appears to be misplaced, in 2 senses. First: farmers want the inevitable presence of invasive plants to interfere with the product's growth as little as possible, and the damage caused by insects, microbes, viruses and fungi to be prevented or minimized. Therefore, crops that have been made tolerant to weed-killers and resistant to pests are very popular among companies and workers in the fields, be they industrial businesses or simple peasants. We are focussing on the point of view of the farmer, rather than the consumer; because of the distrust among the public, the seed industry talks to those who can exploit the benefits of modern agricultural biotechnologies, i.e. the growers. A survey of 49 analyses in scientific publications shows that in 2009, virtually all users were happy with GM crops (Carpenter 2010; see also Cattaneo et al. 2006, Marvier et al. 2007). Another meta-analysis conducted in 2010 points to substantial economic benefits for the farmers that use cotton and maize cultivars which have been made resistant to certain insects (Finger et al. 2011).

Moreover, because of the high development and regulatory costs, agribusiness multinationals have focussed their efforts on commodities that are traded in large volumes on world markets. In addition, private research and development investments are biased towards major hybrid crops (e.g. maize), whose seeds are much more productive if they are bought season after season: this is why staple crops such as rice and wheat, whose grains can be reused as seeds and possibly exchanged, are not a priority for the 'green' biotechnological giants. Furthermore, large private companies have paid little attention to less diffused crops with lower commercial value. All of these facts reinforce the view that public investments in agri-food biotechnologies, tailored on the needs of smaller players (both seed companies and farmers), should be encouraged, not significantly hampered where the GMO stigma is in place. Instead, the successful demonization of GMOs by many activist organizations, which has encouraged a regulatory thicket and huge added development and compliance costs (issues that I examine below), ensures that only big players can make the related massive investments. Therefore, hearing 'anti-GMO' critics complaining about the outcomes of their own achievements leaves the spectator quite puzzled. Again, this empirical analysis does not seek to establish whether the activists' action is ethically and politically good or bad: I simply expose a vicious circle. These are the motives why currently widespread GMOs are an advantage for producers (seed compa-

nies) and their main clients (farmers), while consumers are not substantially benefitting from them.[7]

HELPING THE ENEMY

The anti-GMO struggle is deeply flawed because it creates various counterproductive effects compared to the stated aims of its supporters. First of all, the never-ending propaganda causes some PR damage to the multinationals; but we have noted that the customers of big seed companies (from many small peasants to big farmers) pay no heed to the opprobrium to which their suppliers are constantly subjected. Even where the opposition has managed to inhibit the cultivation of GMOs, the corporate target has not really been hit: since genetically engineered maize and soy cannot be legally raised in most of Europe, these products are massively imported from the Americas, accounting for several million tonnes annually (Tagliabue 2016b): 'Whilst less than 0.1% of the global acreage of GM crops is cultivated in Europe, more than 70% of EU animal protein feed requirements are imported as GM crop products' (Baulcombe et al. 2014, p. 5). At any given moment, huge cargo boats, full of these commodities, are crossing the Atlantic: the revenues that seed giants are forbidden to make in certain regions are made in another part of the world. So far, nobody has ever calculated the added costs generated by this enormous long-distance trade for animal breeders and consumers, and for the environment as well. Indeed, maritime transportation has a huge environmental impact (see Wan et al. 2016).

Moreover, the insistent anti-GMO opposition favours the enemy by activating a peculiar socio-economic dynamic, designated by the spot-on expression 'bootleggers and Baptists' (Yandle 1983). Strange alliances are created by the action of groups or social organizations which, by working according to particular motivations and rigidly pursuing their separate and possibly opposing goals, push for the stringent regulation of a particular sector of the economy. However, in doing so, they may find themselves *de facto* favouring their adversary. For example, during the short period of prohibition in the USA, the insistence of preachers on demanding laws to ban the sale of alcohol made the fortune of the illegal business of clandestine distilleries and taverns; liqueur smugglers, who were obviously completely indifferent to the moral value of abstinence, as promoted by priests, were very interested in a law to forbid its legal consumption.

