INVESTIGATING THE ENVIRONMENTAL RISKS OF TRANSGENIC CROPS

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■ ABSTRACT: Legitimation of public policies that support the widespread plantings of transgenic crops presuppose, among other conditions, that (1) evidence supports that there are no unmanageable environmental risks and (2) there are no better ways to produce enough nourishing food that can dispense with the transgenics-oriented ways. This paper discusses: (a) the kinds of scientific inquiry that are needed to address (1) adequately, (b) the connections between investigations of (1) and (2), and (c) how these investigations are related with controversial social values.

■ KEY WORDS: risk; risk assessment; transgenics; control of natural objects; agroecology.

In recent years plantings of transgenic (TG) crops have increased at a startling pace. Clearly this would not have happened if the farmers who use them did not perceive them to be the source of significant benefits. At the same time a chorus of opposition to the use of TGs in farming has arisen. While it often questions whether there are significant benefits to be gained, especially for consumers, poor farmers and rural communities in "developing" countries, its principal themes are "risk" and "better ways to practice farming." It draws upon the principle that expected benefits alone do not suffice either for *legitimation* – the right of farmers to use TGs and corporations to develop and market them – or

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for *justifying a public policy* that encourages their widespread use, especially one that aims to make the use of TGs a prioritized component of the farming of the future (Lacey, 2003d: 140–141). A necessary condition for legitimation requires (presumptive) support for a claim like:

> **MR** (*Environmental Risk is Manageable*): There are no environmental hazards arising from the use of TGs that pose serious risks of significant magnitude and probability of occurrence, which cannot be adequately managed under responsibly designed regulations

Legitimation also requires a similar claim about no serious risks to human health, which I will not address in this article. In addition, a necessary condition for justifying a public policy encouraging and supporting the use of TGs requires a claim like:

> **NBW** (*No Better Way*): There are no alternate ways of farming that could be deployed instead of the TG-oriented ways without occasioning unacceptable risks, and that reasonably could be expected to produce greater benefits concerning productivity, sustainability and meeting human needs.

When critics point to the importance of **MR** and **NBW** they are on solid ground. Many proponents maintain, however, that – under what they take to be appropriate interpretations – presumptive cases for **MR** and **NBW** have been established to the satisfaction of the bulk of the scientific community. In turn, critics question the adequacy of the empirical support that has been offered for them. The critics also have a political agenda – more accurately a varied assortment of political agendas – but that does not mean that their judgments about risks or alternatives lack empirical backing; just as the fact that many of the proponents have links with agribusiness – or claim to value "science" as a major and indispensable source for the solution of such big and urgent problems as hunger and malnutrition – does not *per se* cast into question their scientific objectivity. While political, corporate and value agendas contribute to the apparent intractability of the disputes about TGs and the hostility that tends to mark them, they should not overshadow the importance of questions of empirical investigation that are involved.

My objective in this article is limited to addressing the following three matters: The role of empirical investigation in coming to endorse (or not) claims like **MR** and **NBW**, the logical interactions among judgments that are made concerning these two claims, and the apparently indispensable role of social value judgments in supporting judgments of endorsement.

I

The controversy about TGs is not an isolated one. I am think of it as a proxy for a bigger one, which involves issues not only about the nature of scientific inquiry but also about its relations with widely held, specifically modern values connected with the control of natural objects (Lacey, 1998, 1999–especially Chapter 6, 2002b). Certainly, to their proponents, developments of TGs (more generally of biotechnology) are informed in an exemplary way by scientific knowledge, where generally "scientific" knowledge is thought of as that represented in theories that posit the underlying structure, process and interaction of phenomena and display their lawfulness, the kind of knowledge that furthers human powers to exercise control over natural objects (Lacey, 2000, 2002a, 2003a; Lacey & Barbosa de Oliveira, 2001). Valuing the furthering of these powers is at the heart of modern ways of valuing such control, for these powers are seen as indispensable for addressing problems like hunger and malnutrition; and the related values are deeply embodied in the predominant institutions of the advanced industrial countries.

