



Are current EU policies on GMOs justified?

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Abstract The European Court of Justice's recent ruling that the new techniques for crop development are to be considered as genetically modified organisms under the European Union's regulations exacerbates the need for a critical evaluation of those regulations. The paper analyzes the regulation from the perspective of moral and political philosophy. It considers whether influential arguments for restrictions of genetically modified organisms provide cogent justifications for the policies that are in place, in particular a pre-release authorization requirement, mandatory labelling, and de facto bans (in the form of withholding or opting out of authorizations). It is argued that arguments pertaining to risk can justify some form of pre-release authorization scheme, although not necessarily the

current one, but that neither de facto bans nor mandatory labelling can be justified by reference to common arguments concerning naturalness, agricultural policy (in particular the promotion of organic farming), socio-economic effects, or consumers' right to choose.

Keywords GMO · Policy · Risk · Natural · Organic · Labelling · Authorization · Opt-out

Introduction and preliminaries

On July 25th 2018, the European Court of Justice ruled that a number of new techniques for developing new crop varieties fall within the scope of the European Union's legislation on genetically modified organisms. Crops made using these techniques will therefore be subject to a cumbersome pre-release authorization procedure, labelling requirements, and possible bans by individual member states. The ruling ended the hope that the emergence of new techniques could facilitate an end to the state of near-nonexistence of agricultural biotechnology in Europe, by way of a 'compromise' whereby traditional GMOs were left heavily regulated while the products of new techniques could go into use. Consequently, the ruling only exacerbates the need to critically evaluate the EU's existing policies on GMOs—and indeed, the

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ruling occasioned a call for a revision of the legislation by the European Commission's Group of Chief Scientific Advisors.¹

In this paper, we ask whether the EU's policies on GMOs for use in agriculture are justified from the perspective of moral and political philosophy. Our aim is to investigate whether common arguments for restrictions on GMOs are cogent and plausible when considered as justifications for the most important types of policy that exist in the EU, namely *pre-release authorization*, *mandatory labelling*, and *de facto bans* (in the form of opt-outs from and withholdings of authorization from individual member states). Our question, then, is whether these policies are *morally* justified—i.e., justified by reference to plausible principles of morality and justice. We do not consider what might be called pragmatic or strategic justifications, such as that policies are necessary concessions to win support for GMOs from a skeptical public, or that strict regulations of GMOs give EU countries advantages in global trade. We do not deny that such things are relevant for policy-makers and policy advocates to consider, but they fall outside the scope of our paper (as does a full moral evaluation of such pragmatic justifications). Our aim is to re-align the philosophical, ethical and political debate about GMOs by drawing attention to the difficulty of justifying restrictions on the basis of the most common and cogent anti-GMO arguments.

The paper proceeds as follows. In the section “[Current EU policy on GM](#)” we describe how the complex decision-making structure of the EU results in the three types of policy we consider. In the section “[Grounds for authorization: risk and precaution](#)”, we discuss whether the risks associated with GMOs justify pre-release authorization procedures. In the section “[Grounds for opt-outs: Naturalness, agricultural policy, and socioeconomic effects](#)”, we consider arguments for opting out of authorizations—that is, banning certain GMOs—based on naturalness, agricultural policy (especially promoting organic farming), and socio-economic effects. In the section “[Grounds for labelling: consumers' right to choose](#)”, we consider whether the consumers' right to choose what to eat justifies labelling GMOs. We argue that some form of pre-release authorization is justified

(but not necessarily in the form it has today), but that the remaining policies are not justified by the arguments considered.

We will assume that two kinds of argument provide a presumption in favor of allowing and even promoting GMOs. The first argument points to the societal benefits that GM crops have, and the larger benefits they are likely to have in the future. Current societal benefits are primarily environmental and health related, in the form of decreases in pesticide use (or, in the toxicity of the pesticides used), and agronomic, in the form of higher yields and lower input costs (Brookes 2014; Brookes and Barfoot 2016, 2017; Finger et al. 2011; Kousser and Qaim 2011; Mannion and Morse 2012; National Academies of Sciences 2016). Possible future benefits include the continuation and broadening of these trends, but also other and larger benefits. For example, GMOs may be used to combat nutritional deficiencies in developing countries, as in the well-known case of Golden Rice.² In addition, food production must double by 2050 in order to meet projected demand, and GMOs may be a necessary, and are certainly a useful, tool in meeting this demand without increasing agricultural land use (Ray et al. 2013; Royal Society 2009; Taheri et al. 2017). Call this the *benefits argument*.

The second presumption in favor of GMOs stems from considerations of individual freedom. In a liberal society, it is a basic principle that people can do what they want, provided that there are no (sufficiently strong) reasons to prevent them from doing it. Hence scientists and biotechnology companies should be free to develop GM crops, farmers should be free to plant them, and retailers should be free to sell them—provided there are no (sufficiently strong) reasons to prohibit these activities. Call this the *liberty argument*. The liberty argument does not claim that all considerations of liberty fall on the pro-GMO side. In particular, consumers' freedom to refuse to consume is one of the things that can limit producers' and

¹ See https://ec.europa.eu/info/sites/info/files/2018_11_gcsa_statement_gene_editing_2.pdf.

² Golden Rice is modified to combat Vitamin A deficiency. It has been heavily criticized by some anti-GMO groups, partly for reasons relating to the so-called technological fix objection which we discuss in the section “[Agricultural policy](#)” below. For overviews of the controversies surrounding Golden Rice, see e.g. <https://grist.org/food/golden-rice-fools-gold-or-golden-opportunity/> and <https://geneticliteracyproject.org/2018/02/13/golden-rice-gmo-crop-greenpeace-hates-and-humanitarians-love/>.

retailers' freedom to sell. We return to this argument in the section "[Grounds for labelling: Consumers' right to choose](#)".

When considering whether an argument justifies a policy, we should be aware of whether the policy *targets* the problematic phenomenon that (supposedly) provides a reason for the policy. It can fail to do so either by contributing little or not at all to solving the problem, or by being more restrictive than what was necessary to solve the problem. The latter corresponds to the legal principle of *proportionality*. The former could be termed the principle of *efficacy*. Arguably, policies can be partially justified despite violating either of these principles. With respect to efficacy, one might argue that *some* contribution to solving a problem is better than leaving the problem wholly untouched (which, presumably, relevant alternative policies do); and with respect to proportionality, it might be argued that some collateral damage must be accepted when solving societal problems. However, lack of proportionality or efficacy does create a presumption that the policy is not wholly justified.

Current EU policy on GM

The European Union has a complicated federal structure in which member states (MS) retain substantial power. It is therefore not always obvious what we should count as EU policy and what we should count as MS policy. In the case of GM crop regulation, this is particularly important to keep in mind. While it is a fact that GM crops are only used to a very limited degree in the EU, the responsibility for this fact lies less with federal-level EU institutions, such as the European Commission (EC), and more with the MS's. In this section, we outline the policies that are in place at the EU level and how MS's actions can make (and have made) these policies very restrictive in practice.

The EU's policy on GM crops is defined in a number of legislative documents, in particular Directive 2001/18/EC (on the deliberate release of GMOs into the environment); Regulation (EC) 1829/2003 (on genetically modified food and feed); Regulation (EC) 1830/2003 on the traceability and labelling of genetically modified organisms and the traceability and labelling of food and feed products produced from genetically modified organisms); and Directive (EU) 2015/412 (amending directive 2001/18/EC as regards

the possibility for the Member States to restrict or prohibit the cultivation of GMOs in their territory).

The core of the policy is a procedure of *pre-release authorization*. Authorization is given on the basis of an assessment of safety for human and animal health and for the environment conducted by the European Food Safety Authority (EFSA). A GMO can be authorized either for cultivation on EU territory, or it can be authorized for use in food and feed that is sold on the European market. If a GMO is authorized, it must be *labelled* when sold to consumers. This must be done in the list of ingredients. The requirement does not apply where the proportion of GMO products (in the product as a whole or in a given ingredient) does not exceed 0.9%, provided that the presence of these small amounts of GMO products is "adventitious or technically unavoidable".

