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Scientific Research, Technological Innovation And The Agenda Of Social Justice, Democratic Participation And Sustainability

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ABSTRACT

Modern science, whose methodologies give special privilege to using decontextualizing strategies and downplay the role of context-sensitive strategies, have been extraordinarily successful in producing knowledge whose applications have transformed the shape of the lifeworld. Nevertheless, I argue that how the mainstream of the modern scientific tradition interprets the nature and objectives of science is incoherent; and that today there are two competing interpretations of scientific activities that are coherent and that maintain continuity with the success of the tradition: "commercially-oriented technoscience" (CT) and "multi-strategy research" (MS). The greater part of this article is devoted to discussing what is involved in MS, by pointing to its positive research program in three areas ("social technology", agroecology and food sovereignty), and its critical stance towards the innovations of CT, especially insofar as it makes use of the Precautionary Principle. In this way important dimensions of the agenda of science and technology for social justice, democratic participation and sustainability become clear.

Keywords • Decontextualizing strategies. Context-sensitive strategies. Commercially-oriented technoscience. Multi-strategy research. Precautionary Principle. Agroecology. Food sovereignty.

Science and technology for social justice, democratic participation and sustainability (S/T-SJDPS) refers to scientific activities and technological developments carried out in response to the question: "How should scientific research be conducted, and by whom, with what priorities and using what kinds of methodologies, and how should technologies be developed and administered, so as to ensure that nature is respected, that its regenerative powers are not further undermined and restored wherever possible, and that the rights, well being and conditions for constructive participation in a democratic society, are enhanced for everyone everywhere?" (Lacey, 2008b; 2014). I have discussed what is involved in engaging in S/T-SJDPS in Lacey & Mariconda (in press) and Lacey (in press). In this article, I will summarize ideas and arguments that have been elaborated extensively in these articles.

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Critics have charged that posing this question is misguided because, they say, it runs counter to the ideal of neutrality – i.e. the ideal that scientific knowledge and technologies are available (in principle) to be used by all parties regardless of the values they hold – to link scientific research and technological innovation (as distinct from their applications and uses) with any particular values. Nevertheless, posing it gains traction from the fact that the hegemonic institutionalized practices of science and technology today are themselves subordinated to particular values – of technological progress [V_{TP}] (section 1.2.1) and of capital and the market [$V_{C\&M}$] – and they often weaken the embodiment of the values of social justice, democratic participation and sustainability [V_{SJDPS}] (section 1.2.2). Thus, it would appear that the same charge of running counter to neutrality could be made of mainstream scientific practices. Despite this, the critics' complaint has not been easy to dismiss, for mainstream scientists tend not to recognize that their research is subordinated to particular values in this way; and so the appeal to neutrality seems to carry weight against the sound scientific credentials of S/T-SJPDS, but not against engaging in current mainstream scientific and technological research. It will help to clear the ground for answering the question that I have posed to understand what lies behind this attitude. Its roots, I maintain, lie in widely-held views about the nature of scientific investigation. Elsewhere (cf. Lacey, 1999; 2005; 2008a; 2010), I have developed a detailed account of scientific investigation, the role of methodological strategies in it, and a model of the interactions of scientific activities and values (cf. Lacey & Mariconda, in press). In the next section, I will rapidly summarize some aspects of it – leaving aside nuances, qualifications, elaboration of concepts, and references that can be found in these publications – for the sake of exposing these roots.

1 Some characteristics of scientific methodology

Conducting a scientific research project requires the adoption of a methodological strategy – i.e., specifying constraints on the kinds of hypotheses, models and theories that may be entertained in it, identifying the kinds of possibilities that may be explored and conceptual resources that may be deployed, and criteria for selecting the kinds of empirical data to procure, of what phenomena, and using what kinds of descriptive categories and data-gathering mechanisms and procedures (Lacey, 2005, ch. 1). Investigating different kinds of phenomena may require adopting different kinds of strategies (section 1.3.1): e.g., one kind to investigate the genomes of plants and engineer-

ing techniques for modifying them; another to investigate their effects on health and environment in the lifeworld contexts in which the plants and their products are actually used.