In the light of the modern values about control of natural objects and their presuppositions, it is presumed that there are no (significant, large-scale) alternatives outside the trajectory of those that may be informed by modern scientific knowledge. (There may be alternatives for special niches.) That is why **NBW** tends to get very little attention in the discussions about TGs in the advanced industrial countries, where it tends to be taken as sufficient – by farmers who intend to use them and corporations that wish to market them – to show the benefits of TG-intensive farming in contrast to those of conventional forms of high-intensity farming. While individual farmers may make different cost/benefit estimates (when they share the assumption **MR**), matters of assessment of evidence are not likely to be central to these differences (at least in the long run). In this context, safety will be the key to legitimation, comparing the potential risks of TG-intensive and conventional farming methods. Holding the modern values about the control of natu-

ral objects provides, I suggest, a primary source of the *prima facie* legitimacy that proponents of TGs often feel entitled to claim. (See § 3 below.) This is reinforced by another widely held presupposition of the modern ways of valuing control: It is likely that any undesirable side-effects of the application of scientific knowledge can be addressed adequately in the light of further applications of scientific knowledge used to create additional novel technologies. Indeed, to many of their proponents, TG technology itself is portrayed as such a novel technology that – since it will supposedly, e.g., involve the use of smaller quantities of herbicide or pesticide – can alleviate the environmental damage caused by an older technology (chemical-intensive conventional farming) (Coyne, 2003; Rauch, 2003).

To their proponents, *TGs represent a novel power for controlling natural objects, another in the long line of triumphs of scientific research, a new opportunity for further embodying the modern values concerning control and deploying scientific knowledge for the solving of great human problems.* To question the legitimacy and value of using TGs is, then, tantamount to questioning more generally the value of modern science and its technological applications (Lacey, 2002e). I think that, deep down, this is at the heart of the controversy. Although critics recognize the novel power and opportunity engendered by TGs and their source in scientific developments, they tend to contest the modern values about control of natural objects.[2] Rather they interpret the positive rhetoric, notwithstanding the sincerity of those who use it, as cover for the subordination of the well being of poor peoples to the interests of those (corporations, the global market, the military, investors) who gain from the further entrenchment of the modern values concerning control (Cayford, 2003). Specifically, they do not think that TGs offer much of significance for dealing with problems of the poor like hunger and malnutrition, and that probably their spread will make

2 Here I do not pretend to speak all the critics of TGs. (Some of them engage in quite shoddy arguments. In this respect they keep good company with some of the proponents.) I am sketching here a critical posture, which is worth contending with, that I think renders intelligible the thrust, if not the detail, of many of the critics' arguments. Some variant of this posture is usually lying in the background when the critics raise questions about evidence in discussions of risk. I do not think that anyone has put forward a considered argument in which a critical stance towards TGs is adopted on the basis of *first* concluding that there are unacceptable risks. Likewise I don't think that proponents' legitimations reach conclusions about safety independently of their background social values. This does not mean that matters crucially open to empirical investigation are not at stake in the disputes about risks.

things worse.[3] This in part because they maintain that the further implementation of TGs (even of the celebrated varieties like "golden rice" that currently are under development), and the conditions required for it, reflect the interests of the global market system, the very same system within which poverty, seen as the fundamental cause of hunger and malnutrition, persists today (Lacey, 2002a, d). The critics, whose arguments I am attempting to synthesize, are principally linked with movements of small farmers (and rural workers) in poor countries (including Brazil), who contest the modern values about control, and the institutions and policies that embody them, from the perspective of the set of values often called those of "popular participation" (Lacey, 2002c, d).

These critics have in mind alternatives that can be informed by scientific knowledge – but not exclusively by scientific knowledge of the kind specified above, which is considered to be just one (albeit very important) kind of scientific knowledge that by itself is significantly incomplete. Research on *the underlying structures, processes and interactions of phenomena* (e.g., seeds and crop plants), and *the laws governing them*, is able to provide knowledge and evidence about the technical possibilities of genetic engineering, but it *dissociates these phenomena from their agroecological environments* and so is unable to address the full range of possibilities open to seeds and crops, and the effects of their uses on the environment, people and social arrangements. I call research of the first kind that conducted under *materialist strategies* (Lacey, 1998, 1999, 2002a, b) and that which does not dissociate phenomena and their possibilities from their environments *agroecological strategies*. (There are many varieties of agroecological and closely related strategies that often are in continuity with the traditional knowledge of local farmers – Lacey 1998: ch. 6, 1999: ch. 8, 2001, 2002a, d). I consider *scientific inquiry* to be any form of *systematic, empirical inquiry* conducted under a strategy, so that scientific inquiry cannot be reduced to that conducted under materialist strategies (Lacey, 1999: ch. 5, 2001, 2003c). Knowledge gained under agroecological strategies, as well as being pertinent to judgments made about the side-effects of the use of TGs, informs the farming practices of *agroecology*, which can be

3 Elsewhere (Lacey, 2002a, 2002d), I have elaborated this into a criticism of the presuppositions of the modern ways of valuing control, charging that they dissociate proposed "scientifically-grounded" solutions to problems from the causal networks that create and sustain the problems. Often this has the effect that the socio-economic conditions needed to effectively implement a solution are rendered invisible.

and are being developed to generate much greater productivity of essential crops (and livestock) and, at the same time, they nurture sustainable agroecosystems and thus further social emancipation (Altieri, 1998). While their long-term productive potential remains open to further investigation, there is good evidence that they are particularly well suited (perhaps uniquely so) to ensure that rural populations in "developing" countries are well fed and nourished, so that without their further development current patterns of hunger are likely to continue.