The actual procedure for authorization is, however, more complicated than the above description suggests. Passing EFSA's risk assessment is not sufficient for receiving authorization. If the safety assessment is positive, EFSA recommends to the EC that the GMO be authorized. If the EC finds the assessment inadequate (for example following information attained through the public hearing process), the EC can ask EFSA to perform a new assessment that mitigates the shortcomings (Weimer and Pisani 2014). If the EC finally receives a satisfactory and positive safety assessment, it submits a draft authorization proposal to the Standing Committee on Food Chain and Animal Health, which consists of civil servants from the various member states, who can reject or approve the draft by qualified majority (this is a standard procedure in the EU, known as "the committee procedure", or "comitology"). Since the 2003 regulations came into force, the Standing Committee has *never* managed to reach a qualified majority either for or against. In response to this deadlock, the EC can refer the draft to the Appeals Committee—where the same result arises. The EC will then approve the application without the explicit backing of the member states—a course of action which the EC may be legally obliged to take (Geelhoed 2016; Salas Ferrer 2016).

The result of this complicated process is somewhat paradoxical: While no application for authorization has ultimately been rejected by the EC after having received a positive final EFSA safety assessment (Weimer and Pisani 2014), only one GMO is currently authorized for cultivation in the EU (Monsanto's

MON810 pest resistant maize). Thus, the absence of authorized GMOs for cultivation is caused by lengthy delays in the authorization process—for example, the authorization process for Syngenta's Maize 1507 has run since 2001 and is yet to be completed—and pursuant reluctance on the part of biotechnology companies to apply for authorizations. For food and feed use, a larger number of GMOs (more than 60) are authorized. The difference between the very low number of authorizations for cultivation and for food and feed use can be explained partly by political factors—there is less opposition from stakeholders and the public to food and feed use than to cultivation (Tagliabue 2017)—and by the fact that the environmental risk assessment for food and feed use is less extensive than for cultivation (EFSA 2010).

The systematic failure of the committee to reach a decision on GMO authorization represents a unique dysfunction of the comitology system. In an attempt to improve this unfortunate situation, the EC proposed an amendment to the procedure that was eventually adopted in 2015. Previously, the only way in which an MS could circumvent an authorization was through the use of the safeguard clause, according to which an MS is allowed to temporarily ban a GMO on the basis of new evidence indicating risks ignored by EFSA. Several countries have used this clause, but all have ultimately been stricken down as illegal. Under the amended legislation, individual MS's are permitted to *opt-out* of the authorization of the cultivation of GMOs on their territory for reasons other than safety. In effect, this means the individual MS's are allowed to ban the cultivation of a given GMO even if it has been judged safe by EFSA. The grounds for a ban cannot contradict the EFSA's findings, but it is as yet unclear if member states can invoke uncertainty about possible undetected adverse effects as a grounds. Indeed, although decisions to opt-out must in principle be justified in certain ways in order to respect the rules of the EU's internal market (not to mention WTO rules), it is unclear if member states are de facto limited in any way from banning GMOs. In response to a deadline on October 3rd, 2015, 19 EU countries chose to opt-out of authorizations for cultivation of different varieties of GMO (most of which remain in the authorization process). No comparable policy exists for the use of GMOs for food and feed, although it has been proposed by the EC. Thus, de facto bans are

only allowed on cultivation, but may in the future be allowed on use for food and feed as well.

The 2015 amendment further complicates the picture with respect to the relative responsibility of the EU and MS's. It represents a significant de-harmonization of policy, and the ultimate decision to implement the very restrictive policy that an opt-out is—i.e., a de facto ban—lies with the MS's. And it is debatable whether one should see the amendment itself—the act of *allowing* MS's to de facto ban GMO cultivation—as a restrictive policy or not. On the one hand, it predictably leads to a situation in which GMO cultivation is de facto banned in much of the EU. On the other hand, the aim of the amendment is to make it more likely that GMOs will be authorized for cultivation at the EU level, and thus to make it more likely that cultivation can take place in those MS's that do not choose to opt out. Since only one GMO was authorized for cultivation prior to the amendment, it seems likely that the amendment will at least not result in fewer authorizations.

In the rest of the paper, we will largely abstract from the details described here, and focus instead on whether the *types of policies* that are in place in Europe—pre-release authorization, labelling, and de facto bans—can be justified by the *kinds of argument* that those critical of GMOs most frequently invoke. In the next section, we discuss whether pre-release authorization can be justified by arguments from risk and precaution (including whether withholding authorization can be justified on these grounds given a positive safety assessment). In the two sections following that, we take up de facto bans and labelling, respectively.

Grounds for authorization: risk and precaution

Perhaps the most widespread reason for apprehension concerning the use of GMOs in agriculture is the possibility that there is a risk of harm to human health or the environment. In principle, the desire to avoid such harms can justify both pre-release authorization based on a safety assessment, and bans of GMOs deemed too unsafe. In the case of EU policy, bans might enter at two levels. First, a denial of authorization is tantamount to a ban of the relevant GMO; and second, an individual MS's opt-out amounts to a ban of the GMO in the relevant MS. Whether risks

ultimately do justify these policies depends on how serious those risks are, and on moral principles for the regulation of risk. The seriousness of a risk is standardly defined as a product of the likelihood or probability of an adverse outcome and the level of adverseness of that outcome, although it is controversial precisely how the interaction of these two factors translate into more or less serious risks (for example, is a very high probability of a moderately adverse outcome, such as a broken leg, a more serious risk than a low probability of a very adverse outcome, such as death?). Likelihood or probability is interpreted as an epistemic phenomenon. Thus, a certain event is more likely or probable the stronger our reasons are for believing that the event will occur. In the next section, we describe moral principles for risk regulation.

Moral principles of risk regulation

The topic of risk has only (relatively) recently been discussed in moral and political philosophy, and no widely accepted answer has emerged (see Hayenhjelm and Wolff 2011). On the one hand, *consequentialists* argue that the risks of an activity should be balanced against its benefits. Thus, we should take the course of action that leads to the greatest expected value, where ‘expected value’ is the sum of the values of each possible outcome multiplied by the probability that that outcome will occur. Consequentialism has a number of problems, including that it is insensitive to the distribution of risks and benefits, and thus would allow risks to be imposed on some to the benefit of others. It thus seems to be too permissive in what risks it allows people to be subjected to. For our purposes, a more immediate problem is that consequentialism requires precise estimates of the probabilities of various outcomes, which is not available in the case of GMOs.³

On the other hand, *deontologists* and *rights theorists* argue that there should be a right against being subjected to a risk without one’s consent. The problem for this theory is that it quickly leads to paralysis. Quite a large number of the things we do on an

everyday basis impose risks on others, and therefore an absolute right against such risk impositions would make virtually every action a rights violation. Thus, deontologists and rights theorists must restrict the scope of the putative right, for example by setting a threshold of *de minimis* risk, such that imposing risks that are less serious than the value defined by the threshold are not violations of rights.

An intermediate position between consequentialism and deontology/rights theory is *contractualism*. According to contractualism, a risk imposition is acceptable if and only if it could be justified to each reasonable person (Lenman, 2008). According to a leading contractualist,

the cost of avoiding all behavior that involves risk of harm would be unacceptable. Our idea of ‘reasonable precautions’ defines the level of care that we think can be demanded: a principle that demanded more than this would be too confining, and could thus be reasonably rejected (Scanlon 1998, p. 209).

Thus, according to contractualism, we can be justified in imposing risks on others provided that we have taken reasonable precautions to avoid the harm. Because the costs of avoiding risks altogether would be unreasonably large, we cannot accept a principle that disallows risky activities altogether. But in many cases, there are ways of mitigating risk—of making harm less likely, or making potential harms less serious—that are not excessively costly. For example, driving a car imposes risks on others, but it would arguably be unreasonably costly to forbid driving. But we can take precautions, such as being diligent behind the wheel or imposing speed limits, that mitigate the risk. On the contractualist view, risk imposition is only justified if we have taken all precautions that are not unreasonably costly. In some cases, perhaps, precautions are not possible, and the activity should be banned on the contractualist view.

The contractualist emphasis on precautions lead us naturally to the precautionary principle (PP), which plays a very important role in environmental ethics and law generally, and in the case of GMOs in particular.⁴ There are many formulations of the PP in

³ It also requires precise relative values of different possible outcomes, and that all outcomes can be traded off against each other: For example, it requires that there is some precise (but possibly very large) amount of money that is worth exactly as much as a human life.

