Democratic values, technoscientific progress, and the responsibilities of scientists

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1 INTRODUCTION

It is often said that modern science is or should be considered part of the common patrimony of humankind. Certainly it has produced an enormous stock of reliable knowledge and understanding of phenomena of the world, a good deal of which has been used to inform countless applications in technology, medicine and other areas. These applications, which are widely valued positively, have contributed greatly to enhance human powers to act and to solve problems that hitherto had remained intractable, leading to a fundamental transformation of the world we live in.

Yet, for the full picture about science, the following three phenomena need also to be taken into account. First, the principal tendencies of scientific research today are closely tied to technoscientific innovation, economic growth and other commercial interests. Second, the application of scientific knowledge, in the socioeconomic conditions characteristic of modernity, has contributed causally to the current environmental crisis, often accompanied by social and cultural devastation, a crisis that threatens to provoke irreversible environmental and social damage. Third, it has not been a priority for scientific research to produce knowledge that would be adequate to deal with this crisis, or to anticipate further risks that the application of scientific knowledge might occasion; and, in addition, the benefits of technoscientific progress have not been uniformly distributed among rich and poor – worse, under prevailing socioeconomic conditions, many poor people have suffered greatly, materially and socially, as a consequence of this progress. Key democratic values have thereby been weakened – in particular respect for human rights and the capacity of citizens to assume active, responsible, participatory roles in shaping the practices that address their basic necessities.[1]

2 THE RESPONSIBILITIES OF SCIENTISTS

What responsibilities do scientists incur *now* that science is increasingly at the service of technoscientific progress oriented by the interests of economic growth and other commercial interests, and, thus, an accomplice in economic practices that weaken democratic values?

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It is difficult to answer this question. Throughout the modern scientific tradition, an unjustifiably limited conception of scientific methodology has prevailed; and it has reinforced a myopic view of the responsibilities of scientists. No one seriously contests that scientists do acquire some special responsibilities, in virtue of their being scientists; in particular, that they are the ones primarily responsible for determining the priorities of scientific research. According to a widespread view, however, in matters of the application of scientific knowledge, the sole special responsibility of

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[1] These assertions and the argument of this paper are elaborated in Lacey (2008b, 2008c, 2009b).

scientists is to provide objective knowledge that may inform applications; how the knowledge is used (for that is outside of their power), and what the effects of its use, are matters for which the responsibilities of scientists are no different from those of any other citizens. Thus, scientists, qua scientists, cannot be held to bear any special responsibilities for the environmental and social crises and the inequitable distribution of scientific-derived benefits, or for when, on application, scientific knowledge is used to serve (e.g.) the interests of big business corporations (or the military) at the expense of those of poor peoples and their movements (or of the bearers of other values in play in a democratic society).

This view is myopic. It fails to see that, in matters of application, the special responsibilities of scientists must extend beyond that of providing objective knowledge to that of making sure that *all* scientific knowledge that is relevant to an application is generated and considered; and, when it is not, to insist on the need for more research – or (at least) not to lend the authority of science to proposals that remain uncertain in the light of available evidence. All things considered, it may be reasonable to accept that how scientific knowledge is used is outside of the special responsibilities of scientists; but what knowledge is available for application, and whether or not all knowledge relevant to making a particular application is available to be taken into consideration, is inseparable from being responsible for determining the priorities of research

Two kinds of questions are involved when applying scientific knowledge: *efficacy* – will it work? And *legitimacy* – is it legitimate to apply it in the conditions of a proposed application? Deliberations about legitimacy involve ethical value judgments. They also need the input of knowledge, e.g., concerning harmful side-effects, equitable sharing of benefits, and comparison with alternative ways to gain the benefits of the applications. Scientific institutions, however, have lagged in efforts to investigate these matters, and prioritized questions pertaining to efficacy; and so, knowledge that could inform questions of legitimacy is underdeveloped. Scientists and their organizations do share responsibility for this, and because of this – without questioning the primary responsibility of the economic interests associated with economic development – for the environmental crisis.

What are the implications of this for scientists (and for philosophers of science)?

3 OBJECTIVITY, NEUTRALITY AND AUTONOMY

Today, what is normally called 'science' has become virtually identical to technoscience (which I will define below), and much of it with so-called *private-interest science* (Krimsky 2003), i.e., research funded by and oriented to commercial interests, supplemented by government-sponsored research that is oriented by the interest to innovate for the sake of gaining economic benefits.