These critics, I emphasize, propose a systematic alternative program in agriculture (part of a package of proposals that also pertain to other areas of social life), not in the first instance because of worries about the risks of TGs or because they defend the *status quo*, but because they wish to further the values of popular participation, which include a different vision of human interaction with nature (Lacey, 2002c, d). Their objections are first against the modern values concerning the control of natural objects and (perhaps more fundamentally) many of the values (related to property and the market) of the institutions that nourish them; they do not oppose technologies that enable novel forms of control *in principle* (Guerra, *et al.*, 1998; Costa Gomes & Rosenstein, 2000), but evaluate them in relation to how they may contribute to further the values of popular participation, and so they in practice (perfectly coherently) endorse some of them. Many (perhaps all) of their objections to the use of TGs are also objections to using methods of high-intensity farming and perceived as such; to them TGs simply represent the latest innovations in high-intensity, industrial agriculture, whose driving forces are the institutions of global neoliberalism), and which may also pose some novel (perhaps non-minor) problems.

II

Consider **MR**. Some critics of TGs maintain that there *are* serious risks; others that there *may be*, that not enough is known to reach a sound judgment on the matter. For present purposes I will take the critics to hold:

> **R**: **MR** is not sufficiently well supported by available empirical evidence.

The proponents, of course, when they endorse **MR**, maintain that it is well supported by available evidence or, more cautiously, that in the light of available evidence there is a presumption in its favor. They often

claim the authority of science in doing so, and sometimes suggest that the critics have no genuine interest in the evidence and are driven solely by their political agendas. At the same time, however, often they overstate the available evidential support for **MR**, suggesting to their critics that they have rushed hastily to claim legitimation – perhaps because of their links with business interests whose investments might be harmed by delayed innovations of TGs, or because furthering these innovations will provide an impetus for further scientific research and new possibilities for funding favored kinds of research. There is plenty of opportunity here to tar one's opponents with ideological or self-serving labels. Nevertheless, this should not obscure that (as we shall see) there remains a deep question about what counts as *sufficient evidence* for a proposition like **MR**.

Normally we should not expect to be able to obtain evidence for **MR** that is as compelling as the evidence for (e.g.): "A gene from the bacterium *Bt* may be inserted into the genomes of maize plants so that they contain a toxin lethal to many varieties of insects." Yet, normally it's not reasonable to withhold assent to **MR**, and thus to deny legitimacy to agricultural innovations that are informed it, until we gain *comparably compelling* evidence. More generally, evidence for the effectiveness of TG technology is more clear-cut than evidence for the presuppositions of legitimacy, and (normally) the same research that produces the evidence for the former is (comparatively) silent on the latter – research that produces the positive products of genetic engineering (conducted under a variety of materialist strategies) abstracts from the ecological (and social) context of their use, and so does not address the ecological (and social) consequences of their use. What kinds of research are pertinent to appraising **MR**? What counts as "sufficiently well supported by the available evidence"? In my opinion, the contending parties – to the extent that they consider themselves to be making scientifically respectable judgments – are committed to giving explicit answers to these questions. In particular, when one questions the adequacy of an opponent's evidence, it is incumbent on one to characterize the kind of research that could be conducted to satisfy one's doubts.

When critics affirm **R**, they may be affirming one or more (perhaps all) of the following:

> **R** (a): Insufficient research has been conducted to identify possible hazards of TGs; (while many possible hazards are known, the as yet unknown ones might be more problematic.)

(b): Insufficient research has been conducted on the severity, magnitude and probability of risk occasioned by the known hazards.
(c): There is insufficient evidence that the risks can be managed so as to avoid serious harm to the environment; or, under prevailing circumstances it is unlikely that adequate regulatory systems will be implemented.