In the same way, the ceaseless pressure of the anti-GMO groups for rigid and cumbersome regulation of rDNA cultivars has created appalling distortions: in the USA, between 7 and 14 million dollars, in the EU between 10 and 20 million Euros per product are needed just for bureaucratic costs which are additional to those for research and development (Baulcombe et al. 2014, Executive Summary, Chapter 'Safety and risk assessment' and 'Part 3: Safety and risk assessment, Summary'); in almost all countries, for many years, such red tape has been causing problems for small companies and public or private institutes (universities and philanthropic foundations), thus restricting competition in favour of those large companies which the enemies of capitalism would like to hinder. This perverse dynamic has been recorded on numerous occasions: 'Compiling and submitting regulatory dossiers would place an unnecessary burden on both the public sector and start-up companies and would, ironically, favour multinational corporations and hinder the advancement of science and technology' (European Commission 2010, p. 23). Thus, the anti-capitalist activists are facilitating the oligopolistic efforts of a few multinationals, which 'have actively and aggressively lobbied in favor of certain major regulatory or legislative initiatives that often are more restrictive even than those sought by regulators themselves. The industry's goal is ostensibly to placate anti-biotech activists and provide reassurance to consumers' (Miller & Conko 2003, p. 12). The big agribusiness players thus pretend they want to concede something to appease the protestors and the public, but *de facto* they gain an advantage: they do have to absorb those additional costs which they would not have faced if the regulation was more balanced; but it is a good investment, if it damages the competition so much. The second and third negative side effects to which the anti-GMO protestors contribute are therefore clear: not only is the market altered to favour the oligopoly, but they throw a spanner in the works of products which have been publicly researched and hamper the initiatives of philanthropic foundations.

So, here we have a strange case of 'regulatory capture': this expression, which is typical of political economic language, indicates the excessive pressure

[7]Complaints about Big Pharma are frequent from anti-biotech groups, and it is a very unfortunate fact that anti-vaccine movements are part of this. Yet, these groups are reluctant in attacking 'red' biotech products the way they do with 'green' ones; this may be because consumers/patients are greatly benefiting from the products – consider, for example, insulin from rDNA bacteria. However, a discussion of this subject is beyond the scope of this paper

often exercised on those who establish the rules (lawmakers, control authorities, ministerial bureaucracies) by those who will then have to follow those rules. The phenomenon more often occurs in opposite terms to those described here: sector-specific lobbies (usually groups and associations of industrialists or dealers across a range of sectors) normally tend to convince the regulators that lighter regulation is preferable; in the case of GMOs, starting from the USA, the very opposite has happened, due to the combined and convergent efforts of leading biotech companies and anti-biotech groups.

DOUBLE DAMAGE

There is a fourth important point connected to the previous ones: as mentioned, agribusiness multinationals do not sell only GMO seeds, they also trade in many products which have nothing to do with rDNA biotechnology, such as weed-killers which are not coupled with individual cultivars and pesticides with a broad scope: fighting herbicide-tolerant plants means favouring the sale of more toxic herbicides (Brookes & Barfoot 2013); prohibiting transgenic crops with their endogenous insecticides (plant-incorporated protectants) forces farmers to use pesticides whose impact is less controlled: this increases costs, harms the health of operators and also affects 'non-target' micro- and macrofauna (Naranjo et al. 2005). In one way or another, this or that sector of the agribusiness continues to make money. However, if and to the extent that the action taken to hamper GMOs is successful, more farmers will use traditional methods in the inevitable fight against weeds and pests: herbicides more harmful than those used together with the rDNA seeds which are tolerant to them (Duke & Powles 2008), and pesticides in greater quantities; add to that heavier ploughing than that needed by GMOs, the consequent increased use of machinery, the contribution to pollution and the greenhouse effect, and soil erosion. Being environmentalist and at the same time 'anti-GMO' is a patent contradiction.

