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sometimes been invoked inappropriately, for example, in situations of generic, undefined alarm. For this reason, the European Commission (Brussels) recommends: “A decision to invoke the PP does not mean that the measures will be adopted on an arbitrary or discriminatory basis”; instead, a decision to apply the PP should be based on “detailed scientific and other objective information”⁴. That is not the case for GMOs. Any attempt to apply the PP to this fake container as a supposed coherent object is meaningless. Nowhere is this more evident than in a recent paper entitled “The precautionary principle (with application to the genetic modification of organisms),” the main author of which is renowned scholar and popular author Nassim Nicholas Taleb⁵.

In the very first sentence of the paper, Taleb *et al.*⁵ seek to reformulate the meaning of PP. Thus, in the authors' view, the PP “states that if an action or policy has a suspected risk of causing severe harm to the public domain (affecting general health or the environment globally), the action should not be taken in the absence of scientific near-certainty about its safety.” This is a major change in the spirit and the letter of the original and extended principle. The PP does not recommend waiting for near-certainty about the safety or health impact of the possible action that implies a suspected risk (which, moreover, can be local, not global); instead, it says that the lack of scientific certainty about the risk of an action must not in itself preclude states from intervening in order to contain such a risk preventatively. Even if the authors' reformulation of the PP definition were acceptable, they do not provide a clear justification for it.

In any case, for argument's sake, let us accept their re-interpretation of the PP—a principle that, the authors state, must be invoked only when extreme danger is predicated, the consequences of which “can involve total irreversible ruin, such as the extinction of human beings or all life on the planet”⁵. Thus, we understand that the PP should, in short, be applied only in the case of an apocalyptic prospect. To distinguish the cases in which the PP should not be applied, and those instead where it must be considered applicable, the article enters into a detailed eight-page discussion on the assessment of risks—which may be more or less catastrophic—of human activities, with particular regard to planetary environmental scenarios. We won't enter into the merits of their explanation; let us accept it *en bloc*, and turn to the applications they choose for discussion.

The nonsensical GMO pseudo-category and a precautionary rabbit hole

To the Editor:

The term genetically modified organisms (GMOs) is a useless and imprecise category used to pigeonhole products (mostly crops) that have had their genetic content engineered to cancel undesirable phenotypic traits (e.g., allergenicity or toxicity) or to express desired added traits (e.g., resistance to pests, herbicide tolerance, improved nutritional properties or better performance under abiotic stress, such as flooding, drought or heat). It is theoretically and practically impossible to precisely specify a supposed common denominator for all these products; thus, the awkwardness and contradictions of the two main current pseudo-definitions by the European Union¹ (Brussels) and the Cartagena Protocol². On the one hand, these two botched regulations lump together, in a very mixed pile, a whole range of ‘green’ biotech products with very different characteristics just because they all have spliced DNA; on the other, they omit

everything with often similar or identical properties, obtained through genetic manipulation that is neither direct nor targeted (e.g., traditional cross-breeding and hybridizations, cell culture, and physical or chemical mutagenesis).

As formulated in the *Rio Declaration on Environment and Development*, the precautionary principle (PP) states: “In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation”³. Originally created with the aim of protecting the environment, the PP has subsequently been broadened by the European Union to cover also policies for safeguarding consumers, and human, animal and plant health. However, the PP has

The authors consider two areas where they argue their definition of the PP might be applied; nuclear energy and GMOs. The parallels drawn between nuclear energy and GMOs are—not to put too fine a point on it—bewildering. If these academics had compared the risk of radioactive pollution with that of pathogenic or weaponized microorganisms, it might have made some sense; instead, we are informed that the risk of nuclear holocaust is “local” and not overly important because it has been thoroughly studied. Thus, the PP is not applicable to nuclear energy.

GMOs, in contrast, are another story. They “have the propensity to spread uncontrollably, and thus their risks cannot be localized.” GMOs are a cataclysm waiting to happen and thus should be placed under the PP. Bizarre nonsense. Taleb *et al.*⁵ have no appreciation that GMOs are not a thing *per se*—they are simply an ill-labeled group of things (those in agriculture being most commonly in the public eye) produced in certain ways, each of which has a unique profile of risks and benefits. No GMO plant, or any other vegetable for that matter, is capable of spreading uncontrollably across the planet.