Elaborating **R** in this way brings out sharply the complexities involved in appraising **MR**. First, terms like "severity" and "serious harm" require interpretation (and, contextually, some kind of operational definition). How they are interpreted will necessarily reflect assessments of benefits expected to be gained (a risk to the environment will be judged less severe if it is balanced by other environmental benefits), and comparisons to the risks occasioned by other agricultural practices. (Ultimately appraisals of **MR** and **NBW** are deeply interconnected. Relative to chemical-intensive conventional farming, use of TGs may occasion less risk; but relative to agroecological approaches much more; then assessing the risk will be linked with issues about the productive and other possibilities of agroecology and, also, about the likelihood of their widespread use.) Second, especially in the light of (c), it is clear that the matter cannot be settled in the course of research that is limited to the methods of biotechnology (molecular biology, physiology, etc) and ecology. There is an irreducible social dimension to the appraisal, and risk-assessment procedures that abstract from it cannot be decisive. Third, when stated in this way, it is still incumbent on the critics to give reasons why they claim that there is insufficient evidence on these matters. How is the evidence cited by the proponents insufficient? And what further research projects would they design to get at their reservations?

We would expect the proponents to respond that the critics are demanding too much, for they tend to interpret **MR** in such a way that the legitimation of planting a particular TG crop (e.g., a variety of *Bt* maize) does not require the general and open-ended legitimation of TG technology. Hazards vary with the TG and the environment of planting, the proponents readily acknowledge. Some may pose serious risks and others (most?) will not, and the risks of some but not others may be able to be managed. Risk analysis is (and should be) carried out *case by case*. Then, proponents might want to interpret **MR** in a narrower way, perhaps *somewhat along the following lines*:

MR' (i): The TGs that have been released for use in the USA (and countries with comparable regulatory agencies to the USA) – sometimes with their use confined to certain geographical regions and certain conditions – give rise to no environmental hazards that pose serious risks of significant magnitude and probability of occurrence, which cannot be adequately managed under responsibly designed regulations; and
(ii) Current regulatory procedures are adequate to identify serious risks concerning new TGs that may be introduced and thus to prevent the release of risky ones (and to contain harm should a risk become apparent after introduction), and these procedures are under regular review so as to ensure that they continue to be improved.

If critics were to acknowledge that **MR'** is well supported by the evidence, then it would not be open to them to deny legitimacy to plantings of the released TGs *on the ground that* these particular plants posed environmental risks. But, for the critics I wish to represent, the question of risk does not reduce to a case-by-case matter. They consider the currently released TGs to represent the first steps of a trajectory that involves the radical transformation of farming worldwide. They may acknowledge **MR'** but deny legitimacy to the planting of these TGs *on the ground that* they are an integral (initial) part of a trajectory that may occasion serious risks. This is not an *ad hoc* move. After all, the companies that are developing TGs publicize that this is what they are (and they would not have been developed in the first place if this were not the case). So, too, do the Foundations and NGOs that want to develop varieties of TGs that they think may serve to meet the needs of poor countries (Lacey, 2002a, d). Long-term research and development projects have been planned on the basis of this understanding. To the critics, the legitimacy of plantings of particular TGs is deeply linked with the legitimacy of the planned trajectory of TG research and development. Not so to the proponents! Nevertheless, to them the value of these crops is linked with the expected legitimacy (as well as perceived desirability) of the trajectory, so that I interpret them to incorporate the following conjunct into **MR'**:

(iii) TG technology (regulated under the procedures mentioned in (ii)) may be safely expanded even to the point – as the current trajectory of its development may suggest – that the practices it informs come to be a major and widespread component of farming from now on (or at least to have much greater salience than they currently do).

Do the risk-assessments that have been conducted under the regulatory procedures provide sufficient evidence for **MR'**, or good grounds to grant a presumption in its favor, so that the "burden of proof" should

rationally fall squarely on the critics?[4] In the context of countries with well functioning regulatory bodies, this is (and is intended to be by the proponents) a difficult burden to assume. Given (ii), its successful assumption would presumably be to identify a hazard that, according to standard risk-assessment procedures, poses a serious risk for which there is evidence that it is unlikely to be contained given current (and foreseeable) regulatory procedures. (Recent studies conducted in England suggest to some people that critics may have already successfully carried the burden of proof – see Giles, 2003.) The burden arises for the critics, however, only in the light of the proponents themselves having met a "prior burden": showing that the released TGs pass their risk-assessments and that there is regulatory oversight in place to ensure that no releases of TGs occur without their having passed properly designed and implemented risk-assessments. This is important to emphasize. The outcomes of risk-assessment can vary in critical ways with the kind (and specific variety) of TG and the environment of planting. E.g., "no risk" in one environment does not imply "no risk" in another; TGs released for planting in the USA, having passed risk-assessments deemed adequate by US regulatory agencies, may yet pose serious risks in another agricultural environment (NRC, 2002: 247). That is why my formulation of **MR'** is so heavily qualified. While sound judgments of the efficacy of TG technology travel easily across national and regional boundaries, the outcomes of risk-assessments do not. Here it is interesting to observe that critics of TGs in Brazil have been on a sound empirical footing. The "prior burden" has not been assumed in Brazil. Testing (relating to environmental risks) of TG varieties proposed for release here has not been carried out in the context of Brazilian agroecosystems. When CTNBio (Comissão Técnica de Biossegurança) approved for release varieties of RoundUp Ready soybeans, it judged that planting them involved no unacceptable risks to the environment, it did so on the basis of risk-assessments conducted in USA. Thus, according to my analysis, when a Federal Court (responding to lawsuits brought on behalf of a number of NGO critics) overruled this judgment, stopping the release of these varieties pending environmental impact studies being conducted in Brazil, it acted correctly and fully in accordance with