Another significant side effect of hyper-regulation is the difficulty which is created for all those who deal with the latest biotechnologies, and do not have the financial means of the multinationals. GMO opponents therefore cause double damage by preventing public research and facilitating not always crystal-clear relations with agribusiness: '[T]he greens' demonization of genetically modified crops has effects that are contradictory to their values. Promoting blanket disapproval of such crops helps drive public-sector genetic modification into the arms of industry. Genetic modification is expensive, and most public projects are in a constant struggle for funding. Industry provides some funds and access to genetic materials; greens provide no funding and obstruct philanthropic investment. [...] activists demonize public research along with corporate projects' (Stone 2002, p. 618). A completely deleterious fight. A disaster.

TREATED LIKE 'USEFUL IDIOTS'

Against this background, the boycott of the cultivation of rDNA crops in the EU (only 1 variety of maize is allowed, though more in theory than in practice, as it is stifled by national and local regulations) is attributable in equal parts to opposition from activists as well as the traditional crop-protection industry. In the 1990s in Europe, the conventional chemical industry, a large producer of herbicides and pesticides, realised that the agricultural biotechnological innovations coming from the USA would have soon threatened their profits, were the Old continent to allow them. As it turns out, those companies did not even have to push for strict regulations, with the risk of exposing themselves to criticism. All they had to do was let the 'Greens' do their job, in a European version of the 'bootleggers and Baptists' effect: 'given that activist groups were already highly motivated for their own reasons, all the incumbent industry needed to do to achieve a desired result was to abstain from intervening and to leave the activists unchallenged in forming the public's opinions and risk perceptions of biotechnology' (Graff et al. 2014, p. 20). This contradictory effect shows once more the damage caused by the rigid anti-GMO attitude.

These advocacy movements have long been treated as 'useful idiots'. Again referencing Lenin's political strategy, these were the harsh words that the Russian revolutionary allegedly used to describe agit-props, the agitators and propagandists, who were used cynically and effectively by others. To be clear, I am not using this term as an insult: the expression, as strong as it is, has its place in the political language (see https://en.wikipedia.org/wiki/Useful_idiot, accessed 17 March 2018). In this case, the dedication of many, rather than contributing to the environmentalist cause, simply boosts the profits of other capitalists: agrochemical, instead of 'GM'. Worse still, it tends to perpetuate the profits — which

are legitimate, but certainly not environmentally friendly — from the sale of large quantities of traditional products anywhere in the world where rDNA crops, which do not rely on them as much, are ostracized.

CASUALTIES IN THE 'ANTI-GMO' WAR: THE POOR

The last, but certainly not least, harmful counterproductive effect of the anti-GMO action is that the neediest fall under 'friendly fire', i.e. the populations of the Third World, which anti-capitalists are willing to help. This is confirmed by a leading African scientist, who was a senior director of the Convention for Biological Diversity: 'Critics of biotechnology argue that the industry is controlled by a few large corporations, which they incessantly demonize. But their actions have resulted in developing countries unnecessarily raising the regulatory bar so high that only large corporations have the resources needed to get new crops approved by the restrictive regulatory bodies. In practice, anti-biotechnology activists inadvertently promote monopoly of the biotechnology sector by large corporations' (Juma 2013, online).

At the same time, the opposition to GMOs has simply shifted the production areas of commodities (mostly from Europe to the Americas). However, while consumers in rich nations can afford to buy many available non-GMO foods, it is not so in the Third World, where new cultivars could improve yields and nutritious properties, but are frequently forbidden: 'Farmers in poor countries rely almost entirely on food crops, not on crops for animal feed or industrial use, so today's de facto ban on GMO foods is specifically damaging to those poor farmers' (Paarlberg 2014, p. 227). Such a dichotomy in the outcomes of the war to certain applications of advanced agricultural biotechnology is very clear: 'When it comes to GMO food crops, anti-GMO campaigners have thus won a remarkable yet dubious victory. They have not prevented rich countries from using GMO animal feed or GMO cotton, yet farmers and consumers in poor countries need increased productivity for food crop' (Paarlberg 2014, p. 223).