1.1 Decontextualizing strategies

What I call "decontextualizing strategies" [DSs] have been privileged, almost to the point of exclusivity, in modern natural science (Lacey, 1999, ch. 5 – in which, DSs are called "materialist strategies"). Under DSs, admissible theories are constrained so that they can represent phenomena and encapsulate their possibilities in terms of how they are related to their underlying order: underlying structures and their components, processes and interactions, and the laws (mathematical) that govern them; and empirical data are selected, procured and reported using descriptive categories that generally are quantitative, and obtained by measurement, instrumental, experimental and computer-assisted interventions. Representing phenomena in this way dissociates them from their contexts in the lifeworld: from their links with human agency, value, sensory qualities and social arrangements, and from possibilities they may gain in virtue of their places in particular social, human and ecological contexts; and the categories used in theories, developed under DSs, do not include the intentional and evaluative ones often used for descriptive and prescriptive ends in the lifeworld.

Adopting DSs has proved to be remarkably fruitful and versatile: Fruitful – it has enabled an enormous amount of knowledge to be accumulated of the underlying causal order of phenomena in the world, and countless hitherto unknown possibilities for human action to be identified. Versatile – new kinds of DSs regularly are devised to deal with phenomena whose features have resisted the grasp of earlier ones: e.g., Newtonian methodology replaced Cartesian methodology in order to explain adequately the motions of the planets; in quantum mechanics, methodologies permitting the use of probabilistic laws were introduced to deal with subatomic phenomena; and some theoretical biologists have rejected reductionist methodologies in favor of models incorporating mathematical complexity. Adopting DSs and exploiting the versatility they offer have enabled celebrated discoveries of laws, constituents and processes of the universe (in "basic" scientific research), as well a large stock of knowledge that informs technological and (e.g.) medical innovations, and that explains under what conditions their use is efficacious.

1.2 Mutually reinforcing relations between adopting strategies and adhering to value-outlooks

There are complex mutually reinforcing relations between adopting the strategies of a research project and holding values that are embodied in practices and institutions in the lifeworld; and holding these values often contributes to explain why certain types of strategies are adopted (cf. Lacey & Mariconda, in press; Lacey, 2005, ch. 1).

1.2.1 Relations between adopting decontextualizing strategies and holding the values of technological progress

Worthy of special notice are mutually reinforcing relations between adopting DSs and holding the value-outlook, V_{TP}, that derives from taking control ("the domination of nature") to be the characteristic human stance towards natural objects. The following are values in contemporary versions of V_{TP} (Lacey, 1999; ch. 6, where "V_{TP}" is called "the modern valuation of control"; 2012, section 4.3):

> **(i)** exercising control over natural objects;
> **(ii)** expanding human technical capacity to exercise such control – to do, to make, to observe (measure), to innovate, to intervene including into the very small and the molecular biological, and for overcoming communication barriers and going to new places – in an increasing variety of domains;
> **(iii)** the penetration of technologies, informed by knowledge gained in research conducted under DSs [DS-research], into ever more domains of human and social life;
> **(iv)** the definition of human, social and ecological problems in terms that permit solutions using innovations derived from DS-research.
> **(v)** Moreover, for V_{TP} **(v)** these values are not systematically subordinated to interests connected with other values.

What is most distinctive about V_{TP} is **(v)**. Probably all value outlooks include **(i)** as a value, and many contain qualified versions of **(ii)**-**(iv)** in which they are subordinated to other values.

1.2.2 Relations between adopting strategies of S/T-SJDPS and holding the values of social justice, democratic participation and sustainability

The grounds for some other value outlooks involve rejecting that control is the characteristic human stance towards natural objects, and subordinating control to stances towards natural objects that further sustainability: e.g., respect, conserve/restore, harmonize with, cultivate, contemplate, enjoy. These stances are integral to forms of life that embody the value outlook, V_{SJPTS}, and that contest the social relations that are required for the furtherance of V_{TP} (cf. Lacey, in press). They can be found particularly in the World Social Forum (WSF) and in the social movements that it includes. I have drawn the following list of values (articulated in a way that points to contrasts with items of $V_{C\&M}$) based on my reading of a lot of their documents: Solidarity in balance with individual autonomy; social goods ranked above private property and profits; the well being and agency of everyone and their communities ranked above the market; strengthening a plurality of values in place of emphasizing commodification; human emancipation in balance with individual liberty and economic efficiency; rights of the marginalized, and equity within and between generations, ranked above interests of property; taking responsibility for the future instead of resignation in face of the projects of the powerful; democracy enriched with participatory mechanisms and not limited to formal democracy; proper balance of civil/political and social/economic/cultural rights. As articulated here, V_{SJPTS} should be considered an ideal type. The movements of WSF themselves tend to articulate their aspirations by reference to various values in the list, which can be expressed in a great variety of local idioms. How well their actions actually match their aspirations varies from case to case.