4 It is not uncommon for proponents of transgenics to appeal to the alleged "substantial equivalence" of transgenic and conventionally grown plants, and thence to argue that no special testing is needed for transgenics. For a compelling argument against such equivalence, see Mariconda & Ramos, 2003.

proper scientific standards (Cezar, 2003; Leite, 2000; Marinho, 2003). Of course, if the prior burden were to be met, the burden of proof would then shift to the critics.

Has the "prior burden", in fact, been adequately assumed by those who endorse that all TG varieties that have been released in USA can be presumed to be safe? The celebrated case of the monarch butterfly illustrates why critics are not convinced. Laboratory studies in 1999 showed that pollen obtained from *Bt* corn grown commercially (and fully in accord with regulations) is toxic to the larvae of monarch butterflies (Losey, *et al.*, 1999), thus identifying a hazard that had not been investigated in the risk-assessments conducted prior to approving these crops for use. Subsequently risk-assessments were conducted. They concluded that this hazard did not pose a serious risk in actual practice, except perhaps in the case of one variety of the *Bt* corn – which, the investigators noted, was being phased out from the market (Sears, *et al.*, 2001; and five other articles in the same issue of *Proceedings of the National Academy of Sciences*). *Post hoc* risk-assessment showed that this hazard did not pose a serious risk to the population of monarch butterflies. The toxicity observed in the laboratory was apparently, according to these investigators, an artefact of the quantity of pollen to which the larvae were exposed. This outcome has been interpreted by proponents as further empirical support for the environmental safety of TGs, and the well-functioning of the regulatory system: no harm was done by crops that had passed the regulatory measures, and when a new hazard was subsequently noted the regulatory authorities responded appropriately and successfully to it.

Critics interpret the matter differently, pointing out: (i) This hazard was not identified prior to approval of these crops, and one variety that had significant (though not catastrophic) impact on the larvae was used for several years. (ii) This suggests possible weakness in the hazard-identification processes, and raises the question – one of great salience for risk-assessments of *Bt* crops planted in other countries – of what other non-target insects might be affected adversely by *Bt* crops that have not been identified. These processes appear to involve at their core mere guesswork (or perhaps carelessness or very casual induction based on earlier studies). (iii) When the hazard was identified, there were no procedures in place to deal with investigating it immediately; the response was *ad hoc* (special funding had to be arranged and proposals to carry out the investigation solicited), reflecting that there are no serious mechanisms for on-going scrutiny for risks that might only

become apparent *post hoc*. (See NRC, 2002: 192ff, on the need for continuous "post commercialization testing.") (iv) The recourse to an *ad hoc* response and the expense involved in carrying out the risk-assessments suggest that it is unlikely that thorough comprehensive risk-assessments can be expected generally to be made, especially as the quantity, variety and complexity of TGs increases.

III

Many critics maintain that the process of risk-assessment is marked by guesswork, lacking a systematic means for identifying hazards, dependent on *ad hoc* response mechanisms, with inadequate procedures for enforcing regulations (Pollack, 2003) – and whose investigations are often (but not always – see Giles, 2003) conducted and held confidential by the corporations who conduct most of them and who have an interest in positive outcomes. Then, they may question why it is rational to expect the critics to pick up the burden of proof when the prior burden has only been assumed in a perfunctory way (cf., Powell, 2003). In this way, they question accepting a presumption in favor of **MR'**. But the proponents tend not to be moved. To them, the critics' complaints are misplaced and over-stated, and they ignore not only the already demonstrated and currently anticipated benefits of TGs, but also **NBW**. Why should further steps be taken to deal with (largely unidentified) risks, the proponents say, when there are so many clear benefits to be gained, when the kind of risks that might arise are no different from those that might arise within "conventional" farming, and when there is no serious alternative approach? (In §1, I indicated that critics point to agroecology as a serious alternative.) Without endorsing **NBW**, the presumption in favor of **MR'**, even though it may draw some support from the data of risk-assessments, is considerably weakened. Is there an argument for a presumption in favor of **NBW**?

