

WELL-ORDERED SCIENCE: THE CASE OF GM CROPS

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ABSTRACT: The debate over the use of genetically-modified (GM) crops is one where the heat to light ratio is often quite low. Both proponents and opponents of GM crops often resort more to rhetoric than argument. This paper attempts to use Philip Kitcher's idea of a "well-ordered science" to bring coherence to the debate. While I cannot, of course, here decide when and where, if at all, GM crops should be used I do show how Kitcher's approach provides a useful framework in which to evaluate the desirability of using GM crops. At the least Kitcher's approach allows us to see that the current state of research in to, and use of, GM crops is very far from the ideal of a well-ordered science and gives us a goal to work towards if we wish to achieve a more well-ordered agricultural policy.

WHAT IS A "WELL-ORDERED SCIENCE"?

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here are, Kitcher tells us, a number of different ways in which the research agendas of science may be set up. Four possible models we might consider are, *Internal Elitism*, which, "consists in decision-making by members of scientific subcommunities," *External Elitism*, which "involves both scientists and a privileged group of outsiders, those with funds to support investigations and the ultimate applications" that is, "paymasters," *Vulgar Democracy*, which, "imagines that the decisions are made by a group that represents (some of) the diverse interests

in the society with advice from scientific experts,” and finally, *Enlightened Democracy*, which, “supposes decisions are made by a group that receives tutoring from scientific experts and accepts input from all perspectives that are relatively widespread in society.”¹

In most societies the status quo is a variety of external elitism that scientists actively try to turn into internal elitism.² Additionally, when the paymasters of external elitism are not governments or universities, but large corporations, there is a strong tendency to pander to the interests of vulgar democracy insofar as this helps sell products made by the corporations in question.³ It is not clear that this is an improvement. Kitcher’s own proposal, “well-ordered science” is meant to be an idealization of the values that he hopes would come from enlightened democracy as a means of setting a scientific agenda. I turn now to the details of this view.

Well-ordered science is not a description of how science is currently structured or practiced. Rather, it is, “Intended as an ideal” towards which we might aim in setting up the governing of science.⁴ This ideal, as a variety of enlightened democracy, results from the process of deliberation of a certain sort, loosely based on the idea of deliberative democracy found in such political theorists as Rawls and Gutmann.⁵ While vulgar democracy tends to lead to the ‘tyranny of the ignorant,’ a dismissal of epistemic significance, and an emphasis on the short-term and ‘hot topics,’⁶ it is hoped that the enlightened democracy favored by well-ordered science will find and use our tutored preferences and so will be able to arrive at the real common good which we should use to order science in a democratic society.

Importantly, however, “The collective good is whatever is identified as such through this ideal democratic deliberation.”⁷ This follows from Kitcher’s rejection of the idea that there is an idea of scientific significance or a goal of and for science independent of our interests. That is to say, the interests of deliberators, or at least ideal deliberators, play a constructive role in the idea of a well-ordered science much like that deliberators play in Rawls’s constructive political theory. Through this, Kitcher hopes to avoid appealing to any sort of interest-independent idea of a goal for science.

Kitcher distinguishes three phases in his ideal inquiry. In the first, decisions are made (by the ideal deliberators) to commit resources to particular projects. In the second, projects are pursued in the most efficient way, subject to the moral constraints, also decided on by the ideal deliberators. Finally, in the third step, the results of the investigation are turned into practical applications, again under the guidance of ideal deliberators.⁸

Ideal deliberators, among other traits, are those who have ‘tutored preferences.’ Without tutored preferences, we get not ‘enlightened’ but rather ‘vulgar democracy.’ Tutored preferences arise when each deliberator is informed of the significance, both epistemic and practical, assigned to a project by the other deliberators.⁹ Assumedly this process involves the deliberators becoming familiar with the scientific significance of a project, even if they cannot become experts in the science.

