Why the concept of GMOs is meaningless

Because there is no such thing as a GMO — the acronym for Genetically Modified Organism, the popular but meaningless term for agricultural technologies — European Union legislation regulating crop and agricultural biotechnology is hopelessly warped.

The confusion lies in the basic definitions incorporated into current EU law. According to Directive 2001/18/EC, a crop or animal that has been bioengineered is defined as “an organism, with the exception of human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination”.

So, as far as agriculture is concerned, it would seem to follow that targeted crossbreeding of individuals belonging to sexually-reproductive animal and vegetal species, performed by plant growers, farmers and breeders (traditional artificial selection) is considered “normal”; from which it could be deduced that any product which is the outcome of “unnatural” methods, such as many laboratory techniques, including direct intervention on the DNA and chemical or physical mutagenesis, is a “GMO”. Simple, right? No.

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The EU Directive is a web of confusion. Some detailed specifications are defined, and for those we must turn to an annex to the Directive: “Techniques […] which are not considered to result in genetic modification, on condition that they do not involve the use of recombinant nucleic acid molecules […]: (1) in vitro fertilisation, (2) natural processes such as: conjugation, transduction, transformation, (3) polyploidy induction.”

But, we may ask, what has happened to mutagenesis, which is a technique pioneered in the 1930s in which the chromosomes of seeds are scrambled haphazardly using harsh chemicals or atomic gamma rays with the hope that the random mutations might yield some beneficial traits? We have more than 3000 mutagenized crops and plants, including popular favorites such as the Ruby Red and Rio Star grapefruit, Osa Gold pears, and basmati rice that are often sold as organic despite their very “unnatural” heritage.

To find how mutagenized crops are treated, we must hunt it down and turn to yet another annex that says: ”Techniques/methods of genetic modification yielding organisms to be excluded from the Directive […] are: (1) mutagenesis, (2) cell fusion (including protoplast fusion) of plant cells of organisms which can exchange genetic material through traditional breeding methods.” There is no scientific or logical rationale provided from not classifying mutagenized crops as “unnatural”. Mutagenesis can be obtained with a number of methods, physical or chemical—except for the fact that the ineffable lawmaker concedes it “on condition that they do not involve the use of recombinant nucleic acid molecules”.

This convoluted and disorganized text is the basis for the contorted and contradictory EU regulation. At the start of the Directive, the general definition — well, sort of — insisted on the “unnaturalness” of “GMOs”, which we must assume is different than the *naturalness* of, say, *in* vitro fertilisation or polyploidy induction. Wheat, for example, after millennia of hybridization and modification by humans, has strains

that are diploid (two sets of chromosomes), tetraploid (four sets of chromosomes) with the common name of durum or macaroni wheat, and hexaploid (six sets of chromosomes) with the common name of bread wheat. Many agriculturally important plants of the genus Brassica, such as cabbage, Brussel sprouts, broccoli, cauliflower and kale are also tetraploids.

Why, if the effect is exactly the same, are certain techniques allowed and others not? Answer: if you just give DNA a little tweak, the cultivar becomes a "GMO"! The rational enquirer asks: and what's supposedly wrong with recombinant DNA technology *per* se, why should we be wary and seek to uniquely regulate so-called "GMOs"? No answer is given. In fact, there is not a single peer-reviewed paper—not one.—that even tries to argue in favour of such imaginary unique riskiness, giving hints of a possible biochemical mechanism which might justify general fears regarding advanced agri-food biotechnologies — or "GMOs", as ill-defined as they are: a real theoretical desert.

Moreover, with complete disregard for reality (and for the principle of non-contradiction), it is stated *by law* that numerous genetic modification techniques "are not considered to result in genetic modification".

Why the contorted mess in defining and regulating GM crops and foods?

The reason for these arbitrary conceptual and semantic contortions is clear: while they struggle to suppress the introduction of "GMOs", EU lawmakers must preserve a myriad of existing agricultural products (several thousand cultivars) and derivatives (from pasta to beer) which, if the numerous exceptions to a definition that was ridiculous from the off were rejected, would be classified as "GMOs". After all, the highest quality European durum pasta is made from mutagenized wheat.

These contortions by lawmakers are aimed at identifying a (pseudo) category of products to be regulated separately, subjected to sectarian bureaucratic regulations: pointless tests, interminable analyses and needlessly repeated studies.