Paul Thompson (Professor of Philosophy and Agricultural Science at Michigan State University), in arguing that there should be a presumption in favor of "food biotechnology" (and, therefore, in favor of endorsing **MR'**), effectively draws upon the data gained in risk-assessments and his judgment that the risk-assessment procedures are fundamentally sound, and also upon "the late twentieth century social bias in favor of technology ... [the fact that] industrial societies are organized in ways that institutionalize the bias favoring technology," and thus that any alternative approach will be extremely costly (Thompson, 1997: 23-25; see also Thompson, 2003a, b). I interpret this as supporting a presumption in favor of **NBW** – where "reasonably" is understood as "reasonably, given the social realities within which farming must be practiced today."

Then **NBW** is presumed on the basis not of empirical evidence about the possibilities of alternative forms of farming, but of an assessment of social trends that do not permit alternative forms of farming to gain significant space. It makes judgments about the possibilities of alternative forms by taking into account the social context of contemporary farming (it's just "realism"!). Now, the "bias" that Thompson cites is an integral part of adopting what earlier (§1) I called "modern values about the control of natural objects." The social trends that permit little space to alternative forms of farming embody highly the modern values about control (as well as values connected with property and the market which shape the institutions that are the primary bearers of the modern values about control today), and it is *because they do so* that they allow only that little space. Put like this, the presumption in favor of **NBW** is derived from an empirically based social analysis, and need not involve the proponents actually adopting the stated values.[5] But such analysis of actual trends cannot rule out that there are possibilities (that might be actualized by movements which embody competing values) to counter those trends (Lacey, 2002c). Not to take them into account is effectively to adopt the stated values. Certainly when movements that embody competing values develop in "developing" countries and gain some political strength, and the presumption of **NBW** is posed against their endeavors, then holding the stated values is the key support of the presumption – "benefits" are now interpreted so that the furtherance of these values is seen as definitory of "benefits", so that no alternative can genuinely compete. Among those who hold the modern values about control, high standards of "proof" would be required to rebut **NBW**, and one would expect little interest in carrying out relevant investigations on the matter (Lacey, 2000, 2002a, d).

5 The presumption in favor of **NBW**, so defended, might hold in some places (USA) but not others (poor countries). Thompson himself appears hold such a view. He certainly does not think that values like sustainability and empowerment of the poor should be routinely subordinated to the furthering human control over natural objects, especially if that control is mediated by market mechanisms (Thompson 1995, 1997, 2003a).

Critics do not endorse **NBW**. They might even argue that available evidence supports a presumption in favor of **BW** (There is a Better Alternative, e.g., agroecology), at least in certain social spaces. They also question the inevitability and the values (the ones stated above) of the institutions, which are restructuring the world under the "bias favoring technology," e.g., from the perspective of the values of popular participation. They do not deny the actuality of the social trends just referred to and the powerful forces driving them, so that they recognize that no alternatives could be implemented without a struggle (Lacey, 2002c). They also emphasize that the possibilities of alternative forms of agriculture are matters for empirical inquiry – e.g., inquiry that would explore the productive potential of agroecology. (Not to recognize this would be to subordinate scientific inquiry to social interests – Thompson, 2003a: 212.) That inquiry – given that agroecology is concerned simultaneously and interactively with productivity, sustainability, preservation of biodiversity and the empowerment of local communities – will not sharply separate the biological and the social (Altieri, 1998). For agroecology, crop plants and their seeds *are* objects of agroecosystems, and it is an abstraction to consider them simply as biological entities; and this holds also for TGs (Lacey & Barbosa de Oliveira, 2001; Lacey, 2003a). They interpret **MR** so that "TGs" is understood as "TGs in the agroecological systems in which they will actually be used", and so for them risk analysis, which does not take into account the socio-economic context of use and the indirect risks to the environment that might be occasioned by undermining the conditions needed for agroecology to develop, is seriously incomplete (Lacey, 2000, 2002a, d).