Private-interest science creates tensions with the fundamental values that the scientific tradition has held to characterize scientific practices, and thereby to ground the authority that scientific results should be accorded. I have identified three such values: *objectivity*, *neutrality* and *autonomy* (Lacey 1999, 2005, 2008a, 2009a). Here are abbreviated formulations of them:

> **OBJECTIVITY**: a hypothesis should become accepted as scientific knowledge only when it is judged to be well supported by available empirical evidence in the light of strict cognitive criteria (e.g., empirical adequacy) that do not reflect particular ethical or social values.
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> **NEUTRALITY**: scientific results, *considered as a whole*, do not support some ethical or social value outlooks at the expense of others, either by way of their *logical implications* or of their *consequences on application*.
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> **AUTONOMY**: (1) issues about proper scientific methodology and the criteria for evaluating scientific knowledge cannot be settled by appeal to ethical outlooks or personal preferences; (2) the priorities of research, for the scientific enterprise as a whole, should not be dominated by the

interests of a particular value outlook; and (3) scientific institutions should be constituted so as to be able to resist external interference.[2]

Objectivity and neutrality provide the ground for the claim that science belongs to the common patrimony of humankind, as well as for the claim that scientific practices and institutions should be granted autonomy. Neutrality and autonomy are hard to reconcile with the *predominance of private-interest science*, whose conduct and outcomes serve well the values of capital and the market (of economic growth and other commercial interests), but not those of (e.g.) sustainability or food sovereignty. This is reflected in *research priorities*: technoscientific innovations are emphasized and their social and environmental impact is under-researched, and issues of great significance for popular social movements are marginalized.

Not only research priorities, however, but also fundamental ***methodological issues*** are at stake. Private-interest science grants virtual exclusivity to one kind of methodological approach, one properly used in research that pursues technoscientific innovations, but not adequate for investigating key issues connected with legitimacy, such as risks and certain types of alternatives. Adequate research on these latter issues cannot be conducted without deploying a pluralism of methodological approaches. To get at what is involved it is helpful to think of a methodological approach as defined by the adoption of what I have called a **strategy**, whose principal roles are:[3]

- to *constrain* the kinds of hypotheses that may be entertained in a research project, specifying the kinds of possibilities that may be explored and conceptual resources that may be deployed; and
- to *provide criteria for selecting* the kinds of empirical data that acceptable theories should fit.

I call the approach, privileged by private-interest science (and also by much of the modern scientific tradition), **the decontextualized approach**. It incorporates strategies (a great variety of them) under which admissible theories are constrained so that they can represent phenomena and encapsulate their possibilities in terms that reflect their lawfulness, thus in terms of their being generable from underlying structures and their components, process and interactions, and the laws that govern them. *Representing phenomena in this way decontextualizes them, by dissociating them from any place they may have in relation to social arrangements, human lives and experience, from any link with human agency, value and sensory qualities, and from whatever possibilities they may gain in virtue of their places in particular social, human and ecological contexts.* Complementing these constraints on admissible theories, empirical data are selected, and reported using descriptive categories that are generally quantitative, and applicable in virtue of measurement, instrumental and experimental operations.

4 TECHNOSCIENCE / METHODOLOGICAL PLURALISM – THE SCOPE OF THE 'SCIENTIFIC'.

All **scientific research*, i.e, all systematic empirically-based inquiry responsive to the norms of objectivity***, is conducted under a strategy. **Technoscience** (as I use the term) refers to research practices conducted within the decontextualized approach, which either keep the horizon of technological innovation in view and often produce results that inform innovations and explain their

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[2] These are contested and often ambiguous notions. More complete formulations of them can be found in Lacey (2008c). I have discussed these and alternative formulations (and terminological variations) in several works (Lacey 1999, 2005, 2008a, 2009a).

[3] The ideas of 'strategy', 'decontextualized approach' 'methodological pluralism' and what characterizes 'scientific research' are elaborated in the works cited in the previous Note. In them, what I now call 'strategies of the decontextualized approach' are called 'materialist strategies'. Summaries of my views on these issues can be found in Lacey (2004), and in the introductions to Lacey (2005) and Lacey (2009a).

efficacy, or whose conduct is dependent on deploying advanced technoscientific products. Science is not reducible to technoscience, for the latter does not encompass all the strategies under which objectively confirmed knowledge may be obtained – in particular, those that permit empirical investigation that integrally takes into account the ecological, experiential, social and cultural dimensions of phenomena and practices. Science permits **methodological pluralism**, without which it cannot hope to deal with all the issues pertinent to deliberations about legitimacy.

