“GMOs”, “contamination” and “coexistence”: Challenging the misuse of concepts and wrongheaded regulation of agriculture and food

The term “genetically modified organisms” (or “GMOs”) has come into wide use over the past two decades although it is not a scientific term. The terms used in the science community are “genetic engineering” or “genetic modification”. Yet the more popular nomenclature has persisted in part because biotechnology skeptics know that it stigmatizes a safe process. Who would want to eat an “organism”?

Yet many journalists and even some scientists persist in using such terminology even though it subjectively conveys that transgenic alterations, which have occurred naturally over millions of years of evolution, is somehow uniquely harmful. That framing has helped feed public misconceptions that genetically modified seeds yield grains, fruit and vegetables that are inherently harmful.

It also obscures the fact that single new non-transgenic cultivars may show undesirable properties, independently of the process which is used to create them. For example, that’s what happened with the Lenape potato, which was developed in the 1960s for the snack business to make potato chips, was discovered to be ‘naturally’ toxic, and the now infamous “poisoned potato” had to be pulled from the market .

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Using such words as “contamination” and “pollution” when referring to recombinant DNA crops shows a bias: the conviction that “GMOs” create a “coexistence” problem, and therefore genetically modified crops should be segregated all along the food chain. That’s a groundless fear. Based on the science, regulations that impose burdens and costs on farmers who work with inherently safe recombinant DNA crops should be scrapped.

Coexistence does have to be managed to avoid commingling to preserve their uniqueness, not to protect against “dangers” that don’t exist. Organic farmers, whose certification depends on limiting comingling with nonorganic crops and products through processing to less than 5% can prevent that by freely choosing to take on the costs of separation.

“GMO” is a misleading meme, scientifically spurious and factually inconsistent

A particular facet of the debate about so-called “genetically modified organisms” originates from a corollary of the basic suspicion that many often link to agri-food genetic engineering, i.e., the alleged difficulty linked to the proximity between recombinant DNA crops and those which are more or less traditional and “conventional”; this problem, according to a frequent narrative, is even worse where “GMO” fields are adjacent to “organic” ones. The underlying belief is that cultivars which derive from certain direct interventions on their genomes are essentially different from the other varieties, in a somewhat negative sense. Hence the issue of managing the coexistence of “GMO” and “non-GMO” produce all along the

agricultural chain, from cultivation to harvesting, storing, packaging, labelling, tracing, sales: caution is imperative, it is said, to avoid “contamination” between the two allegedly incompatible categories.

This conviction is wrong, in a double sense.

First, the error is *theoretical*. Not a convincing peer-reviewed paper has ever been published which gives scientific justifications for considering recombinant DNA methods as used with agri-food plants, animals or microorganisms (as part of “green” biotechnologies) as *inherently* dangerous (or indeed safe). Biologists and geneticists have been trying for decades to explain that considering “GMOs” as a group on its own is a fallacy which is falsely based on a “genomic misconception” (Ammann 2014), i.e., the groundless idea that certain *processes* should be singled out as peculiarly problematic and therefore, together with the resulting *products*, should be made subject to sectoral regulation. A declaration signed by over three thousand scientists, including several Nobel prize-winners, says: “We also urge policymakers to use sound scientific principles in the regulation of products produced with recombinant DNA, and to base evaluations of those products upon the characteristics of those products, rather than on the processes used in their development.” (Prakash et al. 2000-2014). Indeed, numerous scientific societies and academies released official statements to explain the same concept, and they did so very early; just one example: “there is no scientific justification for additional, special legislation regulating recombinant DNA research *per se*. Any rules or legislation should only apply to the safety of products according to their properties, rather than according to the methods used to generate them.” (European Molecular Biology Organization 1988, as quoted in Cantley 1995, p. 560) An impressive block of studies, funded by the European Union, confirms that scientific assumption: “The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are not *per se* more risky than e.g. conventional plant breeding technologies” (European Commission 2010a, p. 16). An authoritative, in-depth study stresses the point for the nth time: “Emerging genetic technologies have blurred the distinction between genetic engineering and conventional plant breeding to the point where regulatory systems based on process are technically difficult to defend.” (National Academy of Sciences 2016, p. xviii).