Above I indicated how critics may question that a presumption in favor of **MR'** has been properly established. Usually, however, they go further; they question the identification of **MR'** with **MR** and, thus, deny that **MR'** suffices to play its intended role in the legitimation of the widespread use of TGs. Those who hold a view like **MR** usually interpret "environmental hazard" as potential harm that is *directly* due to planting the crops, where "directly" normally means explicable in terms of molecular, genetic and cell biological, plant physiological and "natural" ecological mechanisms (NRC, 2002: 56 ff). Consistent with this, standard risk-assessments consider the causal implications of TG seeds and crops *qua* biological entities (entities studied in the biological sciences), but not their causal implications *qua* members of agroecosystems which have an irreducibly social dimension (Lacey & Barbosa de Oliveira, 2001; Lacey 2003a). On the one hand, they abstract from potential ecological harm that may arise from the socio-economic context of the research/development/use of TGs and, on the other hand, they abstract ecology from social ecology by not addressing potential social harms, e.g., those that might arise from corporate control of the food supply that is furthered through the granting of intellectual property rights for transgenic plants and related engineering procedures (Lacey, 2000; Lacey & Barbosa de Oliveira, 2001). Critics are likely to be wary of any judgments made where these two abstractions are made, and to interpret **MR** in a way that does not make the first abstraction.[6] But such wariness should be expressed explicitly and not be turned simply into the demand for further evidence for **MR'**. That would be obfuscating what is at issue for, to these critics, it is not "more evidence" (more of the same kind of evidence) but "different kinds of evidence" that is at issue.[7]

IV

Considering the planting of TG crops as legitimate and of value depends respectively on endorsing **MR** and **NBW**. Judicious proponents have maintained that there is a presumption in favor of **MR**. (Injudicious proponents maintain that the case for **MR** has effectively been settled scientifically.)

While empirical inquiry (risk assessments) provides an indispensable part of the argument in favor of the presumption, so too does accepting a presumption in favor of **NBW**. The latter presumption is largely based in an appraisal of social realities that, I submit, is ultimately unintelligible unless one endorses the values embodies in the predominant trends of that reality. Critics contest these values, and from the values (of popular participation, §1) they endorse draw strong motivation

6 This is relevant to grasping why critics of TGs tend to be unimpressed by an argument that has recently gained considerable currency: Once **MR'** has been endorsed (following standard risk-assessments), farmers have a right to use TGs (the ones that have passed the risk-assessments) if they choose.

7 Nevertheless, it is not always possible to separate the narrow notion of hazard from social considerations, for what counts as a *serious* hazard often cannot be determined in abstraction from the social context. E.g., one environmental hazard of *Bt* crops is that resistance to the *Bt* toxin will be developed in the target pests. How serious one considers the risks posed by this hazard depends (in part) upon the value that one accords to the organic farming practices that will be disrupted when those pests become resistant. Awareness of this kind of complexity is present in NRC (2002: 236ff) and Thompson (1997, 2003a).

to explore empirically approaches that they see as promising to provide counter evidence to **NBW**. As indicated in §1, they deny the presumption in favor of **NBW**, and thence also that in favor of **MR**. From the perspective of agroecology, e.g., in making the presumption in favor of **NBW** the proponents are not taking into account available empirical evidence that supports that the possibilities of agroecology are considerably more vast than those currently actualized (Altieri, 1998; Lacey, 2002a and the references listed there); they are subordinating scientific to ideological commitments. (This is ironical, since usually the critics are accused of subordinating their scientific judgments to ideology.)

From the critic's own point of view, it does not follow that TGs should be categorically rejected as devoid of value. They do not have compelling evidence that **NBW** is false, only open lines of investigation that promise to come to show this; at most they can claim now that **NBW** has not been established. Perhaps it will turn out that the alternative approaches cannot be developed sufficiently to meet the world's food needs; then TGs might in fact be indispensable (at least in some environments). Then issues about the proper balance of TGs and alternatives would arise. Thus, critics should not reject out of hand research and development of TGs. Nevertheless, they are not unreasonable in questioning the urgency of this, in insisting that risk-assessment needs to be much more encompassing and long-term than current standard risk-assessments, and maintaining that there are more urgent priorities (e.g., developing agroecology). While not unreasonable when considered in the light of available scientific knowledge, they might be judged unreasonable (by proponents) in lacking appropriate "realism" about the state and tendencies of the actual social order or in failing to endorse actual hegemonic values, and thus dismissed in a way that precludes investigation pertaining to **NBW** being conducted.

V

Scientists, *qua* scientists, often need to make judgments concerning matters like **MR** and **NBW**, concerning which less than decisive evidence is available. Clearly, as discussed, such judgments should be based on rigorous empirical inquiry. But the appropriate evidential standards to be utilized must reflect (social) value judgments. To endorse **MR**, e.g., requires making a judgment of the following kind:

> **MR** has sufficient empirical support so that applying it (or acting informed by it) responsibly does not have to take into account that further research might lead to its disconfirmation, and that possible negatively-valued consequences might be produced by applying it (should **NR** actually be false).