⁴ For example, both the 2001 Directive and the 2015 Amendment mention the precautionary principle as a basis for GMO policy.

various policy documents and elsewhere. Here, we initially outline the basic schema of the PP (following especially Steel 2014; Trouwborst 2006). Basically, the PP mandates precautionary action where we have a certain reason to believe that an activity will lead to a seriously harmful outcome. The PP thus sets thresholds for adverseness of outcomes (the *harm condition*) and the strength of our reasons to believe such outcomes will obtain (the *knowledge condition*), such that if we have a sufficiently strong reason to believe that a sufficiently bad adverse outcome will occur if we implement policy P, then P should not be implemented (it is *forbidden*). Thus understood, PP does not recommend any particular policies, but only forbids policies that we have sufficiently strong reasons to believe might lead to a sufficiently adverse outcome. Of course, the crucial question now is what the relevant thresholds of harm and knowledge should be. Rather than discuss this in the abstract, let us instead turn to the case of GMOs.

Do GMO risks justify restrictions?

According to the High Level Group of Scientific Advisors under the EU's Scientific Advice Mechanism (SAM), "genetically and phenotypically similar products deriving from the use of different techniques are not expected to present significantly different risks" (SAM 2017, p. 19). Thus, any effect, negative or otherwise, that a GMO has on its environment or on those who consume it will be due to its genotypical or phenotypical characteristics—that is, to the physical and chemical composition of the plant. It is these characteristics that determine whether the plant is nutritious or toxic to human beings or other animals that eat it, and whether it will have any other impacts on the ecosystem (e.g., effects on the soil). But of course, the physical and chemical composition of GMOs might be changed relative to their well-established counterparts with a "history of safe use". Since those changes may have adverse effects, GMOs are in that basic sense risky.

Suppose we are considering *de novo* what regulations to impose on GMOs. What policies would the relevant risks justify? The first thing to consider is what baseline we judge risks from. On the one hand, we could judge them from a perspective of *no regulation*. In this case, we consider what risks there would be from an entirely *laissez-faire* approach,

where everyone is free to develop, plant, and sell GMOs as they see fit. On the other hand, we could judge it from the perspective of the regulations that apply to relevant comparators to GMOs—that is, to novel plants and foods, and to such things as pesticides (which GMOs may contain). While the latter is the more relevant perspective—in the sense that this is the situation that would obtain if GMOs were not specially regulated—we will start by considering the (hypothetical) case of no regulation, since that provides a clearer perspective.

Let us start by considering the various harmful outcomes that some have suggested could result from the unregulated use of GMOs. These range rather widely, including

- harm to non-target species (ranging from minor harms to extinction),
- large-scale ecosystem damage,
- negative health effects for agricultural animals that are fed with GMOs,
- negative health effects for human beings (ranging from minor allergic reactions to cancer and deaths),
- major agroeconomic losses from crop failure,
- the collapse of the food production system and possible human extinction.

Consider these from the point of view of the PP. If the PP is supposed to apply only to catastrophic outcomes, as suggested for example by Lauren Hartzell-Nichols (2012), then arguably only the last of the listed items could trigger the PP. If, as Stephen Gardiner (2006) proposes, we should consider cases involving "unacceptable alternatives", then serious health effects for humans and sufficiently extensive crop failures would count. Some environmental activists, perhaps, would suggest that all the listed effects are sufficient. Some authors, such as Alan Randall (2011), have suggested that the PP should be triggered when the possible adverse outcomes are "disproportionate" to the possible benefits of the activity in question. In that case, the question of whether a possible adverse outcome is serious enough to trigger precaution partly depends on what benefits the activity has.

Suppose that a certain potential harm is sufficiently serious for the PP to be relevant. The question then is how strong reasons we have to believe that the harm in question will occur if we adopt a *laissez-faire* approach to GMOs. Possible knowledge conditions include

anything from mere theoretical possibility to strong evidence that the harmful outcome will occur. Of course, the plausibility of the PP is lower the less stringent the knowledge condition is (i.e., the more possible scenarios we consider). It is worth noting, therefore, that the highly adverse possible outcomes of using GMOs are not ones we have particularly strong reasons to believe will occur. Perhaps it is theoretically possible that using GMOs will lead to the collapse of the food system, but not much more. On the other hand, we have fairly good reasons to think that non-target species will suffer minor harms, but most would probably agree that requiring precautionary action to avoid such harm is excessive.

Let us consider a case where the harm is more serious than in the case of harm to non-target species, and the knowledge condition less lax than the global catastrophe scenario, namely the chance of serious negative health effects on human beings. Let us call this scenario S. Is S a sufficiently serious risk to require pre-release authorization of GMOs? And is S a sufficiently serious risk to justify withholding or opting out of authorizations?

Pre-release authorization

Consider first pre-release authorization. The harm involved in S is sufficiently serious to merit regulations against imposing risks that it will occur, we will assume. The question thus is whether we have sufficiently strong reasons to believe that, under a *laissez-faire* approach, some GMOs that have adverse health effects on human beings will be brought to market. Of course, we know that it is possible that a GMO will have such effects. For example, soybeans modified with genes from the Brazil nut were famously shown to be allergenic to people with Brazil nut allergy (Nordlee et al. 1996). Under a complete *laissez-faire* regime (which does not actually exist anywhere in the world as far as we are aware), it seems likely that such GMOs would reach the market and cause adverse effects. So, it seems that it is reasonable to require some safety testing of GMOs before they reach the market, and hence that pre-release authorization is justified.

However, concluding that *the EU's* pre-release authorization scheme is justified would be premature. There is macro-level empirical evidence that less stringent pre-release authorization procedures than the EU's are sufficient: No adverse effects have been

documented from any GMOs that are approved in any country (National Academies of Sciences 2016; Pellegrino et al. 2018). And indeed, the Brazil nut soybean was never approved for human consumption. This suggests that the less stringent policies that are in place in, for example, the United States, are sufficient to avoid adverse effects. A devil's advocate might even argue that, since safety testing in the United States is, legally speaking, voluntary, the fact that no adverse effects have materialized, and that the Brazil nut soybean was never brought to market, suggest that a *laissez-faire* scheme is in fact sufficient (because companies will safety assess where necessary to protect sales). In answer to the devil's advocate, one might point out that while safety tests are *de jure* voluntary in the US, they are *de facto* mandatory. On the other hand, it could also be argued that, at least as far as the EFSA safety assessment itself is concerned, the EU's approach does not differ from (for example) the US's—both follow the widely agreed-upon procedure of comparative safety assessment which is based on the principle of substantial equivalence (Kok et al. 2008; OECD 1993).

One sense in which the EU's requirements are more stringent than the US's is that it requires a specific set of safety assessments of all GMOs, while the US regulates GMOs like all other plants. This brings us back to an evaluation of GMO pre-release authorization relative to those regulations that apply to counterpart products (for example, novel plants for agricultural use). In other cases where pre-release testing is implemented, such as medicines and chemicals, we know that an arbitrary medicine/chemical is very likely to have some adverse effect, at least at some dosage. With respect to novel foods, however, there is no basis for a presumption that an arbitrary novel food has adverse effects, except in cases of “specific defined components” that are known health risks, such as glycoalkaloids in potatoes (Kok et al. 2008, p. 100). Thus, although there are regulations in place for all novel plants in the EU, “[i]n practice, only novel plant varieties with large intended compositional effects nowadays go through the... authorization procedure” (Kok et al. 2008, p. 102)—again, with the exception of specific cases where a presumption of adverse effects is warranted, such as glycoalkaloid testing of potatoes. The reason is that it is only in cases where there are such intended compositional differences that we have significant reason to believe that adverse effects might occur. The lack of observed adverse effects from novel non-

GMO plants without large intended compositional difference suggest that this is sufficient. However, adverse effects of novel varieties are difficult to detect outside a controlled study, and such studies have not (as far as we know) been done on, say, high-yielding hybrid wheat or any other recent variety. Thus, it might be reasonable (for novel varieties where a presumption of adverse effects is not warranted) to require a relatively limited initial test to detect unintended compositional changes, followed by more extensive tests where such changes are detected.