I have often used the case of transgenics to illustrate this last claim (Lacey 2005, part 2; Lacey 2006). The pluralism certainly includes the decontextualized approach, which is well exemplified in the research in molecular biology that has led to developments of transgenics. It also includes the strategies needed to pursue investigation in **agroecology**, a form of agriculture that does not use transgenics and that is the favored form of agriculture for many movements of poor farmers in South America – for agroecology investigates the possibilities (clearly contextualized) of agroecosystems with respect to the desiderata: productivity, ecological integrity and preservation of biodiversity, social health, and strengthening of local people's cultures and agency – with a view to discovering the conditions under which the desiderata may or may not be actualized in appropriate balance.[4] The pluralism also includes the strategies needed to investigate the risks occasioned by transgenics, *qua* economic commodities, as well as *qua* biological objects.

Introducing transgenics is an important instrument for growth in powerful sectors of the international economy; and also transgenics are exemplary products of research, development and innovation in technoscience. The interests that foster economic growth are well served by considering it legitimate to expand the use of transgenics widely and rapidly, and hence by acceptance of claims that are part of its legitimating conditions such as 'there are no serious risks' and 'there are no better alternatives'. Evidence accruing against such claims could become an obstacle to economic growth. Thus, it is not surprising that in private-interest science, research on the innovative possibilities of transgenics will be *prioritized*, and that on the legitimating conditions of their use marginalized. It is easily obscured that setting priorities in this way is driven by special interests. It can seem to be the 'scientific' way to go, when scientific institutions endorse virtually exclusively using the decontextualized approach at the expense of alternative strategies, e.g., those involved in agroecological research. When they do this, they effectively identify 'scientific' research with that conducted within the decontextualized approach, and thereby grant virtually unique scientific status to technoscience. Then, arguments and evidence that there are risks that derive from context, and alternatives that are not based on technoscientific innovations, will (by definition) almost always be considered not 'scientific'.

5 THE SPACE OF ALTERNATIVES

Prioritizing economic growth reinforces, and is reinforced by, granting virtually unique scientific status to technoscience (see Lacey 2008d, section 4) and, by not taking methodological pluralism seriously, leaving under-developed the strategies needed to investigate threats to environmental and social sustainability that often have human rights dimensions. In contrast, taking sustainability to be a primary objective, to be well balanced with economic activities that engender well-being for all human beings, reinforces the necessity for methodological pluralism that is needed to investigate the full range of issues pertaining to the legitimacy of technoscientific innovations. It also motivates attempting, for each technoscientific innovation that is being pursued, to locate it within a **space of alternatives**.

What is a space of alternatives? That will depend on what the anticipated benefits are. In the case of transgenics, alleged benefits of universal value are easy to specify, *viz*., meeting the world's food and nutrition needs for the foreseeable future. So, identifying the space of alternatives, would be a response

[4] For details and references on agroecology – and also pertaining to the discussion that follows on risks and legitimacy, see (Lacey 2005: Part 2; 2006a).

to the question: "what agricultural methods and in what combinations and with what variations,[5] *could* be *sustainable* and *sufficiently productive*, when accompanied by viable distribution methods, to meet the food and nutrition needs of the whole world's population in the foreseeable future?" Questions like this may be posed for every technoscientific innovation (Lacey 2008b) – answering them depends on methodological pluralism.

When the alleged benefit is meeting a particular need (hunger, food security, energy production), identifying the space of alternatives should take into account that the innovation is not only a physical (biological) object, open to investigation within the decontextualized approach, but also a socioeconomic object, and it should involve investigating, under appropriate strategies, the historical and socioeconomic causal context of the need. Moreover, the questions raised should include: Does the proposed solution deal with the causes that have brought the problem about and maintain it? Is it to be implemented within the same system that generates these causes and, if so, is it likely to entrench or alleviate the need, or create new (equally or more serious) ones? Will it have positive impact on the interests and values of those who are experiencing the need? How does it fare, on these matters, compared to potential alternatives that are entertained by those who take the causal nexus of the need into account?