This is an instance of a general point, which also applies to **NBW**, made by Rudner almost 50 years ago (Rudner, 1954; see also Lacey, 2003b). The scientist, in making the judgment to endorse (or not) **MR**, makes judgments about the negative value of certain possible consequences. In turn, they will involve further value judgments that take into account the value of expected benefits and others that are linked with the context of investigation of **NBW**. These clearly can differ depending on the full value commitments of the scientist. Whether or not to endorse **MR**, in the light of this, cannot be based solely on available empirical data (or its absence) obtained from risk-assessments, or even from analysis of risks expanded to consider socio-economic mechanisms and long-term and large-scale consequences, and the possibilities of alternative methods of farming. That does not mean that data on these matters is unimportant, only that it is indecisive; then, value judgments influence what count as appropriate standards of evidence and (to some extent) what are the most salient data.[8] Commitment to the modern val-

8 I said above that we should not expect to be able to gain the same degree of empirical support for statements like **MR** and **NBW** and statements expressing the efficacy of particular instances of TG technology. (This is partly connected with the negative existential logical form of these statements.) With the former, but not the latter, the intermingling of evidential (empirical) factors and social values cannot (at present) be avoided. In contrast, concerning matters of efficacy empirical evidence can be decisive. When it is I speak of *accepting* the results, which I distinguish from *endorsing* the former claims. For more on the distinction between *acceptance* and *endorsement* see Lacey (2003d).

When dealing with statements with negative existential form, issues of burden of proof inevitably arise, and where one stands concerning where the burden should be placed will inevitably be affected by the values that one holds. Often, e.g., proponents of TGs insist that there is no *scientific* evidence against **MR**, thereby implying that they have the support of science on their side. Given its logical form, the only evidence for it is (in the long run) the absence of evidence against it. But absence of evidence against it is not *per se* evidence for it – not unless relevant investigations, from which no counter-evidence was obtained, have been conducted, that is, unless the "prior burden" has been assumed. Assuming the "prior burden" is to provide evidence that no specific hazards, which have been identified, occasion serious risks; evidence must be provided against specific claims (grounded either in experimental studies, or field observation, or theoretical analyses) that there is evidence against **MR**. Assuming that burden successfully depends on *appropriate locally available* regulatory oversight. In the framework I am presently considering, once the "prior burden" has been carried, the burden of proof then shifts to the critics. To assume

ues about control inclines one towards endorsing **MR** (or making a presumption in its favor); commitment to the values of popular participation incline one against doing so. Recognizing this makes clear that the dispute about TGs is – to a significant degree – one about social aspirations and the values they reflect and how forms of farming relate to them (cf. NRC, 2002, p.244; Thompson, 2003b). Judgments about risks (including about who should assume the "burden of proof") are integral to the disputes, but they should be located within this bigger picture.[9]

LACEY, H. Investigando os riscos ambientais das sementes transgênicas *Trans/form/ação*, (São Paulo), v. 27 (1), p.111-131, 2004.

- RESUMO: A legitimação de políticas públicas que apóiam o cultivo de lavouras transgênicas em larga escala pressupõe, entre outras condições, (1) que os dados empíricos garantem não haver riscos ambientais não-administráveis e, (2) a não-existência de modos melhores de produzir alimentos sem a utilização de técnicas transgênicas. O artigo discute: (a) Os tipos de investigação científica necessários para um exame adequado da condição (1), (b) como as investigações sobre (1) e (2) se relacionam entre si, e (c) como tais investigações se relacionam com valores sociais controvertidos.

- PALAVRAS-CHAVE: risco; avaliação de risco; transgênicos; controle de objetos naturais; agroecologia.

this "posterior burden" requires identifying further specific hazards for risk-assessment. It involves (as interpreted in the framework) identifying further specific research projects to be carried out – more of the same kind of research that led to the judgment that the "prior burden" had been successfully assumed. The logic here is clear enough: Given the logical form of **MR**, evidence can never be conclusive, and this enables opponents (if sufficiently motivated) always, no matter that evidence has accumulated against specific claims of risks, to keep saying indefinitely – without falling into contradiction – "not enough evidence!" for who knows what the unknown risks may be? Opponents with this kind of stance effectively are putting the matter beyond the purview of scientific research; for them considerations of social values settle the matter without the need for empirical investigation. They do not *endorse* **R**; they opt out of investigation. If there were compelling evidence for **BW**, this might be a reasonable stance to adopt.

9 A version of this article was presented to the 13th Biennial International Conference, Society for Philosophy and Technology, Park City, Utah, July 7–9, 2003. I thank Paul Thompson for many helpful comments made in discussion, and Marcelo Leite for providing me regularly with material pertaining to the discussion of TGs in Brazil. A grant from NSF (SES-0322805) partially supported the research reported in this article (which expresses views of the author and not necessarily those of NSF).

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