There is certainly scope for reasonable disagreement about the specifics of what regime should be implemented. But whatever the precise details of the regime are, the same trigger (in terms of likely, detected, or intended compositional differences) should apply to GMOs as to other new varieties. Since many GMOs—in particular those with novel traits that are not familiar from other GMOs or existing non-GMO varieties—will have compositional changes that warrant a presumption of potential adverse effects, they will *de facto* face relatively extensive scrutiny. But the *de jure* regulations would not be stricter for GMOs. The principles of efficacy and proportionality we described above suggests that unless GMOs were in general more risky than novel non-GMO counterparts, the difference in pre-release authorization requirements in the current policy is not well-targeted: Either the EU's policies on GMOs are disproportionate to the risks involved, or it is inefficacious. If we think the current policies for non-GMO novel varieties are adequate for managing the risks involved with those varieties, then the stricter GMO regulations are disproportionate. If, on the other hand, we think managing risks of unwanted properties requires something like the policies that currently govern GMOs, then EU policy is inefficacious, because it does not adequately regulate non-GMO novel varieties. Policies could also be both disproportionate and inefficacious, if the appropriate policy is less strict than current GMO policies but stricter than current policies for other novel varieties.

There is one sense in which GMOs may be riskier than traditionally bred counterparts, namely if GMOs are more likely than their novel non-GMO counterparts to contain compositional differences (of a certain kind)—relative to a variety known to be safe. Suppose this is, in fact, the case, and that GMOs are in this sense more risky than traditionally bred counterparts. This

still does not justify special regulations of GMOs, assuming that a safety assessment regime based on (likely, detected, or intended) compositional differences from safe varieties is in place. Such a regime would already in effect subject GMOs to more extensive safety assessment than non-GMO novel varieties, since the likelihood that an arbitrary GMO would be subjected to detailed risk assessment is higher than the likelihood that an arbitrary non-GMO novel variety would be. But, unlike current EU policy, this would be proportionate to the higher incidence of compositional changes of the relevant kind in GMOs. Also unlike current EU policy, such a regime would not submit GMOs that are substantially equivalent to existing and already-approved GMOs to the same scrutiny as GMOs with wholly novel traits, and thus not drag out or stop entirely authorizations of GMOs that can be presumed safe.

Generally speaking, then, the risks involved in GMOs do warrant some regulation in the form of a pre-release authorization procedure, but not one that applies to GMOs specifically, rather than to all novel varieties. Furthermore, the fact that there has been no (observed) adverse effects from less stringent regulations of GMOs, or from the *de facto* absence of regulations of novel foods without large intended compositional differences, suggests that less stringent requirements than the ones GMOs are currently subjected to are sufficient. From the point of view of the PP, this is significant, since the PP is typically constrained by a principle of proportionality (European Commission 2000). Thus the PP cannot be used to justify a pre-release authorization scheme that is more burdensome than what is needed to ensure that the relevant harm does not occur (or rather that it becomes sufficiently unlikely).

Bans: withholding or opting out of authorizations

Suppose now that a GMO has been cleared by some reasonable safety assessment procedure, and that the EFSA's procedure is reasonable. Can the residual risks justify withholding authorization (as many MS's have done for years) or the opt out of authorizations (as 19 MS's have done since that became possible) of GMOs generally⁵ or of a given GMO? For simplicity, we will

⁵ In practice, this would require systematically withholding or opting out of authorizations of each GMO on an individual basis.

describe these as bans of the relevant GMO. Since EFSA's assessment does not rule out all possible harms, there is in principle scope for the PP to apply. However, that would require relaxing the knowledge condition and/or the harm condition. For example, one might in principle argue that the risk of harm to the monarch butterfly is sufficient, both in terms of the harm and the knowledge conditions, to justify banning certain varieties of Bt maize. Or one might argue that it is theoretically possible that the food system will collapse if we allow GMOs, and that we should therefore ban GMOs in general.

Arguments like the two just mentioned do not succeed in justifying bans on standard accounts of the PP. For one thing, mere theoretical possibility is typically not taken as sufficient for precautionary action (Trouwborst 2006, p. 106). For example, the EC requires that “preliminary objective scientific evaluation indicates that there are reasonable grounds for concern” (European Commission 2000). Furthermore, it is a commonly accepted requirement for any application of PP that it is *consistent* (Steel 2014, Ch. 2). Consistency requires that the precautionary measure suggested does not itself trigger the same combination of harm and knowledge condition that was used to argue for it on PP grounds. Consequently, when harm and/or knowledge conditions are relaxed—meaning that the demand for precautionary action is more easily triggered—the consistency requirement becomes more difficult to satisfy. If, for example, we suggest that the possible extinction of the monarch butterfly is sufficient to trigger precautionary action against Bt maize, then consistency requires that the alternative policy implemented—in this case a ban on certain Bt varieties—is not at least as likely to lead to an outcome that is at least as adverse.

Interestingly, Daniel Steel, who defends the use of the PP, argues that “the case of Bt corn is perhaps the best example on [the] list [of excessive precautions]” (Steel 2014, p. 79). This is because the reasons to believe that serious harm will occur are very sparse, and because the harm in question, while not negligible, is not particularly serious.⁶ Thus, an equally slight possibility of harms of

equal importance resulting from the ban would trigger the very same demand for precautionary action *against the ban*. Steel argues that banning Bt maize does in fact create equal possibility of equal harm as allowing them. Here, of course, it becomes relevant whether our presumptive arguments in favor of GMOs hold, and to what extent. Only if GMOs/a specific GMO have (possible) benefits will a precautionary ban be inconsistent, since inconsistency requires that banning Bt maize is likely to result in foregone benefits that are equally as important as the possible harm. If we take the restriction of liberty involved to be as (or more) important than a suggested harm, then the ban can be trivially shown to be inconsistent, since the liberty restriction occurs with certainty (it is, as it were, identical to the ban). But if one believes that GMOs/a specific GMO have no (possible or likely) benefits at all, or that the relevant liberty restriction is of no importance, then it is easy to justify bans based on risk and the PP. But we take it that this is not a plausible position to take.

Conclusion

We conclude, then, that some pre-release authorization procedure is justified, but that bans of GMOs that have passed a reasonable safety assessment are not justified (on risk grounds). Whether the EU's pre-release authorization procedure is justified is unclear, partly because it is unclear what that procedure actually is. On one view the pre-release authorization procedure is as follows: The GMO is subjected to EFSA safety assessment, and if that assessment comes out positive, the GMO is (or should be) authorized. In that case, the pre-release authorization procedure is reasonable, although it is possible to argue that it is still somewhat too stringent. On another view, however, the pre-release authorization procedure consists of the EFSA safety assessment *and* the implementation procedure that comes after it, which includes demands for further evidence, and long delays. On this view of the procedure, it is not justified on risk grounds.

On the first view, we have a reasonable pre-release authorization requirement that just needs to be implemented appropriately. On the second view, we have a very stringent procedure that works as intended. In a sense, both views are probably true: The internal logic

⁶ This is, of course, contestable, e.g. by those who assign very great value to the environment. However, if GMOs are likely to have environmental benefit—i.e., if the use of Bt varieties is just somewhat likely to have considerable environmental benefits—then the laxity of the knowledge condition should be sufficient,

Footnote 6 continued

since the possible benefits of using Bt varieties are of the very same kind as the possible harms.

of the 2001 Directive and the 2003 Regulation suggest that we are dealing with a badly implemented but reasonable procedure. But it is difficult to imagine that the ‘dysfunction’ of the implementation procedure was not intended by at least some MS’s when they agreed to those pieces of legislation. Thus, perhaps the best answer to the question of whether the EU’s pre-release authorization procedure is justified is this: Interpreted in the best light, it is reasonable. The caveat remains, however, that an authorization procedure that is based on the presence or not of compositional differences (of relevant kinds) from safe varieties is preferable to one based on the technique used to create a novel plant variety.

Grounds for opt-outs: naturalness, agricultural policy, and socioeconomic effects

We argued above that withholding or opting out of authorizations on risk grounds is not justified when a reasonable safety assessment has been conducted. But to a large extent, the reasons why MS’s withhold or opt out of authorizations are related to other considerations than risk (indeed, opt-outs cannot legally contradict the EFSA’s findings). According to a 2011 review of the GMO area conducted for the EC, it was the opinion of a number of stakeholders that the procedure of authorizing GMOs on the basis of the EFSA safety assessment alone was insufficient, because it prohibited consideration of non-safety aspects, such as socio-economic and ethical factors (EPEC 2011). The 2015 Amendment is largely an accommodation of this opinion. In this section we consider whether three important suggested grounds for opt-outs justify the very restrictive policy that an opt-out is—namely a ban on GMOs.⁷ The three grounds are naturalness (an “ethical” issue), agricultural policy (especially the desire to promote organic farming), and socio-economic effects.