This principle is affirmed by life scientists as correct not only regarding the safety appraisal of “GMOs”; the same approach is also recommended for assessing possible environmental impacts: “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)

Yet, critics of agri-food biotechnologies still demand strict regulation, not only for recombinant DNA products, but also for any New Breeding Technique: but their arguments are scientifically wrong. (Tagliabue 2018a)

While we can often speak of single “GMOs” (e.g., transgenic cultivars) and examine pros and cons of each product in specific situations, there is no such thing as “GMOness” or “GMOity”, i.e., a hypothetical (suspicious) common denominator for a diverse, heterogeneous bunch of enhanced organisms.

Second, the mistake is *factual*: considering agricultural recombinant DNA products and their derivatives which are *currently on the market* as dubious goes against wide empirical evidence. (Nicolia et al. 2012).

To be clear, the confirmed safety of *each single* product coming from biotechnologies (recombinant DNA or otherwise; agricultural or otherwise) which has been properly checked does not warrant the assurance that a negative impact on the environment or health cannot appear in *other* future products, even if they are very similar. It is correct to say that the results from biotech manipulations (*"GMO" or otherwise*) are not fully predictable: but, while this is true, it is also irrelevant. Preliminary certainty about the safety of this or that green biotechnology method is impossible: yet accurate examination of the outcomes from each individual experiment can give a decent guarantee that introduction into the environment, and/or into the food and feed chains, of new agri-food inventions takes place at minimal risk. Science-based principles are provided to assess the safety of foods, and the guidelines regarding "GMOs" do not differ from the "normal" ones (Codex alimentarius 2003-2008 and 2008): the Codex *ad hoc* committee which was established to write the guidelines for the safety assessment of foods derived from biotechnology drew up the requested documents, and was then disbanded. Anybody can do a simple experiment: take the Codex guidelines regarding "GMO" and delete any reference at the rDNA methods from the whole text: you will end up with a series of rational and evidence-based recommendations that can be applied to the evaluation of *any* food.

As a matter of fact, if this or that new vegetal variety, or micro-organism, or animal, proves to be unsatisfactory, biotechnologists or agronomists just discard it. That is exactly what it has been done in the past in various cases, getting rid of ill-fated "GMO" varieties of barley, canola, maize, potato, rice, wheat, etc. as well as other cultivars from traditional hybridization, e.g., unfortunate outcomes of squash, celery and potato (Haslberger 2003, p. 739-740; Kuiper et al. 2001, p. 516).

One may insist that the safety assessment procedures are inadequate: if so, the evaluation path should be improved for any food, not only "GMOs".

Thus, the meaningless attempt to create a gap between recombinant DNA varieties and other similar products is fully evident, as it is replaced by a meaningful divide between healthy foods/feeds (taken one by one) and invalid ones – which end up in the waste bin.

To summarize, the overwhelming scientific consensus (Tagliabue 2016) has double grounds: from an epistemological point of view, the distinction between "GMOs" and the rest of the agri-food world is pointless and misleading; from a practical point of view, the safety of the commercialized products which derive from recombinant DNA has been confirmed by many hundreds of studies – because the bad outcomes were stopped and dumped before entering the market.

Furthermore, any legitimate consideration regarding the place of socio-economic issues in the regulatory framework of agriculture – both at national and international level – must abandon the “GMO” vs. “non-GMO” misplaced framing. (Tagliabue and Ammann 2018) We will not discuss these issues, since the focus of this article is on a misuse of concepts and words with relation to specious health and environmental safety concerns.

From a mistaken approach, mistreated concepts

Therefore, it is incorrect to use the term “contamination” to indicate episodes of gene flow, i.e., the possible appearance of hybrid plants at the borders between fields of transgenic and non-transgenic crops, or the commingling of rDNA and traditional grains, beans, tubers, fruits after harvest or along the food/feed chain. “To contaminate” means “to make (something) dangerous, dirty, or impure by adding something harmful or undesirable to it” (www.merriam-webster.com/dictionary/contaminate); the same is true for “genetic pollution” or similar expressions: those words have a precise meaning, as they indicate actions or situations which are deleterious for health or damaging to the environment. Talking about “contamination” or “genetic pollution” to be feared from “GMOs” reveals a basic logical mistake, i.e., begging the question: taking as certain what has not been ascertained is an illicit and deceitful pre-judgment. If, at the end of the analysis *of single agri-food items*, a conclusion emerges that the dreaded dangers are real, then it is fully permissible to use words which are loaded with a certain connotation; not before. And, again, a new cultivar which proves to be unsatisfactory must be ditched, whatever biotech process was used to create it. “Anti-GMOers”, on the other hand, being impervious to a myriad of scientific papers which show that the safety tests are working, normally use that kind of tendentious terminology as an effective rhetoric tool, plainly declaring in advance that the issue in question is corrupt: this attitude is *strongly* biased.