Just as there are mutually reinforcing relations between adopting DSs and holding V_{TP}, there are such relations between adopting strategies of S/T-SJDPS and holding V_{SJPTS} (see section 3.2).

1.3 Neutrality: a matter for empirical inquiry

Theoretical categories, utilized by DSs, include no value categories; and so DS-derived results can have no value judgments among their logical implications. This logical fact tells us nothing, however, about the empirical claim that scientific knowledge and technologies are neutral, i.e., that they – considered as a whole, not necessarily item by item (cf. Lacey & Mariconda, in press, section 2.5) – are available (in principle) to be used in valued ways by all parties regardless of the values they hold. They are neutral (inclusive and evenhanded) if, for each viable value outlook, there are some items in

the total stock of available scientific knowledge and technologies that can be of service to it, provided that (in principle) some value outlooks are not served disproportionately and at the expense of others. I wrote above that the appeal to neutrality seems to carry weight in mainstream scientific institutions against engaging in S/T-SJDPS, but not against engaging in current mainstream scientific and technological research. Certainly, scientific research conducted under DSs does not use categories that could be used in making value judgments, and it differs from some research conducted in S/T-SJDPS in this respect. However, I have maintained that the only significant and potentially viable sense of "neutrality" worth considering is that of "inclusivity and evenhandedness" (Lacey, 2013a), and scientific research conducted under DSs is not neutral in this sense.

The historical record demonstrates that DS-research is fruitful and versatile, and we may anticipate that it will continue to be so for the foreseeable future; and it endorses that many technologies informed by its results are almost universally valued. It does not endorse, however, that DS-research produces results that generally are neutral, or that inclusivity and evenhandedness functions as an ideal for it. Rather, it endorses that V_{TP} and $V_{C\&M}$ are served disproportionately well, and often at the expense of V_{SJDPS} – consider, e.g., that DSs are appropriate to investigate the possibilities of transgenics, which serve interests connected with $V_{C\&M}$ well, but undermine the embodiment of V_{SJDPS} (cf. Lacey, 2005, part 2).

1.3.1 Strategic pluralism

The argument, just sketched, draws upon empirical claims (about neutrality not being realizable by research conducted under DSs). Investigation that could test these claims must take into account contextual factors, and so DSs alone do not suffice for it. DSs suffice for investigating many phenomena and the underlying order of all phenomena, as well as for research that aims to produce technoscientific innovations – but not for all scientific research, specifically for that where contextual factors (historical, geographical, social, ecological, etc) are causally relevant, including e.g., that conducted on sustainable agroecosystems (a matter of importance for V_{SJDPS}). I take it that (in summary):

> **(A)** Scientific research is systematic empirical inquiry, held to the commonly accepted standards for cognitive appraisal,[1] conducted under strat-

1 Mainstream scientists and proponents of S/T-SJDPS do not disagree about these standards, and so I will not elaborate them now. I note only that they include "responsiveness to the ideal of impartiality" (Lacey, 2011). According to

> egies that are apt for gaining knowledge and understanding of the kind of phenomena being investigated (cf. Lacey, 2005, ch. 3; Lacey & Mariconda, in press).

(A) is consistent with strategic (methodological) pluralism, the proposal that adequate research on some phenomena needs to be conducted using, in addition to a variety of DSs, strategies that are not reducible to DSs, strategies that I call "context-sensitive strategies" (CSs). Sustainable agroecosystems, and risks of and alternatives to technoscientific innovations, provide examples of such phenomena; others include human agency, social history, and the tension just discussed between neutrality (inclusivity and evenhandedness) and the exclusive use of SDs. CSs have been used successfully to obtain soundly confirmed results, as illustrated by the case of agroecology (section 4.1.2). Sometimes the aims of science cannot be well served without deploying CSs; and, without them, inclusivity and evenhandedness cannot plausibly be considered to be an ideal of scientific practice (cf. Lacey, 2013a; Lacey & Mariconda, in press).

2 Traditional interpretation of scientific research

Nevertheless, instead of **(A)**, a more limited interpretation of what constitutes scientific research has held a firm grip throughout the modern scientific tradition:

> **(B)** Scientific research is systematic inquiry, held to the commonly accepted standards for cognitive appraisal, conducted under DSs (cf. Lacey & Mariconda, in press).