⁷ Two caveats should be noted: First, opt-outs concern individual GMOs, not GMOs generally, and second, the 2015 Amendment only covers cultivation, not use for food and feed. We ignore these two caveats below, since they do not influence the principled points, and since both may de facto or in the future not be true: At least some MS’s will likely opt out of whatever GMOs might be authorized for the foreseeable future, and the EC may succeed in getting legislation similar to the 2015 Amendment enacted that covers food and feed.

Naturalness

The belief that GMOs are unnatural is an important driver of GMO opposition (Tenbült et al. 2005). In a 2010 survey, 70% of Europeans agreed that “GM food is fundamentally unnatural” (Eurobarometer 2010, p. 18). The scope of EU legislation is likewise defined in terms of naturalness, since the organisms covered are those “in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination”. In the 2001 Directive, this definition was explicitly meant to cover (*inter alia*), transgenic recombinant DNA methods (e.g., introducing foreign DNA using bacteria such as *agrobacterium*), and cell/protoplast fusion, but not interspecific crosses, mutagenesis (e.g., using radiation or mutagenic chemicals), and polyploidy. As mentioned in the introduction, the European Court of Justice recently ruled that a number of new technologies, including most prominently gene editing techniques such as CRISPR/Cas9, are also covered by the definition. The legal issue in question was whether these new techniques, which are forms of mutagenesis, were covered by the exemption from the regulation that applies to older techniques of mutagenesis. It was found that they were not exempted, partially because these new techniques constitute an altering of genetic material that does not occur naturally.⁸ Thus, while the original definition of a GMO in the legal documents was perhaps intended simply as a shorthand for specific techniques, in particular transgenesis, the definition in terms of unnaturalness now has real legal effects beyond being such a shorthand.

Let us now turn to arguments for restrictions based on naturalness. The concept of the natural has many senses and connotations, and people are often not clear about the sense(s) in which they are using it. This makes it difficult to assess naturalness-based objections. Below, we review a number of senses of ‘unnatural’ and discuss whether GMOs are unnatural in any of these senses. We will assume that the

⁸ It is debatable whether the EU’s definition of a GMO rationalizes the distinctions between organisms that are covered and those that are not, since most of the kinds of alterations that are covered *do* occur naturally. For example, DNA transfer via *agrobacterium*—the GM technique *par excellence*—occurs naturally, and has, for example, occurred in the evolutionary history of the sweet potato (Kyndt et al. 2015; see also SAM 2018).

naturalness objection takes GMOs to be more unnatural than traditionally bred plants. Although there are views according to which ordinary domesticates and cultivars are objectionably unnatural (e.g. Callicott 1980, p. 330), it seems to us to be a niche view, and furthermore would be a view with rather extreme consequences for our food supply.

Having done that, we turn to the question of whether the ways in which GMOs are unnatural can provide grounds for bans in the form of opt-outs. We will assume that bans could only be justified if (un)naturalness was in some way a morally relevant feature. In the section on labelling below, we will consider the relevance of consumers' preference for natural foods, which may or may not be based on the belief that naturalness is morally relevant. We will review a number of ways in which the natural may be thought to be morally relevant, and argue that GMOs do not come out as problematic according to plausible accounts of the moral relevance of naturalness.

Are GMOs more unnatural than non-GMOs?

There are several possible senses in which GMOs/GM are more unnatural than traditionally bred organisms/traditional breeding techniques. Following Siipi (2008), we can distinguish between two main senses of 'unnatural', namely a *historical* or *independence-based* sense and a *substantial* or *property-based* sense.

On an independence-based conception, an entity is more unnatural the more human intervention it involves. This of course raises the question what 'more human intervention' means. One obvious, but for our purposes unimportant, possibility is that an entity is more unnatural the *more time or effort* humans have spent altering the entity. Another possibility is that an entity is more unnatural the *more changes* human beings have made to it. Here, GMOs come out as (slightly) more unnatural than the cultivars from which they are derived, since an additional change has been made. However, this difference is much smaller than the difference between the cultivar and the wild ancestor. Furthermore, other breeding techniques, such as chemically induced mutagenesis or hybridization, produce more changes relative to the cultivar than GM does; and some GM techniques, such as "rewilding" (Palmgren et al. 2015) would *increase* naturalness.

A third possibility is that *specific types of intervention* are more unnatural-making than others. Siipi (2008, pp. 81–82) suggests that crossing species barriers increases unnaturalness, leaving transgenic organisms more unnatural than cisgenic and gene-edited ones. This means that many GMOs are more unnatural than many non-GMOs, but the difference does not map perfectly onto the GMO/non-GMO distinction. A different variety of the specific-type conception stems from Keekok Lee (1999), who argues that an entity is more unnatural the "deeper" the level of human intervention. Organisms that are created by working directly on the genome are therefore more unnatural than those that have been created by working only by selectively breeding plants based on attractive phenotypic characteristics. Arguably, the "depth" of intervention is larger in those organisms that fall under the EU's definition of a GMO than those that do not (with possible exceptions, such as polyploidy).

On a property-based conception of unnaturalness, it is the presence of specific properties in an organism that makes it more unnatural. One possibility here is that it is the presence of *properties that an organism could not (or very likely would not) have obtained without human intervention*. Based on this conception, some participants in a focus-group study argued that pest resistant GMOs are not unnatural, because pest resistance is not an "artificial" trait type (Mielby et al. 2013, p. 476). However, this conception cannot rationalize a clear distinction between GM and non-GM organisms, since (i) many GMOs have 'natural' traits (e.g., biotic and abiotic stress resistance), and (ii) many non-GMOs have 'unnatural' traits, and would not be able to survive and reproduce in the wild. However, a distinction might be made between traits directly designed by humans, and traits that have evolved as a result of human selection. In the latter case, the human or agricultural environment acts as the biological niche to which plants have adapted, and thus the ordinary (or natural) evolutionary explanation of traits could be maintained.

Another possible conception of property-based unnaturalness takes unnaturalness to be the presence of *abnormal properties*. Abnormality can further be interpreted in several ways. One conception is *statistical abnormality*, according to which properties that are rare, or (for quantifiable properties) statistical outliers, make organisms unnatural. Statistical

abnormality is mainly relevant if we want to draw conclusions about, say, the nutritional properties of a GM maize, using our knowledge of traditional maize as a basis. In other contexts, the statistical conception faces the challenge of demarcating precisely how rare or how much of an outlier a trait has to be. Despite this challenge, people do seem to associate unnaturalness with such things as extreme size or taste (Mielby et al. 2013, p. 476).

A different conception of abnormality is *functional abnormality*, according to which a property is unnatural-making if it does not contribute (or contributes negatively) to the biological functioning or flourishing of the organism. This conception faces two challenges. First, specifying what flourishing consists in for plants that are genetically disposed not to develop as the paradigm of a flourishing wild plant is difficult, since the content of an ‘internal teleology’ seems to depend on genetic makeup, and since we cannot rely on other notions to explicate flourishing (such as the ideas of suffering or distress that we can appeal to in the case of animals). Second, a great number of agriculturally important plants are functionally abnormal by any reasonable account of the concept. For example, broccoli florets are masses of attempted flowers that are genetically programmed to fail—thus, to paraphrase a plant biologist colleague, the broccoli is, from the point of view of its wild cabbage relatives, a grotesque mutant.⁹

A third conception of abnormality compares putatively abnormal specimens to paradigm versions of the plant, or of plants generally. On this *paradigmatic abnormality* conception, a plant is abnormal/unnatural if it lacks a property that a given plant, or plants generally, paradigmatically have (or it has a property that paradigmatic plants do not have). A prime example is perishability. While it is obviously useful to human beings that vegetables and fruits do not decay, proneness to decaying is seen as an indispensable property of paradigmatically natural entities (Mielby et al. 2013, p. 476). Since paradigmatic abnormality concerns specific and somewhat arbitrarily selected traits, it is a conception that lends itself fairly easily to distinctions between GMOs and non-GMOs. However, the relevant traits are unlikely to be uniformly and uniquely found in GMOs, and thus

paradigmatic unnaturalness is unlikely to ground a general GMO/non-GMO distinction.