The preconceived refusal to approve and encourage partial and limited solutions, which could contribute to lessening the serious agricultural, food and health problems of the poor, can be traced back to an old Marxist attitude: 'All or nothing', anti-capitalist critics seem to proclaim, as they often did in the past; the real revolutionaries had to oppose partial solutions and limited interventions, because they delayed the longed for socio-economic rebirth. So, no to Golden rice and similar products designed for the Third World, because it is necessary rather to confront underdevelopment in general: 'The fight to poverty and hunger will not be won and people will still go hungry if the fundamental causes of hunger and food insecurity are not tackled, whereas genetically modified technology is not based on this assumption' (Francescon 2006, p. 381). According to this way of thinking, we should not believe we are helping the indigent by giving them access to agricultural machinery: the mechanisation of agriculture started in rich countries a technical advancement which is not 'based on the assumption' of combating hunger. Instead, we must underline that herbicide-tolerant cotton, which is cultivated in the endless fields of America, is also useful in the half acre worked by the peasant family in Vietnam: the use of such seed avoids the back-breaking labour of hand weeding, which frequently falls upon women and children. Similarly, rDNA corn bears fruit, protected from certain pests, not only in the immense open spaces of Argentina but also on the few dozen plants sown in the kitchen garden behind the suburban house in Kenya. In economic jargon, the technology embedded in the seeds is 'scale-neutral', i.e. the potential benefits of using rDNA cultivars (or any kind of better varieties, for that matter) are not necessarily linked to the size of the farm. Indeed, the scale-neutrality of using certain crops instead of others, while generally recognized in the context of the Green Revolution in Asia, has been recently questioned in the African scenario (see Wale 2012, Fischer 2016). By the way, the new varieties which have been the central factor of the Green Revolution were not GMOs: yet, this does not matter.

Therefore, from a strictly empirical point of view, it makes no sense to identify agricultural genetic engineering as counterposed to broader social policies and the need to distribute wealth in developing countries. Many analysts recommend a detailed approach. The situation is not black or white, but rather 'grey': a detailed reading is needed to avoid 'opposing potentially beneficial agricultural strategies or technologies because they might impede a complete transformation of the agricultural system' (Stone 2005, p. 212). In short: 'Is it beyond the imagination of anti-GM activists that genetic modification could be used for public benefit instead of private profit? The activists may well be sincere in opposing social injustice but, all the same, they think that these problems

arise from something inherent in the technology. In so doing, the complaint is in fact not the business practices of Monsanto, or even capitalism, but technology and progress itself' (Phillips 2014, online).

Embracing an uncompromising war-mongering approach, fighters seem not to realise that any war involves casualties, and therefore the intent to combat capitalism necessarily entails innocent victims. Such a strategy, as a matter of fact, does not work: it seriously damages the weak and poor, without inflicting on the enemy anything more than some minor scratches.

THE JANUS ENVIRONMENTALIST; OR, THE BIPOLAR ECOLOGIST

The previous analysis leads to the conclusion that those who claim to be 'environmentalists', whether individuals or organizations, if they perpetuate the misleading confusion which ensures that such commitment and militancy must require being anti-GMO, may be dubbed as 'Janus environmentalists', after the two-faced Roman god. In the ancient mythological/religious iconography, one face of the god looks to the past and the other to the future; instead, the eco-radical progressive face of today looks to a future which should be free from ecological disasters and threats to nature, while the other face, the anti-biotech one, cries out against something which does not exist as a supposedly negative lot — GMOs! — and so wastes precious energy and causes undesired dire consequences. This has no consistency, not even in purposefully anti-capitalist terms.

If the word 'bipolar' raises suspicion of hypocrisy, that is just the attitude of some anti-capitalist opponents, when the professed environmentalist values become irrelevant, if an alleged ecological damage can be imputed to a GMO. When a lab experiment showed that larvae of the iconic monarch butterfly were damaged if exposed to excessive quantities of pollen from Bt (*Bacillus thuringiensis*) corn plants, the anti-GMO movement took advantage of the media stir: they saw it as 'a gift from heaven'. As one anti-biotech activist remarked, 'A colleague called me up and said, "You are not going to believe this one. They just found out that Bt corn pollen kills monarchs!" [...] It was the best news that we had heard in a long time' (Schurman & Munro 2010, p. 135–136). In cases like this, worse is better, if it looks useful in the fight against the declared enemy: à la guerre comme à la guerre...[8]

'Whole' environmentalists, if we can use this term as opposed to 'Janus' ones, understood right from the start how the question needed to be put: the summary of a huge piece of work undertaken by an ad hoc committee of the Ecological Society of America at the end of the 1980s states that 'genetically engineered organisms should be evaluated and regulated according to their biological properties (phenotypes), rather than the genetic techniques used to produce them' (Tiedje et al. 1989, p. 298).