The fact that **(B)** is rarely contested explains, in large part, why scientists prioritize questions that can be dealt with under DSs concerning technoscientific innovation and its efficacy, but attend much less to key issues – about risks, benefits and alternatives – relevant to the legitimacy of implementing the innovations.

impartiality, a hypothesis becomes accepted as scientific knowledge, or a theory as well confirmed of a specified domain of phenomena, only when it is judged to be well supported by available empirical evidence in the light of strictly cognitive criteria that do not reflect particular ethical or social values, and only after it has been tested in the course of an appropriate program of empirical/experimental research that also thoroughly tests competing hypotheses (cf. Lacey, 2014; Lacey & Mariconda, in press). Being in accord with impartiality does not imply being in accord with neutrality.

2.1 Adopting DSs virtually exclusively and its traditional roots

Are there good reasons to prioritize the use of DSs to the point of virtual exclusivity, and to marginalize CSs and questions about the phenomena, for whose investigation they are needed? One reason that has wide currency is that DSs provide the key to the pursuit of two complementary objectives (respectively, Cartesian and Baconian):

> **(a)** gaining comprehensive understanding of the phenomena, structures and laws of the world; and
> **(b)** augmenting human capacities to exercise control over natural objects – to do, to make, to observe, to innovate, to intervene – and hence to strengthen the embodiment of V_{TP} in the lifeworld.

The Cartesian objective is said to be furthered most clearly in "basic" science, i.e., research conducted under DSs for the sake of expanding understanding of the underlying order of phenomena of the world, without immediate concern for whether and how its results might serve the Baconian objective. As the versatility of DSs is exploited, basic research produces understanding of an increasing number and variety of phenomena; and that fact, combined with affirming materialist metaphysics – i.e., the view that all phenomena are explicable in terms of their underlying order (cf. Lacey, 2009) – supports that (in principle) no phenomenon falls outside of the reach of DSs. At the same time, reflecting the mutually reinforcing relations between adopting DSs and holding V_{TP}, basic research contributes towards furthering the Baconian objective; and, conversely, novel technological innovations (applications of DS-research combined with relatively independent technological developments fueled by technical ingenuity) help to devise the instruments needed to further research conducted under DSs.

The combination of the fruitfulness and versatility of DSs, the mutually reinforcing relations between adopting them and holding V_{TP}, and compelling grounds for holding V_{TP} (if there are any), would provide good reasons to prioritize using DSs, perhaps even to the point of exclusivity. I mentioned above that holding V_{TP} derives from taking control to be the characteristic human stance towards natural objects; it then would follow that adopting DSs is the key to transforming the world in ways that serve human well-being in general. In the tradition, the conclusion has often been drawn from this that V_{TP} is effectively a universal value-outlook, a component of any viable outlook today – and neutrality is taken to follow from this conclusion.

We may summarize the interpretation of modern science associated with **(B)** using the following schema:

> **{1}**: Modern science —> DSs + CU {from fruitfulness, versatility + materialist metaphysics} + N {from control as characteristic stance towards natural objects} + S + ...,

where CU = comprehensive understanding; N = neutrality; S = commonly accepted standards for cognitive appraisal (see note 1); and ... = other components (e.g., autonomy, that I will not discuss in this article).

According to **{1}**, scientific research is neutral; and so, in principle, its results could be put to use to serve the interest of strengthening V_{SJDPS}. Hence, while there remain open practical social/political/economic questions about the conditions to bring this about, posing the opening question of this article would indeed be misguided. (The analysis of this subsection, 2.1, is elaborated in Lacey, in press.)

2.2 Incoherence in the traditional interpretation of scientific research

However, broadly empirical considerations, based in investigation conducted under CSs (referred to in 1.3; 1.3.1), challenge that **{1}** is coherent. They include:

> **(i)** Results obtained in research conducted almost exclusively under DSs are not in accordance with neutrality (and have no prospect of becoming so); on the whole they serve $V_{C\&M}$ (as well as V_{TP}) disproportionately well, and many serve $V_{C\&M}$ at the expense of other outlooks, e.g., V_{SJDPS}. Inferring neutrality from the claim that control is the characteristic human way of relating with natural objects does not change this conclusion, for this claim itself does not express a matter of fact, but rests on grounds that are inseparable from holding V_{TP}.
> **(ii)** There are phenomena, whose characteristics (essentially linked to their contexts) render them unsuitable for research conducted exclusively under DSs, that can be investigated using appropriately chosen CSs. Without endorsing materialist metaphysics there is no reason to anticipate that eventually they might be encompassed within DS-research and to hold that the exclusive use of DSs can lead towards comprehensive understanding. Commitment to materialist metaphysics, however, is neither a result nor a presupposition of conducting research under DSs (cf. Lacey, 2009).
> **(iii)** Among the phenomena just referred are collateral effects of technological innovations. Where V_{TP} are held, however, investigations of risks are limited to standard risk analyses (section 4.2.1), which are conducted under DSs – but they (because contextual factors are involved) are unable

to address many risks that arise in the lifeworld, especially long-term environmental and social risks and those that have socio-economic mechanisms (cf. Lacey, 2005, ch. 9). These latter risks are especially significant for those who hold V_{SJDPS}; thus, the claim that using DSs exclusively is responsive to neutrality is further undermined.