In sum, it is possible to argue that many GMOs are more unnatural than many of their conventional counterparts. However, on most conceptions, not all GMOs are more unnatural than any non-GMO counterpart. If restrictive policies are justified by reference to a conception of unnaturalness that does not warrant a clear GMO/non-GMO distinction, such policies are vulnerable to the charge of being inefficacious (since they fail to apply to unnatural non-GMOs) and/or disproportionate (since they do apply to natural GMOs).

The moral relevance of unnaturalness

We now turn to whether unnaturalness can ground restrictions of GMOs, in particular bans (in the form of opt-outs of authorizations). The main challenge for those who want to argue that the unnaturalness of GMOs warrant such restrictions is to specify for whose or what’s sake we should implement these policies. According to traditional, mainstream moral theories, such as the ones discussed in the section “[Grounds for authorization: risk and precaution](#)” (consequentialism, deontology, rights theory, and contractualism) only the welfare, rights, and/or desires of human beings and sentient animals matter morally.¹⁰ On such views, then, creating unnatural plants can only justify restrictive policies if it in some way harms or wrongs a person or sentient animal. Consequently, on such views, the moral import of the unnaturalness objection reduces to safety considerations (discussed above) or considerations about people’s right to choose (discussed below). However, recent decades have seen the emergence of a number of views according to which non-sentient organisms or ecological wholes also matter morally. We will consider views of this type in this section, starting with views according to which non-sentient organisms matter morally.

The view that individual non-sentient organisms matter morally and can be wronged is known as *biocentrism*. The standard argument for biocentrism is based on the claim that non-sentient organisms have *interests* or *a good of their own* just like sentient

⁹ Michael Palmgren, in conversation.

¹⁰ This goes for the most widely discussed statements of these theories. Nonsentientist versions can be found within each of these four types of theory.

creatures do, since they have aims and goals, and move and change themselves in order to secure self-preservation and reproduction (e.g., Taylor 2011; Goodpaster 1976; Agar 1997). Impartial concern for all interests thus requires taking such organisms into account morally. From a biocentric point of view, the main issue is thus whether non-sentient organisms are harmed or benefitted. The relevant organisms could either be the GMOs themselves or other organisms.

Starting with the second possibility, there can be no doubt that some organisms are harmed by the use of GMOs—indeed, that is the very point of some modifications, such as pest resistance. But the fact that pests are harmed is at best a weak reason for restricting the use of GMOs. After all, pests are harmed under any form of agriculture. The main potential problem from this point of view is thus effects on non-target organisms. However, there is no evidence that such organisms are harmed, certainly to any substantial degree (National Academies of Sciences 2016). Or rather, all forms of agriculture cause some harm to non-pest organisms, and the use of GMOs is at least no worse than conventional farming practices.

The alternative type of biocentric argument against GMOs holds that the GMOs themselves are harmed by being created. Such a view faces the complexities of the so-called non-identity problem, which is one of the most difficult problems in moral philosophy (Parfit 1984, ch. 16). The non-identity problem arises for any view according to which it is morally important whether *specific* people are better or worse off if we do X rather than Y. Since many of the things we do also affect who comes into being, the implication of such views seems to be that many actions that we would normally take to be morally wrong are not in fact wrong (or at least not as wrong as they otherwise would be). For example, whether we adequately respond to climate change will very likely affect who comes into existence, so it would seem that we have very little moral reason to prevent climate change. This is because (many of) the people who exist in the case where we do not prevent climate change just would not have existed in the world where climate change is prevented. Thus, those people are not made better off by our solving the climate crisis, since the alternative for them is not existing at all.

In the case of GMOs, the problem is even clearer: GMOs cannot be harmed in the conventional sense by

being genetically modified, since if they were not genetically modified they would not exist. One way of getting out of the conundrum is to argue that GMOs are being harmed by being brought into existence. It is hotly debated among moral philosophers whether human beings can be harmed (or benefitted) by coming into existence. Among those who think this is possible, the standard view is that one can only be harmed by being brought into existence if one's life is, on balance, not worth living (see e.g. Holtug 2001, p. 362). It seems implausible to us to claim that GM crops' lives are so bad that nonexistence would be better for them.

Another way of getting out of the non-identity problem is to give up the focus on harms/benefits to specific people, and instead focus on "impersonal" considerations. In the case of GMOs, those following such a strategy would argue that the problem is that GMOs have worse lives than the conventionally bred organisms that would otherwise have existed. But it is hard to see how this should be true in general. In the case of biotic and abiotic stress resistance, for example, resistant GMOs are better off than alternative organisms. Even in cases where it is immediately intuitively plausible that the modification made lowers plant welfare—i.e., in cases of functional abnormality—the rudimentary nature of conceptions of plant welfare quickly undermines any notion that GM plants are worse off than non-GM plants.

While biocentrism focuses on individual organisms, *holist* approaches argue that biological wholes, in particular species and ecosystems, matter morally. The most famous examples of holism—the "Land Ethic" originally developed by Aldo Leopold, and the "Deep Ecology" movement associated with Arne Næss—furthermore attach high importance to the flourishing of biological wholes. In Leopold's words, "a thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 1949, pp. 224–25). Thus, these views argue for very extensive changes to current practices, including "a substantial decrease of the human population" (Næss 2005, pp. 37–42), although they accept that such policies should not be implemented in ways that violate basic human rights, and that vital human interests take precedence over preservation of natural ecosystems.

The crucial open question for holism is what it would mean to act *for the sake of* biological wholes. Even more than biocentrism, holism suffers from the lack of a rich and well-developed conception of what it means for biological wholes to flourish. The most common view is that (certain) biological wholes have *intrinsic value*, and that we therefore have reason to preserve them. Importantly, the grounds of this intrinsic value is the independence-based naturalness of the relevant wholes. Thus, species and ecosystems that are independent of human intervention have a certain value that ecosystems that lack independence do not have—or, alternatively, the more human intervention an entity exhibits, the lower its value (e.g., Elliott 1982; Katz 1992). Consequently, the destruction of natural biological entities amounts to the destruction of value.

The most obvious implication of holist views is that damage to ecosystems or species matters. However, there is currently no evidence that such damage has occurred. Some holists, however, make the more sweeping claim that GMOs/GM technology is *generally* “nature replacing” (Lee 1999). But it is hard to see how this is likely to be the case: GMOs will likely replace other non-natural (or low-naturalness) organisms, such as conventional maize. If only highly or entirely natural organisms have significant intrinsic value, which seems to us the most plausible reading of the holist idea, then the value loss of this process of replacement is zero or insignificant. Furthermore, the development and use of GMOs are likely to contribute to the preservation of highly natural biological entities, including both species and ecosystems, by making it possible to increase food production without increasing the area of land used for farming, thereby decreasing pressure on highly natural biological wholes. The inference from the lack of value of GMOs to the undesirability of creating and proliferating them thus seems to us to be a mistake.

Agricultural policy

A second reason for opting out of authorizations of GMOs are agricultural policies, in particular the desire to promote organic farming. This was, for example, very prominent in the debate leading up to the Danish decision to opt out of cultivation of four GMOs in 2015. In this section, we will discuss what basis a desire to promote organic farming might have, and

whether a legitimate desire to promote organic farming can justify restricting GMOs by banning them.

Organic farming and naturalness are connected, since organic farming is frequently taken to be a more natural way of farming than conventional and (especially) GM farming. Paul B. Thompson (2003) has argued that “natural” farming means “artisanal” farming. The artisan-farmer works “with nature” rather than “against” it, meaning that she uses context-specific knowledge of her crops and the ecosystem in which they are situated to design systems that harness naturally-occurring characteristics and relationships to produce desired effects. For example, the artisan-farmer might rotate crops in order to fix nitrogen in the soil, or she might plant several crops that mutually benefit each other in the same plot. The antithesis to artisanal farming is technological or industrial farming, including in particular the use of pesticides and artificial fertilizer. In effect, organic farming is often identified with artisanal farming (Verhoog et al. 2003; Verhoog 2007). This identification is likely false—not all artisanal farmers farm organically, and some organic farms are very large scale and highly mechanized, and hence fit the industrial mold. However, the primary basis for a preference for organic farming is that it is seen to be an environmentally friendly and sustainable form of agriculture, and to produce food that is healthier for human beings.¹¹ Low negative environmental impact, sustainability, and healthy food are all widely accepted desiderata, and we will therefore assume that they are legitimate political aims. But can the aim of environmentally friendly and sustainable agriculture, and of promoting organic farming, justify restrictive policies on GMOs?