One can start from the dogmatic assumption that “GMOs” are “contaminants” and cause irreversible damage to “the purity of non-GM seeds” to draw the obvious conclusion that “coexistence” is “a myth” not compatible with agroecology (Altieri 2005, p. 361). It is easy to turn this pseudo-syllogism on its head: if the underlying premise is wrong, because “genetic contamination” is only a viral meme that contaminates the mind of those who become infected with it, or is a misunderstanding which is opportunistically spread for anti-corporate or commercial purposes, coexistence is indeed a myth – in the sense that it is not a problem at all: the term, in this context, means nothing.

Using a neutral terminology, it is acceptable to talk about *admixture* between recombinant DNA products and others: the mingling may happen in the fields (for instance, cultivation in neighboring areas of insect-resistant and “conventional” maize, where some hybrid plants may appear) or in silos (e.g. soybeans from rDNA herbicide-tolerant plants or otherwise), or in the following steps of processing and packaging: yet, it is difficult to understand why this should be worrisome. Admixture may happen between produce obtained from old-fangled cultivars and others in which one or more traits have been infused to create an advantage for the farmer and/or the consumer; in terms of nutritional and organoleptic qualities, the two different items are often indistinguishable: and even where a difference can be traced, it has no significance in terms of health or environmental risk – once the tryouts have been properly checked and assessed.

Moreover: the same trait (e.g., a rebalanced starch content in potatoes) can be obtained via DNA-splicing, therefore creating a “GMO”, or advanced techniques of induced mutagenesis, so that the product, which is not legally “a GMO”, escapes a lot of red tape and added costs: in this second case, no issues of “coexistence” and “contamination” are claimed. An example of such a bizarre situation is the case of the Amflora potato (https://en.wikipedia.org/wiki/Amflora). It was genetically engineered in order to inhibit the production of one of the two kinds of starch which are typically present in the tuber and which, in order to favor the production of paper (actually, a large share of potatoes is not eaten), is traditionally eliminated using a costly process: the inactivation of a certain gene solves the problem at source. The push and shove between the European Commission, the ministers of various recalcitrant European states, and the challenges of “anti-GMO” organisations regarding the authorization of the new cultivar lasted fifteen years until the producer, BASF, gave up marketing the product in Europe; in the meantime, another German company managed to produce the same desired phenotypic trait through a sophisticated “non-GMO” method of mutagenesis, and immediately started the mass production of its “Super potato” with no particular bureaucratic burden (Fraunhofer-Gesellschaft 2009; see also Anonymous 2009), without raising any reaction from activists. Clearly, the mutagenized potato is politically correct, the “GMO” one is not. No logic in the “GMO” stigma.

“Contaminating” mutagenesis?

To better explain the basic confusion which underlies the “contamination” legend, let us do a mental experiment. Consider another heterogeneous class of agri-food products which are obtained through two well-defined methods, i.e. physical and chemical mutagenesis; here the picture – as far as the description of the interventions is concerned – is clear: such diverse vegetal varieties, which number some thousands (the complete database is available at FAO-IAEA 1950-2023) – and new ones are frequently added to the list – derive from fortuitous results obtained by systematically exposing great quantities of cells or seeds or seedlings, of many crops or vegetables or ornamental varieties, to sources of mutagenesis, i.e. radiation (X-rays or gamma rays) or certain chemical elements (Broad, 2007). Technicians place several lines of different crops at increasing distances from a radiation source in a field (see Figure 1) and provide scalar levels of irradiation, following specified timetables; or they manage cells and seeds in a lab, exposing them to various sources of radiation or to carefully assessed quantities of mutagenic chemicals. Then the outcomes are checked: in almost all cases, the genomes are scrambled in ways that the organisms die or are irremediably damaged.

image

Figure 1: Field for irradiative mutagenesis at Casaccia, near Rome, Italy.

Sometimes – alas, not so frequently! – one or a few survivors show interesting new phenotypic traits, e.g., resistance to certain pests or tolerance to herbicides (note that to obtain such results we often do not need to create “GMOs”). Such “wildcards” are carefully treated like precious living nuggets, then cloned and multiplied in millions of plants of commercial value. If a new cultivar with interesting added features, when properly tested, proves to be allergenic or toxic, it is ditched.