3 Coherent interpretations of scientific research that maintain continuity with the scientific tradition

The interpretation of scientific research that has been held widely throughout the modern scientific tradition is summarized in **{1}**. It is riddled with lacunae. Nevertheless, modern science has been manifestly successful in producing knowledge that is soundly accepted according to the commonly accepted standards for cognitive appraisal (see note 1); and, on application, this knowledge has contributed markedly to the transformation of the life world. I suggest that two competing interpretations of scientific research are available that could replace **{1}**. I call them, respectively, "commercially-oriented technoscience" (CT), and "multi-strategy investigation" (MS). Both CT and MS are coherent; and both maintain continuity with the scientific tradition (but in different ways), and incorporate the manifest successes just referred to. CT has become the dominant interpretation in contemporary scientific institutions (cf. Lacey, 2012). I will sketch an argument that MS, which allows space for conducting S/T-SJDPS, offers a compelling competing interpretation.

3.1 Commercially-oriented technoscience

In CT, scientific investigation in identified with research, conducted under SDs, that gives priority to producing technoscientific innovations that could strengthen $V_{C\&M}$ (cf. Lacey, 2012). Comprehensive understanding is put to the side. Certainly basic science is pursued, but principally where it is anticipated that it will lead to obtaining knowledge and techniques (perhaps in the long run) needed for the conduct of research with directly innovative goals; and neutrality is either ignored, or affirmed on the basis of the empirically unsubstantiated claim that technological and economic progress serve the well-being of everyone. (For a more detailed argument, see Lacey, 2012.)

CT is intelligible in view of the mutually reinforcing relations between adopting SDs and holding V_{TP}; and the facts that V_{TP} is widely held and highly embodied in the hegemonic (commercial, government, political, educational, etc.) institutions of to-

day's lifeworld – as is $V_{C\&M}$, and that the institutions that embody $V_{C\&M}$ are the principal bearers of V_{TP} today.

In place of **{1}**, CT may be summarized with the schema:

{2a}: CT —> DSs {(adoption of DSs) <—> (holding V_{TP}) <—> (holding $V_{C\&M}$)} + S + ...

3.2 Multi-strategy investigation

MS incorporates strategic pluralism. For it, DSs retain an essential role in scientific research; and it also deploys CSs to investigate phenomena of special significance for value-outlooks that contest $V_{C\&M}$. Just as adopting DSs exclusively is linked with holding the values of V_{TP}, adopting particular CSs is likely to be linked with holding particular values (often V_{SJDPS}).

Since MS can deal with phenomena that cannot be grasped under DSs, comprehensive understanding is not precluded as an approachable ideal – for reasons, not based on commitment to materialist metaphysics, but in an ample strategic pluralism, [DSs + CSs]. Under the CSs, results may be obtained that serve interests of V_{SJDPS} and whatever other values may be linked with the various CSs. In turn, this opens the possibility of neutrality (inclusivity and evenhandedness) functioning as an ideal.

Then, MS may be summarized with the schema:

{2b}: MS—> [DSs + CSs]{role for many value-outlooks} + CU {from strategic pluralism} + N {inclusivity & evenhandedness} + S + ...

From the perspective of MS, there is nothing misguided about posing the opening question of this article. It is effectively a question about the mix of strategies needed to pursue S/T-SJDPS.

4 Science/technology for social justice, democratic participation and sustainability

What is involved in pursuing S/T-SJDPS? What kinds of strategies would be adopted in research that aims to inform practices that embody V_{SJDPS}? What kind of critical stance does it maintain towards the priorities, practices and innovations of the dominant CT?

4.1 Research, conducted under CSs, that can inform practices that embody V_{SJDPS}

In this subsection, I will briefly describe three of the areas in which research, which utilizes CSs, serves to inform practices that embody V_{SJDPS}. Keep in mind, however, that – although V_{SJDPS} is incompatible with $V_{C\&M}$ (section 1.2.2) – exercising control over natural objects remains a value in it, but subordinated to other values. Hence, adopting S/T-SJDPS allows positive roles for some DS-derived results, and they may be utilized in the areas discussed.