Where technoscientific innovation is pursued and implemented, instead of these questions being considered, problems are usually defined so that the space of alternatives only includes possible 'solutions' by means of technoscientific innovation. Each problem is reduced to a set of discrete sub-problems, each defined in physical, chemical, biochemical or biological terms, in dissociation from the socioeconomic causal nexus in which it is located. This is to ignore that this nexus may unite the various sub-problems into a whole that can be addressed by research conducted under appropriate strategies, not all of which may fit into the decontextualized approach. The approach of technoscience effectively presupposes that this is not so, although whether it is or not so is, broadly speaking, a matter open to empirical inquiry (although inquiry conducted exclusively within the decontextualized approach could not be sufficient to resolve the matter).

This is nicely illustrated in the case of 'golden rice', a transgenic that produces beta-carotene in the endosperm of rice, proposed as a solution for the problem of vitamin A deficiencies in the diets of children in impoverished regions.[6] Vitamin A shortage, however, is a component of malnutrition, which is maintained by the prevailing socioeconomic system and the political forces allied with it. Golden rice is plausibly part of the solution to malnutrition only if, one by one, we can deal with its every dimension in a similar way and in practice add them up together. Moreover, even if the regular ingestion of golden rice does reduce vitamin A deficiency, the development of golden rice will not lead to this happening unless the means to purchase or acquire it are available for the relevant children. Golden rice without fundamental socioeconomic change cannot solve the problem of vitamin A deficiency; and it barely touches the more encompassing problem of malnutrition. However, the biotechnological research that has produced golden rice, does not utilize the strategies necessary to explore the socioeconomic causes of malnutrition, and the social effects (positive or negative) of the transformation of farming that would be needed to grow golden rice on a large scale. In addition, it does not consider that the space of alternatives should include not only currently conventional and transgenics-oriented forms of agriculture, whose central features are informed by technoscience, but also agroecology and various types of organic farming (see Note 5), whose defining features do not depend on using technoscientific objects and procedures.

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[5] Elsewhere, I listed as in the range of relevant alternatives, the following: 'conventional', transgenic *and* other alternatives, such as organic, subsistence, biodynamic, agroecological, ecologically sustainable, permaculture, the 'system of rice intensification', and others adapted for use in urban settings (Lacey & Lacey 2009).

[6] For details about golden rice, the analysis of this paragraph and references, see Lacey (2005: ch. 8; 2006a: ch. 3).

In general, defining the space of alternatives should not be constrained by the empirically non-confirmed presupposition that technoscientific innovations suffice for solving social problems. Rather, objects should be characterized in all appropriate ways: not only in physical, chemical, biochemical, electronic, etc terms (the terms pertinent to explaining their efficacy), but also as objects with roles in ecological systems and socioeconomic activities, which may have far-reaching effects that cannot begin to be anticipated by conducting research only within the decontextualized approach. The space of alternatives, no doubt, will (and should) include technoscientific alternatives: in the case of energy, e.g., uses of fossil fuel, biofuels, nuclear energy, wind and solar power, etc; but also alternatives that (although they may have technoscientific aspects) are characterized largely in terms of their capacity to reduce energy use through socioeconomic and lifestyle rearrangements.

The space of alternatives needs to be characterized so as to enable empirical investigation pertinent to the question, "Which alternative, all things considered, is best?" – and with variations depending on how "best" may be interpreted differently from different value outlooks. Today, however, in private-interest science, with its reduction of science to technoscience, the space of alternatives tends to be narrowed to include effectively only those alternatives that are realizable within the trajectory of currently dominant capitalism, and so to what is acceptable for particular socioeconomic interests (although this is articulated as what can be informed by 'scientific research') – and sometimes, it appears, this constraint is taken to be a condition of legitimacy. Then, the outcomes of empirical inquiry are limited so that these interests are served, and other alternatives are dismissed, not because – in the course of empirically-based inquiry – they are confirmed to be impossible to bring about, but because they are considered to be not worth investigating. Narrowing the space of alternatives in this way effectively presupposes that risks to sustainability and violating human rights are not of primary importance. This leaves questions about legitimacy in the hands of the predominant powers and their interests, instead of being informed (where they can be) by empirically based results – and it undermines efforts to strengthen the three values that underlie according esteem and authority to science: objectivity, neutrality and autonomy (introduced in §3).