Now, suppose that a movement was created which wanted to affirm the idea that products whose “prototypes” derived from mutagenesis must be suspicious, even unsafe (“Atomically irradiated! Exposed to carcinogenic chemicals!”). Such a stance would be unscientific, for the obvious reason that the legions of “descendants” of the seeds or cells which were initially mutagenized show no trace of the “original sin” through which their “fathers” were born. Ironically, a real danger is inherent in the use of this double biotechnology which nobody is worried about: in experiments of physical/chemical mutagenesis, operators

must follow strict safety procedures while using radiation and nasty chemical substances – a peril that does not exist with green recombinant DNA operations. To be sure, once the reactors have been stopped and the dangerous chemicals have been stored, the outcomes show no trace of their origin: although one of the crown jewels of mutagenesis is the Italian variety of wheat named Creso (Bozzini and Bagnara, 1974), nobody ever ate radioactive spaghetti!

Thus, scientists would explain that those crops are perfectly safe, but people who think otherwise could decide to proclaim their dissent – in a democracy everybody can embrace any beliefs and try to spread them.

Our imaginary anti-mutagenesis movement tries to involve politicians in its action. They push for mandatory segregation of mutagenized crops and resulting produce, claiming that any “contamination” and “pollution” must be avoided, and therefore rigid rules for “coexistence” must be imposed. Most probably, a great majority of laypersons would think that scientists are right and opponents are wrong. That is because no anti-mutagenesis meme was invented and diffused half a century ago: instead, the construction of the “GMO” baseless superstructure has been very successful – mostly taking advantage of the relentless abuse of scaring images (Clancy and Clancy 2016).

Bearing evident costs

Now it should be easy to see how the incessant use of biased terms such as “contamination” or “pollution”, allegedly linked to “GMO” cultivation, is related to baseless, yet successful propaganda, which has often translated into exacting containment rules, established by law. This approach results in the tall order to respect barriers and distances between what is called “organic” or “conventional” and “GMOs”, and other safeguarding measures. Taking the European Union as an example (see e.g., European Commission, 2003, 3.2. On-farm measures), the buffer strips which are imposed by Member states go beyond the already onerous European recommendations, “are not in line with the coexistence principles laid down by the European Commission” (Devos et al. 2009, Abstract). “For example, Luxemburg requires 800 m between GM and non-GM corn and 3 km between GM and non-GM rapeseed. Latvia requires 4 km between GM and conventional non-GM rapeseed and 6 km if the non-GM rapeseed is organic.” These distances have been deemed “ridiculous” (Ramessar et al. 2010, p. 135). Furthermore, the burden is heavier for small farms: for instance, in Germany, according to a survey, “farmers with many fields adjoining neighbors or with relatively small field sizes perceived the minimum distance requirement as having a stronger negative impact”. (Venus et al. 2016, p. 3)

In addition, any violation of the legal iron cage in which rDNA crop farmers are constrained, i.e., breaching coexistence conduct, implies liability and redress norms. (See below)

Documents from professed “environmentalist” organizations are examples of this mindset. In a text regarding “socio-economic effects of GMOs”, and particularly the “hidden costs for the food chain”, the start is the usual unjustified preliminary assumption, i.e. the absolute need to avoid “contaminations” between products from “organic” or even conventional agriculture, and those of transgenic origin: “Conventional and organic farmers, bee keepers, seed developers, as well as the whole food production chain, are constantly threatened by GMO contamination” (Bauer 2010, p. 1); such a looming “constant threat” must be contained by complete separation which should be imposed through draconian regulation, from the beginning to the end of the food chain, from production to logistics, packaging and sales. Since

this alleged need to implement watertight compartments obviously generates costs, it is declared as self-evident that such a burden must fall on those who grow “GMOs”, according to the sacrosanct principle that “the polluter must pay”. No scientific rationale is argued to support such a chauvinistic approach.