The authors go on to rail against newfangled GMO foods that conflict with “human experience over generations,” which “has chosen the biological organisms that are relatively safe for consumption.” The latter is true apparently because safe biological organisms “were subject to selection over long times and survived.” This is often not the case. Plenty of the completely untested non-GMO foods that we eat today were created in the past few decades—even in very recent days—using radiation or chemicals.

As an example of the pervasive threat of GMOs in the food chain, they discuss transgenic maize—a very common crop in the United States, the derivatives of which (e.g., syrup, oil, starch) are widespread; therefore, “the modification of crops impacts everyone”⁵. Let us allow that everyone eats DNA-spliced maize. And so? The derivatives from transgenic maize are exactly the same as those from unmodified maize: syrup, oil, starch. It is in fact impossible to determine whether such derivatives come from transgenic maize or nontransgenic maize. Are the authors seriously proposing then that processed ingredients from approved transgenic maize are potentially catastrophic, whereas the same processed ingredients from traditional maize are not?

The paper is even more disconcerting as it goes on: “The systemic global impacts

of GMOs arise from a combination of (i) engineered genetic modifications, (ii) monoculture—the use of single crops over large areas”⁵. No. This combination does not happen often, and where it happens nothing changes. Extensively cultivated single crops can exist without being genetically modified (e.g., oil palms in Indonesia); they can be pre-existing, and only subsequently be DNA-spliced to add a trait (e.g., alfalfa, a grass for fodder, which has been made tolerant to herbicides in the United States; flax, similarly, in Canada). Also every trait is crossed into tens to hundreds of landraces that perform best in a certain environmental and regional context—hardly “monoculture.” Do these pre-existing crops perhaps change their nature, becoming ready to “spread uncontrollably,” when we add a useful trait through a slight readjustment to their DNA? And in addition, there are numerous small local and typical crops (above all fruit and vegetables), for which genetic engineering solutions are available to protect or improve them in various ways; many are still not applied due to the excessive costs linked to the regulatory nightmare that retards development of GMOs. The claimed link between genetic engineering and extensive monocultivation is not at all necessary, and where there is such a link, it is banal. Consequently, the grounds for the alleged “systemic impact” of GMOs does not exist.

The piece contains other errors of scholarship. Let us look at just the biggest blunder. The authors confuse traits that confer resistance to pests with traits that render crops tolerant to herbicides. They state that the recombination of plant DNA involves “modifying its resistance to other chemicals such as herbicides or pesticides”⁵. Now, “resistance to pesticides,” with reference to plants, means nothing; pests, not vegetables, may evolve resistance to pesticides. In fact, a trait that can be included in vegetal organisms is resistance to certain pests (through specific endogenous toxins), which makes the external use of the related pesticides unnecessary. All the authors need is to be just a little better informed, to avoid talking nonsense. Here we can see that these prophets of the doom (“ruin”) that will undoubtedly follow from GMOs do not even understand the elementary distinction between the two traits that are most frequently inserted into DNA-spliced crops (resistance to pests and tolerance of herbicides).

They also introduce nonsequiturs, such as Golden Rice not being a panacea for food

security; Chinese subjects failing to be fully informed in a GM rice test; agribusiness creating GMOs for profit. All points for debate in themselves, but how do they relate to their catastrophic PP and its applicability to GMOs?

It seems that Taleb *et al.*⁵ are intent on leading us down the rabbit hole—the rabbit hole that takes us to fields where DNA-spliced sugar beets propagate endlessly, while their conventionally bred ‘cousins’ calmly stay put. In this, the authors’ alternative, fictional universe, we should be terrified when faced with a field of Amflora (transgenic) potatoes, but feel safe if the same field contains instead Super potatoes (mutagenized), even if the two varieties express the same phenotype—absence of a certain type of starch. We should erect a safety cordon around the field of Roundup Ready or LibertyLink maize (transgenic and tolerant to two distinct herbicides) but frolic in the adjacent field of Clearfield maize (mutagenized to be tolerant to a different type of herbicide). We should gag on the toxic, harmful and poisonous oil from transgenic canola, but lap up the identical and indistinguishable oil squeezed from seeds whose ‘ancestors’ were mutagenized.

To summarize, the Taleb *et al.*⁵ article bolsters ignorance and continues the spread of misinformation. The confused humbug, mixed with errors and basic misunderstandings, appears to be the latest proof of the inexplicable and perverse fascination of the pseudo-category of GMOs, to which even opinion leaders and intellectuals are susceptible.

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The author declares no competing financial interests.

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