6 UNDERMINING OBJECTIVITY, NEUTRALITY AND AUTONOMY

In private-interest science, these values are under threat. *Objectivity* is weakened, and sometimes the discourse of science becomes barely distinguishable from the rhetoric of advertising or political campaigns, because (ignoring methodological pluralism) scientific authorities put their weight behind dubious claims that cannot be adequately addressed within the limitations of the decontextualized approach. When the authority of science is put behind, e.g., the claim, "there is no scientific evidence that there are serious risks", it often misleads by insinuating that compelling scientific evidence supports that there are no significant risks. When put behind, e.g., "we are on the verge of solving the food and nutrition problems of the poor in developing countries", it counts on its audience to assume that this represents more than just the hope that 'technoscience will deliver'. And, when put behind 'there are no alternatives' it comes close to misidentifying this claim with 'there are no alternatives within the trajectory of capital and the market' (Lacey 2005, ch. 10; Lacey 2006a, ch. 5).

Furthermore, neutrality and autonomy cease to be able to function as regulatory ideals, because the scientific results that are properly accepted (those that inform efficacy), despite their accord with objectivity, on application serve commercial interests especially well, often to the detriment of less-powerful interests. Moreover, as discussed earlier, this is fostered by the current trend, whereby research priorities and methodologies become subordinated to commercial interests.

The tension with neutrality and autonomy is linked with the attitude, usually found among participants in private-interest science, that regulation of technoscientific innovation should be 'science-based', and should only be introduced when positive evidence is at hand that harm is being caused. But, this is tantamount to holding the ethical principle, which I call **the principle of presupposing the legitimacy of technoscientific innovations**: 'normally, unless currently available evidence confirms that there are serious risks, it is *legitimate* to implement – *without delay* – efficacious applications of objectively confirmed technoscientific knowledge, and even to tolerate a measure of social and environmental disruption for its sake'.

This principle is opposed to the **Precautionary Principle**, which proposes delays in the implementation of technoscientific innovations pending adequate research being conducted on the full array of risks (including indirect ones) and alternatives. The Precautionary Principle is inseparable from the general ethical stance that it is *irresponsible* to engage in the kind of research that leads to technoscientific innovations, *unless* commensurate systematic and rigorous research is also conducted on the long-term ecological and social consequences (risks) of implementing them (with appropriate long-term monitoring), taking into account the socioeconomic conditions of the planned implementations, and *unless* adequate research, located in a well chosen space of alternatives, pertinent to appraising the general social value (benefits) of the implementations is conducted. The Precautionary Principle poses no threats to objectivity, and – by opening up spaces closed by private interest science – it enables the ideals of neutrality and autonomy to be more closely approached.[7]

7 THE RESPONSIBILITIES OF SCIENTISTS TODAY

At the beginning of §2, I asked: What responsibilities do scientists incur now that science is increasingly at the service of technoscientific progress oriented by the interests of economic growth and other commercial interests, and, thus, an accomplice in economic practices that weaken democratic values?

My answer is that, *first* and foremost, their responsibility, *qua* scientists, is to act – as worked out collectively in their institutions and organizations – in order to bring scientific practices more into accord with the regulative ideals of objectivity, neutrality and autonomy.[8] In the *second* place, exercising this responsibility today, when private-interest science is increasingly dominant, is furthered by adopting the Precautionary Principle and the ethical and social values embodied in it, and participatory democracy one of them – and, going beyond this, by engaging in scientific practices that are responsive to the question: How to pursue scientific investigation so that nature is respected, its regenerative powers not further undermined and restored wherever possible, and the well-being of everyone everywhere furthered (Lacey 2008c)? When scientists do not exercise their responsibilities well, as they do not in private-interest science, there can be no sound objection, based on the 'autonomy' of science, to citizens demanding roles in directing, monitoring and evaluating scientific projects, and determining the priorities for publicly funded research, for democratic purposes.

Exercising this responsibility, thus, requires engaging in research that simultaneously reflects the two interests: (1) of furthering the realization of the traditional regulative ideals of modern science and (2) of putting science at the service of sustainability and general human well-being. Since it cuts against the grain of current mainstream scientific practices, it is not an easy task, and attempting to exercise it will involve efforts to re-institutionalize science (Lacey 2009b) following a very complex dialectic, which would require – cooperatively, simultaneously and in interaction – expanding successful achievements on each of the following matters (and, no doubt, others):

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[7] These two principles are discussed more fully in Lacey (2008b). On the compatibility of the Precautionary Principle with autonomy, see Lacey (2006b).