This “GMO” ghetto is not an imaginary scenario, since this arbitrarily mandated prevention creates real costs: “in all EU Member States’ regulations, it is the GM farmer who should take the measures (usually administrative measures or technical measures such as isolation distances) and who bears the liability.” (Lusser et al. 2012, p. 10. See all chapter 4.3 Session 3: Economics of segregation/coexistence of supply chain, p. 30-33. See the various “Paradoxes among coexistence measures of the EU” in Masip et al. 2013, p. 317) Some misadventures actually happened: “traces of LL601 rice (which was not yet authorized for marketing in the United States or in Europe) were found in US exports to the EU. The US rice industry lost the EU market for years after this incident and the biotechnology company [Bayer CropScience] recently [2011] offered USD 750 million in compensation to concerned rice producers.” (Lusser et al. 2012, p. 12 and p. 101-102)

So, we are not talking about “hidden” costs: they are very explicit, and they are imposed to translate into reality a fictional dichotomy. Let’s assume that the “contaminating” products (e.g. grains from herbicide-tolerant maize or soybeans from insect-resistant plants), for which strict segregation is demanded, instead of deriving from rDNA cultivars, originated from plants whose “prototypes” had been obtained via physical or chemical mutagenesis, or from traditionally performed crosses, or from spontaneous mutants; new varieties of plants can even appear by chance already endowed with the desired trait and are therefore selected right away by agronomists. In all such cases, nobody claims the need to separate the supply chains: William James’ golden maxim (“A difference that makes no difference is no difference at all”) goes unheeded.

Consider various crops in a particular series (commercial name Clearfield), which have been made tolerant to proprietary weed killers, and consequently are sold together with them; the desired effect was obtained through tissue culture and/or induced mutagenesis or selection of natural mutants which are then crossed with other varieties and so – legalistically speaking – without creating “GMOs”: consequently, the producer has legitimately avoided the major barriers which it would have had to face if the technical staff had “recombined” the DNA of the new varieties of maize, wheat, rice, sunflower, and oilseed rape (Tan et al. 2005)

Another example. Several varieties of vegetables and fruits are – not a very rare occurrence – naturally tolerant to some herbicides (Mason 2016), while most other plants are not: these products tread along the normal path from field to dish; everybody is fine with the “naturalness” of the food. Now, let’s imagine that a clever botanist manages to “copy” from one of those crops the gene which confers the herbicide tolerance and inserts it into another cultivar, that is naturally lacking it; after all the tests have been performed, the new produce turns out to be safe: this brand new crop would be “contaminating” and therefore forced to follow the ignominious path of “GMOs”, kept apart from its “natural” cousins, from the cultivated plots to the dish of the ill-advised consumer. Note that, if the very same trait (and the underlying gene) were transferred to other cultivars via “normal” crosses or advanced lab non-rDNA techniques, nobody would be worried, whereas if we create “a GMO”, it is considered problematic. No consistency at all.

When regulators demand large swaths to be established between borders to ward off “pollution”, and separate post-harvest paths to avoid “contamination”, this is not acceptable, because it has no justification. Some scientists react: “For those with deeply held beliefs that GM is bad, such admixture is seen as violating their right to avoid the technology, which imposes difficulties. What degree of intolerance from such individuals is society prepared to accept, given the cost of imposing very high standards of ‘GM freedom’, and the lack of scientific evidence that such intolerance is scientifically justified?” (Jones 2011, p. 1812)

This situation can involve a broader reflection, whether it is “valid in a democracy to permit a minority of the population to determine the opportunities (economic and life-style related) available to the rest of the population?” (Tait 2016, p. 23) Even if a majority or a quasi-unanimity were against certain products which are recognized as safe after due examination, any unwarranted straitjacket would be a regulatory abuse, i.e., a disruption of a well-regulated free market.

“Organic” idiosyncrasy

The “organic” farmers worry if some hybrid plants appear in their fields, which may be close to similar transgenic operations, but this distress is often misplaced. The “organic” certification is about the production *processes*: if cultivation rules are observed, nobody should care if small percentages of final product contain “the transgene” – that expression is often used with an alarmist tone by the “anti-GMO” propaganda, as if there was anything to worry about an exogenous DNA sequence which is fully integrated in the host’s genome. “It has been argued that plants on an organic farm cross-pollinated by a neighbor’s gene-spliced crops would no longer be organic […]. This argument is without foundation, however, because it ignores the way that “organic” is defined. The USDA’s rules for organic production are based on process, not outcomes. As long as organic growers adhere to permissible practices and do not intentionally plant gene-spliced seeds, unintentional cross-pollination by a gene-spliced plant (or for that matter, the drift of a prohibited pesticide onto their crops) does not cause those crops to lose their organic status.” (Conko and Miller 2011, p. 2) “Organic status is based on a method of farming, so as long as the organic farmer follows the organic procedures, the organic status is not threatened, even if some prohibited material finds its way into the otherwise organic crop.” (Wager and McHughen 2010, p. 726. For explanations provided by the United States Department of Agriculture see McEvoy 2013)