The next step in Kitcher's model involves an exchange of tutored preferences among the deliberators. This allows for deliberation, not negotiation, among the parties as to what the goals of society are. Next, probabilities of reaching these goals are assigned. If we cannot agree on a definitive list of goals or probabilities, we may defer to a group-chosen set of experts and arbitrators. Finally, the deliberators vote on budgets for the research programs, which must be followed within ethical guidelines also decided on by the deliberators. The result of this process is taken to define that which is best for the community.¹⁰ It is not, however, strictly necessary that we actually follow this process for science to be well-ordered. Rather, what matters is that we have institutions and practices that will mimic the outcome of such an ideal process.¹¹ We may well wonder how we can know that we have such institutions and practices without actually following the process, and may further worry that if one group in society has the ability to dominate others, they will be able to insist that the goals of well-ordered science have been reached, even if they have not. We leave these worries, however, for a deeper discussion.

OBSTACLES TO WELL ORDERED SCIENCE

Kitcher makes note of four obstacles to the realization of a well-ordered science. The first of these is the problem of *Inadequate Representation*. He claims,

A group is inadequately represented when the research agenda and/or the application of research systematically neglects the interests of the members of that group in favor of other members of society. Because of the Nonrepresentational Ratchet an early problem of inadequate representation may be self-perpetuating.¹²

If a group is not adequately represented among the ideal deliberators (or the institutions that serve as proxies for them), then their interests may be systematically ignored. Kitcher elaborates on this idea in two important ways. First, even in a democratic system, we cannot expect the invisible hand to solve this problem. There will always be incentives to ignore the weak and minority groups. Kitcher also insists, however, that the mere lack of numbers of a particular group is not enough to show inadequate representation. This is because it is the interests, and not the mere members, of a group that are important. So long as the interests of a group are represented, it need not matter, Kitcher seems to think, if the actual members represent them.¹³ This is perhaps not completely correct. In practice there is substantial reason to think that the interests of groups with little social power will be miss-represented if they are not actually parties to deliberation, even if the intentions of the powerful groups are good. There is good reason to think, for example, that in a patriarchal society, men will tend to systematically misrepresent the interests of women even if they have no intention to do so. To this extent it seems that actual representation by minority groups and others with less social power is more likely to provide for well-ordered science, and to help avoid the problem of

false consciousness discussed below, than merely trying to take the interests of everyone into account will do.

The second obstacle to a well-ordered science is one we have noted briefly above, the *Tyranny of the Ignorant*. This arises when:

Epistemically significant questions in some sciences may systematically be undervalued because the majority of members of society have no appreciation for the factors that make those questions significant.¹⁴

This problem may arise from the fact that, in any given society, the preferences of the vast majority of the citizens are likely to be untutored. So far as science is based on a type of vulgar democracy, there is a good chance of this unfortunate outcome occurring. Similarly, when scientific paymasters are corporations primarily seeking profits, external elitism will, I think, tend towards this problem. For my purposes I want to add to Kitcher's definition in a way that makes it more obviously applicable to the case of GM crops but that still captures his important idea. I will say that we are also facing cases of the Tyranny of the Ignorant when people's untutored beliefs about the effects of a particular scientific program are the reason for blocking the application of scientific findings. I believe that Kitcher would accept this addition. Importantly, we must also note that not every case where scientists do not receive the resources they think most needful for their projects is a case of the Tyranny of the Ignorant. Tutored preferences need not be identical to the preferences of scientists, so it is possible to be in a state of well-ordered science and yet have scientists feel disappointment over their funding. Finally it is worth noting that many who have formal scientific expertise are often ignorant about other fields—molecular geneticists may be ignorant about ecology and biologists more generally may be ignorant of matters of social causation. Members of traditional societies often have practical knowledge that is unknown to those who would “help” them by introducing new technology. We should expect, then, the tutoring of preferences to flow in multiple directions.¹⁵

The third possible road-block on the path to a well ordered science is the problem of *False Consciousness*. Kitcher says:

A research agenda may conform to the tutored preferences of the majority not because the public reasons for the agenda are those that would figure in an ideal deliberation, but because those reasons misrepresent the agenda in ways that cater to the actual (untutored) preferences of the majority. Because these preferences are not tutored, there may be harmful constraints on the pursuit of inquiry and serious threats to the proper application of its results.¹⁶

Kitcher's example of a case of False Consciousness is the human genomes project, which, he thinks, is not supported by the public for the same reasons it is supported by scientists and their paymasters. The public has been lead to believe that the genomes project will likely produce wide-spread and far-reaching treatments for diseases, and will do so in the short term. In fact, there is little reason to think this is so, and this is not the reason the genomes project is supported by most scientists and their paymasters. Rather, these figures support the genomes project

because they believe it will greatly advance basic knowledge in several fields of biology and also will help the US maintain its lead in biotechnology.¹⁷ These are worthy goals, and may even be goals that the tutored preferences of society would favor, but they are not the actual reasons for supporting the genomes project that most people have. So long as this is the case, science is not well-ordered.