4.1.1 "Social technology"

"Social technology comprises products, techniques and/or replicable methodologies, developed in interaction with communities of marginalized people, that represent effective ways for furthering their inclusion in empowering projects" – where "inclusion" is interpreted in the light of the values of V_{SJDPS}.[2]

Examples can be found in several areas, e.g., energy production and use, public health and medicine, water storage and use, workplace machinery designed for worker control, housing and transportation, open software developments, developments of information and communications technologies that serve deaf and blind people, indigenous management of forests, and others. Regarding energy, e.g., projects aiming towards "energy sovereignty": decentralized systems for the production/distribution of energy that permit optimal use of all alternatives without dependence on a single source and that provide opportunities for small rural communities to achieve energy independence; and regarding water, underground cisterns enable water to be stored with minimal evaporation in arid areas that experience only short periods of rainfall and – when planned, constructed and managed under local control – open up the range and quality of agricultural practices that can be engaged in. Social technologies often come in integrated packages. The ones mentioned readily find integration into agroecology.

4.1.2 Agroecology

Agroecology refers both to a mode of farming and to a body of scientific research/knowledge that informs it. Agroecological is different from "conventional" and transgenic-oriented forms of farming that are capital-intensive and embody $V_{C\&M}$ highly. It aims to satisfy – simultaneously and in a balance determined by farmers and their commu-

2 "Social technology" is not commonly used in this sense in English. It translates the Portuguese, "tecnologia social"; and the definition in the text is taken from the Brazilian Rede de Tecnologia Social (Network of Social Technology) (RTS, 2014) with small modifications derived from Dagnino (2012). For more details, see Lacey (2013b).

nities – a variety of objectives (that reflect V_{SJDPS}) that include: productivity, sustainability of agroecosystems (i.e., their robustness, resilience and adaptability, and conservation of biodiversity), health of members of the farming communities and their surroundings, and strengthening of local people's culture and agency (based on Altieri, 1995).

Many technologies deployed in capital intensive farming, because of the values they incorporate, cannot be inserted into agroecology. Transgenics, e.g, cannot be, for using them requires land on which monocultures can be grown and the availability of large quantities of petrochemical-based fertilizers and agrotoxics, and so their use undermines the conditions needed for agroecological farming. Moreover, since currently transgenics technology is (for the most part) controlled in accordance with intellectual property rights, it could have no place in a farming practice in which its users have control over the conditions of production and distribution. Transgenics are not only biological objects; they are derived from research conducted under DSs, and they embody V_{TP} and $V_{C\&M}$, and undermine the embodiment of V_{SJDPS} (cf. Lacey, 2005, part 2)

In contrast, agroecology utilizes kinds of technology that vary with cultural, geographical and ecological conditions. Context is crucial, and so scientific research in agroecology must deploy varieties of CSs that (among other things) can inform variants and developments of traditional techniques (informed by local and, sometimes, indigenous knowledge), e.g., rotation and diversification of crops, ecological pest management, plantings of polycultures with different varieties and species in appropriate designs, green manures, nutrient recycling, natural fertilizers from locally accessible sources, and selection of seeds from harvested crops for future plantings. In addition, illustrating that what is important is the context of use of technological objects and who has control over their use, some technoscientific innovations derived from DS-research may also have a place, the outcome of collaboration between the primary agents of social inclusion and technical "experts" – e.g., following recent research on "participatory breeding" of crop plants, drought-resistant varieties of maize have been developed using traditional methods of selection, aided by techniques of genomic analysis. (For more details, see Lacey, 2005, ch. 10; in press; and especially Altieri, 1995; Vandermeer, 2011; Nodari & Guerra, in press.)

4.1.3 Food sovereignty

Agroecology is an integral component of the policies and practices of "food sovereignty" that has been defined as "the right of peoples to democratically control or determine the shape of their food system, and to produce sufficient and healthy food in culturally