Let us underline that this view applies to the United States – note that the USDA’s National Organic Program (NOP) doesn’t use the term “contamination” in any official context – and basically also to the EU, where the tolerance threshold for the presence of “GMO” with respect to “conventional” or “organic” material has been established at 0.9%: EC Regulation no. 1829/2003 (European Parliament and Council 2003a) concerns the use/importation (not cultivation, regulated by Directive 2001/18, later amended by Directive 2015/412) of genetically modified food and feedstuffs, while EC Regulation no. 1830/2003 (European Parliament and Council 2003b) rules the traceability and the labelling of genetically modified organisms and the traceability of food and feedstuffs obtained from genetically modified organisms. That 0.9% is the limit for the adventitious presence of *authorized* rDNA produce, above which a label becomes mandatory: such percentage drops to zero in the case of *unauthorized* “GMO” material. Instead, in Australia the national “organic” rules are particularly strict: no minimum level of admixture with “GMO” stuff is allowed, and some operators have already lost their certification due to the unwanted presence of “GMO” seeds in their harvest (see Randall 2015). But the request for redress made by one Australian “organic” farmer to his neighbor, who grows rDNA crops, was rejected in court: the judge decided that the economic losses suffered by the plaintiff derive from the rigidity of the standards legitimately established by the National Association for Sustainable Agriculture, the private institution which manages the voluntary “organic” certification, which the allegedly damaged farmer had freely joined. We share the opinion that this judgment is a victory for common sense. (Jones 2014)

Therefore, if “organicists” think they have a problem of coexistence, it is *their* problem. If they want to avoid “contamination”, they could keep their crops at a distance, according to their self-established rules: in a rational world, they should not try to place the burden of such choices on the shoulders of fellow farmers – also because they cannot claim their produce to be more nutritious (Dangour et al. 2009) or safer (Smith-Spangler et al. 2012); rather, the opposite can be true (Harvey et al. 2016).

“GMOs” may be beneficial to other crops

Financial issues apart, the discontent of the “organic” sector regarding the “contamination” of their products should therefore be seen as an issue deriving from their freely chosen hyper-scrupulous rules, not involving *normal* (i.e., conventional *and* recombinant DNA) producers. On the contrary, “GMO” farmers may have good reasons to complain about possible admixtures: they paid more for genetically enhanced seeds because they express traits that save time, labor and costs. For example, crops producing endogenous insecticide need less chemical spraying, and those made tolerant to herbicides require less weed management work; if some of these plants hybridize with pollen of similar plants from adjacent fields which do not have that added quality, such useful characteristics may get lost.

On the other hand, conventional or “organic” bordering farmers sometimes obtain an indirect advantage from the “GMO” fields: the proximity of rDNA cultivars is beneficial for similar “non-GMO” neighboring operations. (Tabashnik et al. 2010. Wu et al. 2008. Hutchinson et al. 2010) Such evidence confirms what is intuitive: for example, if pernicious potato beetles, the most damaging insects for that crop, die as soon as they attack your “GMO” resistant tubers, the lower number of pests around means that also my conventional or even “organic” potatoes in the bordering plots, which would be an easy target, suffer less damage. These foreseeable ecologic dynamics have been confirmed by empirical studies: “in the case of conventional crops grown near GM varieties with insect resistance there have been benefits due to the so-called ‘halo’ effect” (Mannion and Morse 2012, Abstract).

When coexistence and contamination matter

To show a proper use of words, and the consequent legitimate regulation, let us consider a few cases where “coexistence” and “contamination” have a meaning which is grounded in reality.