The final obstacle to well-ordered science that Kitcher considers is the case of *Parochial Application*. This results when:

An actual research agenda and a practice of application may be ideally supported by a principle that would license forms of research not currently undertaken or applications of previous research that are not pursued.¹⁸

Suppose, after a course of deliberation, we decide that one of the goals of science in our society ought to be “reducing cancer.” We might approach this goal by means of the genomes project, developing genetic tests that allows us to screen for genetic defects that make the bearer more likely to develop certain forms of cancer. However, once we decide on this goal, we ought to do what we can to achieve it in other ways, too. For example, we might work to further reduce smoking, to monitor radon, and to cut other cancer-causing pollutions in our environment. A small amount of the money spent on the genomes project could make significant in-roads on these problems, and it seems that if our goal is in fact what we say it is, we ought to take the most efficient means to achieving it. There is, of course, an obvious overlap with the problem of false consciousness here, in that one reason why we do not take the most effective means to pursue our stated goal is that, in many cases, the stated goal is not the actual goal of those who control science.

APPLYING THE IDEA OF A WELL-ORDERED SCIENCE TO GM CROPS

From here I turn to the question of how the idea of well-ordered science might help us make sense of controversies surrounding GM crops. When considering GM crops, there are a number of questions that we must consider if we are to evaluate the legitimacy of their development and application. It is my contention that Kitcher’s idea of a well-ordered science may help guide us here. Questions of interest include:

- What type of agricultural policy is appropriate to a particular setting?
- What kinds of research will support an adopted policy, and will research into GM crops be among them?
- Is GM food safe to eat?
- How will the environment be impacted?
- Will consumers and producers of crops be given a reasonable choice based on solid, understandable, and comprehensive information?
- How will traditional ways of life be affected?
- Will too much power be concentrated in private hands?
- Can the quality of our food be improved by these means?

- Will agricultural productivity be increased?
- Can GM crops benefit those who live in poor and/or developing countries, or only the wealthy in the west?
- Whose needs does biotechnology respond to?
- What alternatives are there, and might these alternatives serve the needs of the world's hungry better than GM crops?¹⁹

Space keeps me from dealing with all of these questions specifically. Rather, in what follows I shall look at each of the four roadblocks to a well-ordered science discussed above, and show how certain aspects of the present situation surrounding GM crops fail to reach the ideal. That the situation surround GM crops is far from the ideal of a well-ordered science, is, I think, clear. This will become clearer yet below. Finally, I shall briefly sketch what I think a well-ordered science should say about GM crops.

Who sets the agenda for the development and use of GM crops? At the present time, almost exclusively, first-world scientists and multi-national corporations have set both the research and the application agenda. As Altieri points out, "most innovations in agricultural biotechnology have been profit-driven rather than need-driven. The real thrust of the genetic engineering industry is not to make agriculture more productive, but rather to generate profits."²⁰ Even proponents of GM crops, such as Pinstrup-Anderson and Schioler, recognize this problem. At present, the agenda for GM crops, they note, is set on "solving the problems of farmers in the wealthy countries."²¹ As of yet the poor have little, if any, say in how and where GM crops are developed.²²

We are, then, facing a problem of Inadequate Representation. Though proponents and opponents disagree about the possible usefulness of GM crops for those in developing countries, they most all agree that at the present time, the needs of people in developing countries are not given proper consideration. Importantly, this may even be the case when projects which are undertaken with the good of the developing world in mind, such as the development of "golden rice." This project, built on good intentions though it may be, clearly came from the west and is dictated to the poor of the world. While it may suit their needs, it is hard to say without consulting them.²³ As Pinstrup-Andersen and Schioler say, "the agenda should be set by those who have to live with the consequences of the resulting action, not by some misguided belief that people in rich countries know what is best for the poor countries and poor people of the developing world."²⁴ My only contention with this statement is to point out that it applies to the agenda being set in the west by agri-business corporations as well, and that we have yet been given no reason to think that when the poor are given a real choice, GM crops will be the path chosen. While that may be the case, we cannot know beforehand.