As things are currently, organic farming and GMOs are incompatible, simply because the rules of organic farming preclude the use of GMOs. However, this is not sufficient for those arguing for restrictions of GMOs based on the benefits of organic farming. We still need to ask whether GMOs are detrimental to the

¹¹ Since the putative health benefits also (according to the proponents of a health-based pro-organic argument) set organic food apart from conventional crops, the relevant health effects are such that they would not be covered by EFSA safety assessment. They would, for example, be associated with lower pesticide residue intake.

benefits that organic farming is supposed to bring. And there is some immediate plausibility to the idea that they could: One of the most widely-used GMO traits, namely glyphosate tolerance, is essentially a part of an approach to agriculture that uses chemical pesticides extensively. If one is worried about the sustainability of such an approach, then it at least makes sense to worry about glyphosate tolerant crops. The other widely-used trait, pest resistance based on presence of Bt toxin, basically moves a pesticide from outside to inside the plant. If one worries about the health and environmental effects of pesticides, then it at least makes sense to worry about Bt crops too.

However immediately plausible they are, these ideas do not stand up to scrutiny. With respect to Bt, the pesticide in question is used in organic farming as well (since it is a naturally occurring substance, it is allowed by the rules of organic farming), and concentrations in GM varieties are below limit values (Mendelsohn et al. 2003). Thus, dangerous exposure to Bt toxin from eating Bt crops is highly unlikely, and no more likely than such exposure from eating organic crops. Similarly, the environmental impacts of Bt varieties are unlikely to be significantly worse than the impacts of organic farming. Indeed, Bt crops arguably contribute to pesticide-free farming. And this will likely be the case for many GMOs, for example those modified for biotic- or abiotic stress resistance.

Perhaps glyphosate resistant crops are a better case for those who favor more environmentally friendly and sustainable agriculture. The widespread adoption of such crops has unquestionably led to more glyphosate use (Benbrook 2016). Furthermore, overall herbicide use, measured by weight of active ingredient, has increased in many places. However, since glyphosate is less toxic than alternatives, the environmental impact is likely lower (Brookes and Barfoot 2017). In addition, the increase in herbicides used is measured relative to a baseline of the amounts used prior to the introduction of GMOs, while an arguably more relevant baseline is the amount of herbicides that would have been used had GMOs not been planted (Kniss 2017). Evidence from countries where GMOs have not been used suggests that this amount is *higher* than the amount associated with the use of glyphosate resistant crops.

It seems, then, that both glyphosate-tolerant and Bt crops thus are making a positive contribution to the aim of more environmentally friendly, sustainable and

healthy agriculture, at least when compared with conventional farming. And at least for Bt varieties, it is plausible to claim that they are equally environmentally friendly, sustainable and healthy as organic farming/products. Furthermore, GMOs with traits that are not yet widespread may also be as good as organic in all three respects. An argument that seeks to justify restrictive policies on GMOs based on the superiority of organic farming thus faces a dilemma: Either we can alter the definition of ‘organic farming’ so it captures all and only those farming practices that are sufficiently environmentally beneficial, sustainable, and healthy—in which case (some) GMOs should be allowed in organic farming (Andersen et al. 2015). Or we can hold on to the current definition, in which case any claim to superiority for organic farming must rely on much more controversial premises than that it benefits the environment—e.g. ecological-holist or biocentric views (Verhoog et al. 2003).

An influential argument seeks to overcome this dilemma by arguing that (1) the creation and use of GMOs is an extension of industrial and technological approaches to agriculture, (2) the industrial-technological approach is expressive of an attitude of domination and control towards nature, (3) this attitude is a major cause of the agricultural challenges humanity now faces, and (4) therefore the use of GMOs in order to *solve* agricultural challenges is hubristic, and unlikely to be successful (or even likely to worsen the problems). If this argument were sound, it would show that GMOs per se are incompatible with environmentally sustainable agriculture. However, it is hard to see how this line of thinking can be successful unless the environmental consequences of GM agriculture are, on balance, negative. Current evidence strongly suggests that such consequences have been preponderantly positive.

An alternative version of the above argument exchanges (4) for an injunction against using GMOs as a “technological fix” that can solve all our problems (Sandler 2007, pp. 134–135). But this version cannot justify restrictive policies on GMOs, since such policies do nothing to promote other solutions to the problem. And, insofar as GMOs *contribute to* solving problems (which is a different claim from the claim that they can solve problems *alone*), restrictive policies are counterproductive. Furthermore, the idea that those promoting or developing GMOs believe that

they are a technological fix seems to us to be unwarranted.

The failure of the technological fix argument points to a more general problem with grounding restrictive policies on GMOs on the superiority of organic farming. Even if we assume that organic farming is clearly superior, restrictive policies based on this fact are poorly targeted, since conventional agriculture is at least as inferior to organic as GM agriculture is. The superiority of organic farming may warrant promoting organic farming, but not restricting any single alternative approach. If GM agriculture is superior to conventional agriculture with respect to environmental sustainability—which, according to the benefits argument, they generally are—restrictive policies on GMOs are especially egregious. In addition, if organic farming is superior it is only in one respect, namely lower environmental impact. GM agriculture promises to be superior to organic agriculture in other respects, which would need to be weighed against organic's environmental superiority. One respect in which GM agriculture is superior is in terms of yields, which is highly important given projected future food demands. And if organic farming cannot meet future food needs without making use of more land for farming,¹² then it is not obvious that organic is even superior in environmental terms, assuming that we *must* feed the growing global population.

Socioeconomic consequences

The final set of objections to GMOs have to do with social and economic justice. According to the most important of these objections, the use of GMOs leads to a shift in power towards large biotech companies and away from farmers. Such worries relate to both effects on the domestic agricultural- and food-economic system, and effects on farmers in poorer countries. In the latter case, the direct import for domestic policy is not obvious. In order for bans to make sense, one would have to think that banning GMOs in (parts of) the EU somehow protects farmers

abroad from problematic socio-economic effects. Worries about the impact on poor-country farmers thus seem more pertinent to labelling, since it might rationalize a preference for non-GMO products (analogously to for example Fair Trade labels). We will return to this below. In this section, we will focus on domestic socioeconomic effects.

There are (at least) two related worries. First, there is a worry about *market power*, or the ability of companies to extract high prices from farmers that have little option but to buy their seeds. Second, there is a worry about *intellectual property rights* (IPR). Since companies have the IPRs to GM seeds, they can engage in aggressive litigation against farmers who use these seeds in ways companies do not want—e.g., farmers who plant seeds retained from last year's harvest, or farmers that unintentionally plant GM seeds that have spread to their fields. Furthermore, they can limit poorer farmers' access to seeds, and will likely develop new seeds that mainly benefit rich-world farmers (who can pay more).

These are all important concerns, but their pertinence to GMOs is questionable, and they are ill-suited for justifying opt-outs (and other of the current policies). Consider first market power. A meta-analysis of studies of the economic impacts of GM crops (Qaim 2009) found that companies do appropriate significant parts of the economic surplus created. However, farmers also appropriate a significant share (from around 20% up to 98.5%). Furthermore, it is not obvious that the use of GMOs drastically worsens problems with market power. Certainly, there is significant market power *within* the market for GM seeds. But the putative problem concerns market power in the *total* market for seeds (not just the market for GM seeds), which is not necessarily impacted to any large degree, since the market for non-GM seeds remains in place.

Even to the extent that market power is a problem, banning GMOs is not well-targeted to dealing with that problem. First of all, regulations such as antitrust laws are already in place to combat market power in general. Instituting bans on one product that is prone to market power is therefore not necessary, and also disproportionate. Second of all, even if we focus solely on market power in the market for seeds, banning GMOs is inefficacious since it does not address the market power that exists in the market for non-GM seeds (such as hybrids). Furthermore, the existence of

¹² A recent analysis found that organic farming can feed the world without increasing land use, but only if combined with (1) a very large reduction in food waste, and (2) an elimination of all use of land that could be used for producing (plant-based) foods for the production of livestock (Muller et al. 2017). Neither of these are likely to be realized.

an expensive and cumbersome authorization procedure—which MS’s withholding authorization strongly contributes to—increases barriers to entry for prospective biotech companies, thereby limiting the number of competing companies and increasing the market power of established players, and it is thus directly counterproductive.