[8] Dominique Pestre urges us to embrace "the duty of objectivity" (Pestre 2008). Scientists can exercise well their responsibilities, *qua* democratic citizens, by exercising well their responsibilities, *qua* scientists, and that is furthered today by holding ethical and social values that contest those that are served by private-interest science, in which (when dealing with issues of legitimacy) the traditional values of science are subordinated to the values of capital and the market.

1. Gaining space in current institutions – especially universities since they are not (yet!) totally dominated by commercially related interests – in order to successfully conduct research in which these two interests can be pursued, no doubt now on a small scale, but in as many areas as possible. (Agroecology is an example; other examples need to be identified for research in medicine, energy, computers and information, communication, biotechnology, etc; and long-term research on environmental problems, global warming, etc).
2. Steps towards strengthening autonomy (as defined above) in research institutions.[9] This means *freeing them from* the disproportionate influence of the values of capital and the market in setting the priorities of scientific research and determining appropriate methodologies, and from the interference derived from holding these values in the conduct of science (e.g., via legal imposition of regimes of intellectual property rights). These steps are proposed *in order that* research be conducted not only rigorously in the light of the ideal of *objectivity*, but also to strengthen *neutrality* by greater inclusion (and funding for the work) of investigators, whose horizon is not technoscientific innovation linked with furthering economic growth, and who pursue investigation that can inform the interests nurtured by values that compete with those of capital and the market (e.g., environmental sustainability and food sovereignty). Taking the steps would contribute to making the results of scientific research available to serve a growing array of interests; and, for the sake of moving towards *neutrality* (understood as implying *inclusivity*), it would give priority to the interests of poor and marginalized peoples, and other interests (like redressing global warming) that pertain to the viability of future human life (Lacey 2009b).
3. More widespread adoption of the Precautionary Principle in research institutions, and incorporation of it in public science policies, so that technoscientific innovation becomes more subordinated to the values expressed in it; and the kinds of research on risks and alternatives, which its use shows to be needed, become conducted more extensively.
4. The growth of – and active collaboration among – movements that aspire to democratic values, including the protection of human rights (the full range of economic/social/cultural as well as civil/political rights recognized in the UN Declaration of Human Rights) and to strengthening of local people's agency, enabling them to engage successfully in activities – including knowledge-gaining practices – they have devised to embody these values more fully in their locales. (In this context I suggest paying special attention to the value of local and national food sovereignty.)[10]
5. The expansion and improvement of practices that are informed by knowledge gained in the research (referred to in items 1 and 4), so that interests from all value outlooks viably held in contemporary society are able to benefit from the input of scientific knowledge.
6. The growth of movements, institutions and programs in which researchers, practitioners and citizens collaborate – including some programs for educating citizens to be able to be intelligent participants in deliberations on science policy matters; and others for scientists to learn from citizens what they consider the principal problems and interests that need to be addressed, and how they experience the problems and perceive the causal networks that bring about and maintain the problems. The participation of scientists, industry and the public is needed to work out how the re-institutionalized science would work, and to create examples showing how democratic and multicultural participation might enhance science.
7. Universities and other educational institutions developing appropriate forms of scientific education, and designing and implementing schedules and conditions of work for their personnel (teachers, researchers, students), that are in tune with scientists acting on the two interests stated above, rather than being caught up in the 'rat-race' towards more and hasty specialization.

[9] For discussion of opposed views of autonomy, see Lacey (2008c).

[10] See Lacey (2009b); Lacey & Lacey (2009).

8. Development and enactment of appropriate public policies that reflect democratic values. (Again, importance of food sovereignty.)

To some extent each of these matters can begin to be addressed relatively independently of the others, but fuller development would depend on interaction among them and, in the long run, unless all of them are developed, each one of them will be curtailed. The conditions for scientists to respond to the two interests cannot be put in place without an extended struggle. I take these eight matters to define points of entry into that struggle that can be pursued immediately. Unless they are pursued, the trajectory of science becoming more and more ‘private interest science’ will remain unchecked.

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