First example: rapeseed and canola. Regulators have been reasonably worried by the possible excessive proximity between fields of rapeseed which is grown to produce lubricating or fuel oil (a “natural” crop) and those where a food and feed variety is cultivated: the edible cultivar, which was created at the beginning of the 70s through selective crosses, is called *canola*. Rapeseed for industrial use contains high percentages of erucic acid, which may be harmful to the heart, while it is almost absent in canola: the possible gene flow, i.e. hybridization between plants in bordering areas – this would be a *contamination* , without inverted commas – is subject to rules of admissible admixture thresholds and minimum distances between fields (in Italy 2% and 100 m), but no other precaution is mandated, because mingling, if it happens, would be so limited as to be irrelevant. Note that we are talking about the nearness of a crop which is toxic and an edible one. On the other hand, we should not worry at all if the transgene, i.e., the DNA sequences infused for the various reasons we already know (mostly herbicide tolerance and pest resistance), of which we don’t have any evidence of danger, is inherited in some hybridized seedlings.

Let us formulate another hypothesis: imagine that a rDNA intervention inside the rapeseed’s genome creates a variety containing much more substance for industrial uses, for which stricter rules of containment in the field and of segregation along the supply chain must be established, to avoid contamination (also here the term is fit): *this* “GMO” would create some small problems of coexistence with food crops and derivatives. Suppose that this new variety were obtained through mutagenesis, or

guided crosses, or any other biotech method: nothing would change, as far as necessary precautions are concerned. The *process(es)* through which a cultivar is created are unimportant; the *product* (the phenotype and its peculiar traits) is all that matters (Tagliabue 2017). Life scientists have been recommending this basic principle for decades, but their plea has too often fallen on deaf ears.

Second example: drug-producing plants. Strong precaution is also mandatory to contain the pollen, and even more so to carefully collect the seeds during harvest, where there is a proximity between fields with food crops and fields with drug-producing plants (the so-called “pharming” operations): “For example, bio-pharm corn must be isolated by at least 1 mile from other corn fields if it is open-pollinated, and by 1/2 mile if pollination is controlled through male sterility or detasseling.” (Byrne 2008, p. 4) Whether the normal and/or special cultivars are recombinant DNA or otherwise is clearly irrelevant: here, prudence is necessary.

Third example: separations linked to trade issues. Reasonable distances are normally kept to avoid problematic admixture between grains from plants of different varieties of the same crop that farmers may want to separate for logistic or commercial reasons, e.g., between yellow or white maize, or between durum or soft wheat. For instance, in Italy dry pasta must be made mostly with durum wheat; a maximum 3% presence of soft wheat is tolerated.

These are cases of *rational* divisions, whereas the separations invoked by the “anti-GMO” groups, and frequently stated by law, are pointless.

Conclusion

We hope we have shown that “coexistence” between rDNA and “conventional” produce should be considered as a non-issue, if people realize that the “GMO” king is naked. The related legislation, as far as it accepts unscientific cleavages and generates useless costs, is unjust: it should be scrapped. The resources of people (scientists, agronomists, public servants) and taxpayers’ money which have been wasted for decades with this nonsensical task should be usefully reassigned to help with the real problems of agriculture.

For Professor Klaus Ammann, who very recently passed away: committed scientist, great communicator; a man of true integrity and a dear friend.

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Notes

1. Of course, the situation is different if we consider “black” biotechnologies (dealing with pathogens for military purposes) or even some objects of “red” biotechnologies (e.g. dangerous viruses or bacteria that must be kept under strict control). “Chromatic” partitions of biotechnology areas may comprise from four to ten colours. (DaSilva 2004; Aldridge 2009)
2. NBTs is a loose expression to indicate several innovative, different biotech methods – comprising CRISPR – to improve and ameliorate cultivars (see EASAC 2015).
3. The reasons for the unstoppable, obsessive use of such bigoted terminology may be ideological (a desire to combat industrial agriculture) and/or economic (the will to push “organic” products), but this discussion (see e.g., Herring 2008 and Tagliabue 2018b) would lead us beyond the remit of this article.
4. The irradiation aimed at mutagenizing crops, to create “prototypes” of new cultivars (https://en.wikipedia.org/wiki/Mutation_breeding) should not be confused with the irradiation of certain foods (https://en.wikipedia.org/wiki/Food_irradiation), a routine treatment, variously disciplined in different countries, to destroy possible pathogens or to prolong shelf life.

5. This Recommendation was replaced some years after by a shorter and less detailed one (European Commission 2010b), whose principles are basically the same.

Dr. Giovanni Molteni Tagliabue is an independent researcher based in Italy who studies and reports on the philosophy of life sciences and political science. He specializes in epistemological, socio-political and legislative aspects of agricultural biotechnologies and is the recipient of the 2017 Innoplanta Science Prize.