The real incentives for rejecting GMOs are a mix of ideological opposition to agribusiness and economic protectionism. Because these politicians cannot be candid about their true motivations, the European Parliament has literally invented a convenient, although flawed, ensemble of agricultural products whose *cultivation* is banned—GMOs—while the *importation* of them as animal feed is massive; Europe is the world's largest market for GMO animal feed. Talk of lawmakers' incoherence.

In deciding whether to approve new genetically engineered foods, Europe has chosen the backward way of regulating the process (which it unscientifically defined, as we've seen) rather than the end product, its phenotypical characteristics. But as biotechnologies progress, methods can be used which are in the area of what we may call a vanishing watershed, a blurred borderline which makes it impossible to distinguish "GMOs" from "non-GMOs". So the question arises: is this or that other cultivar, which has been obtained with a technique that is not listed in Directive 2001/18, "a GMO", or not?

The regulators find themselves powerless; indeed, if rational criterion were solely the empirical one– i.e. to ascertain the environmental safety and healthiness of individual products–we would already know which analytical instruments to use, such as exams of possible ecological invasiveness, allergenicity tests or

toxicity checks. Instead, when we have a blocked and botched list of technologies that are allowed or prohibited, and it is in those arbitrary categories that we must pigeonhole every product, any new method of development gives me a headache, as we can't fit it into one of the listed types. What shall we do then?

Future of genetic innovation regulation in Europe

In 2007 the European Commission set up an international working group, which was charged with ascertaining the status of changes in the biotechnology sector, including an array of gene editing innovations. Please note that Europe does not want to know whether the products which derive from the use of new methods resulting from the gene editing revolution and pioneering CRISPR technology (i.e. oligonucleotide directed mutagenesis; zinc finger nuclease technology; cisgenesis comprising intragenesis; grafting; agro-infiltration; RNA-dependent DNA methylation; reverse breeding; synthetic genomics) are more or less risky for human and/or animal health, and/or for the environment (something which, in any case, could not be known *a priori*!). What scientists are struggling to ascertain is whether and which of these new techniques can be located in the labyrinth of the current law or whether they fall outside of it in some sense. In short, whether the new techniques generate "GMOs" or not.

A final report was produced in April 2012; after almost four years, it has still not been officially presented. The authors were hamstrung right from the start, as they had to broadly discuss terms and expressions which are anything but clear in the underlying convoluted definition of "GMOs" provided by current EU biotech law. Just by way of example, the experts are divided on a particularly tricky problem, i.e. the transitory state in which a genetic modification is only provisional: the outcome is "a GMO", no it isn't, maybe it is, only for a bit.

Let us say without any hint of irony that we have some sympathy for those appointed experts, who have had to spend who knows how many hours discussing useless, gimcrack issues; time and energy wasted to establish whether this or that technique definitely fell into the hodgepodge of the inconsistent European definition of "GMOs" and the related strange exceptions and incoherent digressions. No scientist can provide answers to a wrong question.

The results of biotechnological manipulation (the pros and cons of new cultivars) cannot be inferred *a priori* from the characteristics of the processes applied, and consequently cannot provide the basis for a more or less stringent law regarding the expected healthiness or otherwise of what is being produced: in an ideal world, the experts who were called up would have had to heroically refuse the appointment, simply explaining to the principal (the EU Commission) that the question raised – i.e. whether the "new techniques" produce "GMOs" or not, and how they relate to the crazy existing law – even if it were possible to reply, would be pointless.

Biotechnological research continues and in coming years many new techniques will emerge. For instance, the CRISPR approach has not been examined by the Working Group, so as the unpublished final report is already outdated! Therefore, will EU regulators create never-ending new committees to discuss the advancements, which we expect to come fast and furious, in regards to the current, outlandish EU "GMO" law?

Talk about a waste of taxpayers' money!

As the vast majority of scientists recommend, the norms throughout Europe should be rewritten, thus uprooting the idiotic "anti-GMO" fence that now exists. We need to apply rules – with the necessary strict criteria — not on the complicated processes of making new GM products but impartially on each and every product ("GMO" or otherwise); in other words, once created, *a posteriori*, not *a priori* with respect to the biotechnological processes used. For instance, the European Academies Science Advisory Council recommended: "A future regulatory framework should be product rather than process based so that it is consistent and applies to the novelty of the characteristics of new plant varieties."

Will a little reasonableness win out this time?

This is a shorter version of a paper that has been published in EMBO Reports, the journal of the European Molecular Biology Organization. A related paper was published in Nature Biotechnology and a shorter version of it is available in the GLP website.

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