Now consider IPRs. The first problem with IPRs is that it permits aggressive litigation practices by companies. This problem has been greatly exaggerated by some participants in the debate. For example, there are no examples of Monsanto suing farmers for unlicensed but unintentional use of seeds.¹³ Suits for intentional breaches of contracts seem much less problematic morally—presumably, farmers choose to plant GM varieties because they expect benefits, even given any restrictions in the licensing agreement. Furthermore, for affluent-country farmers, most seed is subject to IPR’s anyway, and the practice of saving seeds is not widespread, because ‘new’ seeds are typically better. Most importantly, current policies are poorly targeted to handle aggressive litigation: Since IPR’s apply to many other seeds besides GM seeds, targeting GMOs specifically is inefficacious; and since less restrictive policies targeting problematic effects of IPR exist—for example, one could disallow clauses prohibiting seed saving—the policies are disproportionate.

Grounds for labelling: consumers’ right to choose

The final reason for restrictive policies on GMOs that we will consider is the consumers’ right to choose. It is relatively obvious that this can only be used to justify labelling. Many consumer organizations and advocacy groups have argued for labelling requirements. What is more, it is intuitively highly plausible to argue that individuals should be allowed to choose for themselves what they want to eat—indeed, the alternative view, that individuals should not be allowed to choose what to eat, looks extremely controversial. So, we will assume that individuals do have a right to choose. Since labels allow people to exercise this right

effectively, is it not simply obvious that labelling is justified?

No, it is not. For what we are considering here is not simply whether it would be a good thing if consumers were able to get any information about an item they consider purchasing easily. Nor are we considering the desirability of voluntary ‘GMO free’ labels. We are considering whether labelling should be *mandatory*, and hence whether it is justified to legally require farmers and retailers to label food as GM. The mere fact that some people take a given property P to be important for their consumption choices is insufficient for grounding mandatory P-labelling on the basis of a right to choose whether to buy P-products. Suppose, for example, that a large subset of the population is strongly adverse to eating food that has been harvested on a Tuesday. This alone is not sufficient to generate a right to choose non-Tuesday-harvested food, and no justification for labelling Tuesday-harvested foods. Any such right requires that people’s preference for non-Tuesday food is based on some interest that ought to be protected.

In the case of GMOs, then, labelling on the basis of anti-GMO consumer preferences requires that some other anti-GMO rationale holds. As we have suggested, each of the considerations above—risk, naturalness, organic farming, and socio-economic concerns—might in principle justify mandatory labelling. However, they do not ultimately do so.

Consider first risk. The rationale would be that the consumer should be able to decide for herself whether she wants to run the small residual risk that may remain after safety testing. Since this risk is low, any such demand is weak—and certainly labels posing as (quasi)-warnings would be misleading. Furthermore, the fact that no adverse effects have been observed from the widespread use for more than 20 years of safety-approved GMOs suggests that the residual risks associated with such GMOs are no higher than the risks of most of the other products for sale. Therefore, risk-based GMO labels would be senseless, since they do not pick out a type of food that is particularly risky. A well-targeted label that addressed such residual risk would have to be put on more or less all foods, which would be unhelpful.

Second, consider naturalness. Since arguments for the moral undesirability of GMOs based on naturalness are not sound, there is no grounds for labelling GMOs merely because people react to their

¹³ See *OSGATA v. Monsanto*, available at <http://www.caafc.uscourts.gov/sites/default/files/opinions-orders/12-1298.Opinion.6-6-2013.1.pdf>.

unnaturalness. Furthermore, there is reason to think that a preference for non-GMO foods based on naturalness would not stand up to scrutiny, since no conception of naturalness rationalizes a clear distinction between GMOs and non-GMOs. Even those that come close likely rests on mistakes at a deeper level. For example, the aversion to transgenic organisms likely partly reflects (largely unconscious) essentialist thinking, according to which genes are bearers of the essence of the organisms from which it is taken (Blancke et al. 2015; Szántó 2018; for a general account of essentialism and its importance for preferences, see Bloom 2011). Such essentialist thinking leads to the belief that tomatoes carrying a gene from a fish are somehow ‘fishy’ (including in taste), or that eating a plant that has an added human gene would be a form of cannibalism. Similarly, people tend to believe—falsely—that more natural foods are more nutritious and healthier than less natural ones (Rozin et al. 2004). To the extent that preferences for natural foods, and attendant aversion to GMOs, are explained by such false preconceptions, the rationale for legislative action on the basis of such preferences is even weaker.

Third, consider organic farming. The most obvious problem with justifying GMO labels on the basis of a preference for organic is that organic labels already exist. Thus, consumers can already easily choose organic if they so wish. Furthermore, if it is true (as we have argued) that current GMOs are better from the point of environmental and sustainability concerns than conventional products, labelling GMOs for reasons of environmental friendliness and sustainability is likely to be counterproductive, since most consumers hold the false belief that GMOs are bad for the environment.

Finally, consider socio-economic impacts. As we suggested above, adverse impacts on poor-country farmers would perhaps justify labelling on analogy with Fair Trade labels. However, labelling products depending on whether they are produced in a way that treats poor-country workers or farmers in morally acceptable ways is not generally mandatory. Thus, the Fair Trade analogy does not hold up. Furthermore, it is far from clear that the reputation of GMOs as part and parcel of exploitative practices, especially aggressive IPR enforcement, is justified. For one thing, IPR’s are generally not very well enforced in developing countries, and as a result seed saving occurs despite

restrictions (Qaim 2009, pp. 667–678). But another worry is that all benefits accrue to rich-world companies, while poorer-country farmers will benefit little (or even lose). It is important, however, not to confuse IPR issues in GM agriculture with related IPR issues, such as the patenting (and thus commercialization) of products and practices already in use in developing countries. The primary potential problem in the GMO case is that poorer farmers will lack access to GMOs, and that innovation will target rich-world needs (notice that this line of argument assumes that GMOs are or could be beneficial, including to poorer farmers). We agree that it is important, especially for those espousing the benefits argument, that innovation is funneled towards solving problems relating to food security in the developing world. This will likely require large efforts by non-commercial actors, such as universities and governments. However, this does not entail that current, commercialized GMOs are problematic, even if they did not [contrary to fact (Qaim 2009, p. 674)] benefit smallholder farmers in developing countries at all.

We conclude that the desire to avoid GMOs does not constitute a sufficiently important interest to consumers to justify mandatory labelling. What is more, if there is a demand for GMO-free products, we should expect farmers and retailers to voluntarily label their products in order to meet that demand. We do not argue that such labels should not be allowed—although they should, of course, conform to general requirements of non-misleading advertising.

Conclusion

We have argued that the most popular and cogent arguments for restricting GMOs do not, in general, justify the types of restrictive policies that govern GMOs within the EU. Bans, which primarily take the form of opt outs of authorizations, are not justified even if we take concerns underlying arguments concerning risk, naturalness, organic farming, and socio-economic impacts seriously. Furthermore, none of these concerns ground a right to choose that is sufficiently strong to justify mandatory labelling. Finally, while some form of pre-release safety assessment is justified, it is worth considering whether the current regulations are fit for purpose. In light of the extremely low number of authorizations given for

cultivation of GMOs in the EU, it is at least clear that the pre-release authorization process is in need of reform. The importance of such reform is only exacerbated by the European Court of Justice's ruling that new techniques such as gene editing are covered by the GMO regulations, which means that there is a risk that future agricultural innovation will be severely hampered if regulations are not changed.

Of course, we have not provided knock-down arguments that are beyond reasonable dispute. This is as it must be in philosophical, ethical, and political debates such as this one. However, we do not believe that such debates should therefore be left untouched. Only by engaging in reasoned discussion can we come to see the strengths and weakness of different views, including our own. We hope to have stimulated such reflection in the reader, and to have contributed to moving the debate forward by inviting reflection on whether restrictions on GMOs are in fact justified by the best anti-GMO arguments.

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