The anti-GMO militancy starts from an original sin of understanding, which has grown abnormally. Let us go back to the late 1980s and hear one of the activists who attacked the experimental field where the spreading of genetically engineered bacteria was sought to cope with sudden temperature drops, preventing the formation of ice on the plants. The director of an ecological movement, Earth First, recalls: 'When I first heard that a company in Berkley was planning to release these bacteria Frostban in my community, I literally felt a knife go into me. Here once again, for a buck, science, technology and corporations were going to invade my body with new bacteria that hadn't existed on the planet before. It had already been invaded by smog, by radiation, by toxic chemicals in my food, and I just wasn't going to take it anymore.' (see http://news.bbc.co.uk/2/hi/science/nature/2045286.stm, accessed 17 March 2018). Such people did not understand that no alien microorganism would have penetrated into anybody; that smog, radiation and toxic chemicals had nothing to do with harmless anti-freeze bacteria — which were already known to exist in nature (www.the-scientist.com/opinion-old/the-nonsense-about-frostban-63769, accessed 31 August 2018); that spraying crops with microbes, for example *Bacillus thuringiensis* (the infamous Bt) with an insecticide function, is a practice which is not in itself of concern, and is even widely used in 'organic' farming. Over a quarter of a century later, these elementary distinctions should finally be grasped.

A POSSIBLE CHANGE OF MIND

The unselective anti-GMO battle line is a dead end, a lost cause, but those who defend it often believe they are fighting for a fundamental pillar of environmentalism and take such opposition as an

[8] 'à la guerre comme à la guerre': French expression, literally translated as 'at war as at war', although the intended meaning is equivalent to 'the ends justify the means'

important symbol: 'The attitude a person adopts to GMO crops is the badge of loyalty that they show in choosing one side' (Thompson 2014, p. 23).

Yet, a few cases of reconsideration allow some cracks in the dogmatism: 'Caution is reasonable. What needs to be rethought, however, is blanket opposition to the very idea of GMOs' (Singer 2014, online). Dave Hanson, an historic environmental leader and activist from California, says: 'if the proposals for agri-food genetic improvement come from public research at a university, I think we will see some really interesting potential solutions with recombinant DNA that could show all kinds of benefits in health and agriculture and other things. So baby and bathwater are separate' (quoted by Ostrander 2014, online); this shows a welcome ability to make distinctions.

Another situation shows that the hard-core anti-GMO front is not completely monolithic. It is well known that the increasing single-crop extensions of ('non-GMO') palm oil in South-Eastern Asia are realised at the expense of primeval forests; some companies are developing methods of synthetic biology (genetic engineering of algae through DNA sequences which are not taken from other organisms but are created ad hoc) to produce oil which is economically competitive with that from environmentally invasive plantations (Strom 2014). An activist who for years has led the defence of tropical environments, says: 'Palm oil has been such an extreme disaster for forests, and the environment more generally, that if these synthetic organisms can produce large volumes of vegetable oil, we should celebrate them' (Glenn Hurowitz, president of Forest Heroes Campaign, as quoted by Johnson 2014, online). Instead, environmentally 'bipolar' organizations are putting forward their protests (Thomas et al. 2014). If we were to find in nature a variety of algae that does the job, then those who are free of bias would have no concern about the related research into synthetic genes being abandoned; just as no-one should complain if, we argue, the current palm trees, which are not GMO, had their DNA recombined to produce double the oil while saving farmable land or virgin forests.

CONCLUSION

GMO is an intellectual weed, a mind-polluting meme that should have never been created; it is time to bury this semantic trap and its related wrong-headed policies, for the benefit of environmental movements worldwide and societies at large.

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