appropriate and ecologically sustainable ways in and near their territory" (Via Campesina, 2010; for elaboration, see Lacey, 2013c.) The international network of movements of family and small scale farmers, Via Campesina, proposes that these policies and practices offer prospects (not offered by the continued dominance of agribusiness) for further implementing and safeguarding the right to food security for everyone. This proposal is based on the claim that – with the introduction of appropriate public policies, including support for the development of an appropriate variety of social technologies (e.g., of agroecology) and for prioritizing scientific research that might inform them – a multiplicity of complementary locally-specific, locally-chosen, locally-directed approaches to agriculture could be implemented that (when appropriately combined) would simultaneously be: (i) highly productive of nutritious foodstuffs, environmentally sustainable and protective of biodiversity; (ii) more strengthening of communities of rural people and responsive to the variations of their aspirations with place and culture; (iii) applicable to small farms in impoverished regions, and so particularly well suited to ensuring that rural populations are able to resist further incursions of current patterns of hunger; and (iv) able, when accompanied by appropriate locally-oriented distribution methods, to play the major role in producing the food necessary to feed and nourish the world's growing population (cf. Lacey, 2013c). Investigating this claim (and coming either to endorse or to reject it) clearly requires deploying CSs. Proposals about food sovereignty are readily complemented by proposals for energy sovereignty and for public health.

* * *

I asked at the beginning of section 4: What is involved in pursuing S/T-SJDPS? Part of the answer – its positive thrust – can now be summarized in this way: To develop research under the CSs needed to inform and strengthen these areas of social/agricultural practices and others – and (where appropriate) to make use of possibilities opened up by DS-research to serve practices that aim to strengthen the embodiment of V_{SJDPS}.

Another part of the answer – the critical outlook – comes from taking a discerning and precautionary stance towards the innovations of CT, one that involves evaluating the likely benefits (and for whom) of CT-innovations taking into account the results of adequately conducted investigations of their likely harmful consequences and risks (and for whom), and the benefits/risks of alternative courses of action informed by CS-research (like those of section 4.1).

4.2 Stance towards the innovations of CT

4.2.1 Criticism of the role accorded to standard risk analyses in CT

In many public policy and regulatory bodies, investigation of risks of technoscientific innovations is considered to be a purely "technical" matter, to be handled in well conducted "standard risk analyses" (SRAs). In SRAs, potential effects of using an innovation, which have been previously labeled "risks", are described – using categories drawn from theories consolidated in DS-research – in a way that enables their quantitative relations with other factors to be determined and the probabilities of their occurrence estimated. Provided that the SRAs, aiming to test the safety of an innovation (whose efficacy has been confirmed), do not uncover serious risks that cannot be managed through enforcing DS-informed regulations, and provided that "technical experts" judge that sufficient SRAs have been conducted, these policy-making bodies tend to conclude that no further consideration of risks is needed in their deliberations about the legitimacy of using an innovation. Then, they conclude that, ceteris paribus, it is legitimate to introduce the innovation for commercial use without delay – without considering risks that may only be investigated using CSs (thereby tolerating a measure of social and environmental disruption), and without considering the possibilities of alternatives that may depend on input gained using CSs. Where V_{TP} and $V_{C\&M}$ are highly embodied, taking this stance is almost a matter of course. Nevertheless, its claim that risk assessment is "purely technical" obscures the facts that, from the perspective of V_{SJDPS}, investigating risks only in SRAs is deemed insufficient for deliberations of legitimacy, and that using the innovations may undermine conditions needed for developing alternative possibilities that embody values that cannot be embodied together with V_{TP} and $V_{C\&M}$.

Innovations have routinely been implemented in contexts where the sufficiency of SRAs for risk assessments has effectively been assumed. Many of them have enabled significant and widespread benefits (e.g., in medicine and communications) to be obtained. However, at the same time, some of them have contributed significantly to bringing about today's major crises (climate, pollution, devastated ecosystems, energy, violence). Moreover, the harmful consequences, and related risks that may be entailed when this assumption is made, include undermining the conditions for practicing agroecology and otherwise weakening the embodiment of V_{SJDPS}, matters that cannot be investigated under DSs in SRAs (cf. Lacey, 2010, ch. 9).

4.2.2 Taking a precautionary stance

S/T-SJDPS incorporates a more complex stance towards what should enter into deliberations about the legitimacy of using an innovation, whose efficacy has been confirmed (cf. Lacey, 2014; in press). For it, SRAs are insufficient (although necessary), since they do not attend to unintended or ignored consequences and risks that require CSs for their investigation – and do not involve comparison with the benefits/risks of CS-informed alternatives.

Furthermore, SRAs (even when the "technical" experts testify that they have been exhaustively carried out) cannot inform sound decision-making in situations where there is little uncertainty that some harm is risked; but there is ignorance or uncertainty about what specific harms are risked, about their seriousness, likelihood and immanence, and about what the potential of alternatives may be. According to the more complex stance, public policy and regulatory bodies should require that precautionary measures be taken in situations where:

> **(1)** the current state of scientific research/knowledge (derived from DSs and CSs) is consistent with the plausibility of the hypothesis that using an innovation could bring about specified (perhaps irreversible) harmful effects on people, social arrangements or nature, but
> **(2)** evidence is unavailable now to enable us to confirm claims about their seriousness, immanence, and probability of occurrence.

The precautionary measures may involve making interventions for the sake of forestalling or diminishing the possible harmful effects – after taking into account both their seriousness and the possible harmful consequences of the interventions themselves – where evaluation of the ethical seriousness of the possible harm is made taking V_{SJDPS} into account. The interventions may include delaying final decisions about whether, and under what conditions and regulations, to permit using the innovation; and, when permitted, requiring that there be long-term systematic monitoring of its actual effects in the lifeworld, so that decisions could be reviewed and, if warranted, reversed in the light of new evidence that might be found. When delay is proposed, it is for the sake of allowing time for scientific research to be conducted (using, as appropriate, CSs and DSs) – on the one hand, on the possible harmful effects, which include possible long-term ecological and social harm, on the mechanisms (not only physical, chemical and biological, but also socio-economic) that might bring them about, and on how regulations might enable the risks to be minimized; and, on the other hand, on the possibilities and risks of alternative courses of action.

Enacting the precautionary measures in policy deliberations for each particular innovation requires decisions being made pertaining to questions that include:

> **(a)** When is a potential risk of using an innovation in the lifeworld sufficiently serious (ethically) to warrant making an intervention? When to intervene, and with what kind of intervention?
> **(b)** What are its possible harmful effects that need to be investigated? With what order of priority? What methodologies should be used in the investigation? What are the standards appropriate for judgments about the safety of its use in the lifeworld?
> **(c)** Has enough time passed to obtain empirical results sufficient to enable a wise decision to be made about using the innovation?
> **(d)** (After an innovation has been approved for use) has evidence been obtained, in the course of monitoring the use of the innovation, of serious harm being caused by it that is sufficient to warrant withdrawing it from use in the lifeworld?

According to the precautionary stance, decisions on matters like these should be made in the course of democratically-structured deliberations, in which representatives of all relevant stake-holders are included.

4.2.3 Implications of taking a precautionary stance for the conduct of scientific research

The precautionary stance has implications, not only for decision-making about and regulation of CT-innovations, but also for the conduct of scientific research (and the priorities of scientific institutions and organizations). It incorporates that it is irresponsible to engage in the research (conducted with DSs) – e.g., in biotechnology, nanotechnology, neurosciences, geo-engineering, synthetic biology, new genomic technologies, biofuels – aiming to inform CT-innovations, unless two conditions are met:

> **(i)** commensurate research (deploying appropriate CSs) is also conducted on the long-term, often worldwide, potentially irreversible ecological and social consequences of introducing them into the lifeworld, taking into account the socioeconomic conditions of the planned introductions and the actual conditions of use; and, when an innovation is introduced, engaging in long-term monitoring of its consequences in the context of its actual use; and

> **(ii)** adequate research is conducted that investigates the full array of alternatives that might be considered valuable to the citizens of a society.

Robust adherence to the precautionary stance depends on obtaining results from CS-research that can inform alternative practices that embody V_{SJDPS}. It requires that these alternatives be taken into account. When an innovation is being considered for implementation, the precautionary stance leads to posing the questions: What is the range of alternatives that could be available if appropriate research were conducted? And, which alternative, all things considered, is the best alternative – or more to the point, taking into account that "best" is likely be thought of differently in the context of different locations and value perspectives, what appropriately varied and combined set of alternatives is the best way to go? The precautionary stance represents the critical side of S/T-SJDPS; at the same time, by way of its posing questions about the range of alternatives, it links up with its positive thrust.

Concluding remarks

I referred above to critics who charge, on the basis of views about neutrality and the nature of scientific research, that it is misguided to pose the question with which this article opens. There also are critics, for whom this question should be dismissed on the ground that it cuts against the grain of our times. They dismiss it on political grounds: S/T-SJDPS is not an option, because hegemonic powerful interests linked with $V_{C\&M}$ – deploying the whole gamut of political, legal, economic, financial, military and para-military mechanisms – act to prevent it from gaining space to develop. These latter critics also like to don the mantle of science. Of course, their innovations are products of CT-science; but they go on to appeal to the authority of science to claim support for maintaining that there are no viable options outside of the trajectory of $V_{TP}/V_{C\&M}$. My argument shows that this appeal has no credibility.

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