These cases show how our present situation is not one of enlightened democracy but rather external elitism edging towards vulgar democracy in search of profits. While these are not the only cases where we can see a lack of adequate representation in matters concerning GM crops, they do show how we have strayed away from

the ideal of a well-ordered science, and give us at least some idea of what must be done to get back onto the path. Both Altieri and Pinstруп-Andersen and Schioler agree, for example, that it is necessary that we move towards more publicly funded and controlled research in agricultural policy and development.²⁵ While publicly funded research does not guarantee adequate representation, it at least moves in that direction and makes it somewhat more likely, especially if the other aspects of a well ordered science are followed through.

We may now turn to the problem of the Tyranny of the Ignorant. Some of the questions here shade into questions about False Consciousness, but I shall try to give them a distinct reading at this point. Of particular interest are questions about public knowledge about GM crops and what prevents it, the possibility of choice and how this is prevented by a lack of knowledge, and the question of labeling.

One of the major problems that prevents us from reaching a state of well-ordered science in the case of GM crops is a terrible ignorance about the issue on the part of most people. As Pinstруп-Andersen and Schioler point out, “a poor grasp of biology” is a serious block to a proper understanding of the issue. For example, only 45 percent of Americans questioned could give the correct answer to the question, “Do ordinary tomatoes contain genes, or is it only genetically modified tomatoes that do?”²⁶ People in several European countries failed to do much better. Given such a sorry state, it is clear that common consumers do not, for the most part, have tutored preferences about GM crops. Given that they do not have tutored preferences, they cannot make real choices about the issue. It is unlikely that the situation is much different in the developing world in regard to knowledge of scientific biology, though there is some reason to think that farmers who actually work the land and know traditional methods in the developing world might know what the relative options are to a better degree than do even many Western scientists.²⁷ Additionally, as noted above, it is likely that those who develop GM crops know little about the lives and needs of the potential end users of such crops, especially those in the developing world. So long as scientists remain ignorant of the needs of those they serve, and the (often social) causes of these needs, they too will not have tutored preferences.

If the public is to have tutored preferences about GM crops, they will clearly need more and better information. Unfortunately, at the present time, while the FDA will declare GM crops to be ‘substantially equivalent’ to regular crops, how to interpret this is beyond the means of a typical western consumer. Furthermore, the vast majority of scientific information used for the testing of GM crops comes not from independent researchers but is based on, “information provided voluntarily by companies producing GE crops.”²⁸ Since few, if any, independent long-term studies have been done on the effects of GM crops, both on consumer health and on the quality of the crops themselves, we do not yet have the information needed to form tutored preferences.²⁹ While we may agree with Pinstруп-Andersen and Schioler that both western consumers and people in the developing world “should be given a real choice”³⁰ about using GM crops, it seems clear that while people are

ignorant of the science, scientists are ignorant of the complex etiology of problems faced by farmers and consumers in both the western and developing worlds, and the majority of information comes not from independent research but from interested parties, a real choice cannot be made. Before we can overcome the Tyranny of the Ignorant in regards to GM crops, significant work will have to be done to educate those potentially affected, both in the west and in the developing world, and to provide independent, disinterested testing to determine the safety and effectiveness of GM crops, especially as compared to alternative methods.

Many opponents of GM crops, both moderate and extreme, call for labeling of products that contain GM components. At first sight this might seem like an obvious step towards overcoming some aspects of the Tyranny of the Ignorant. While I agree that labeling is a good thing, and necessary if consumers are to have a choice as to whether to buy and eat GM foods, we should not think that this will solve our problems. Labeling will do little good unless it provides consumers with information that they can understand and make use of. Additionally, there are difficult questions to answer about what, exactly, should be labeled as GM. So, while labeling of products as containing GM foods is perhaps a necessary step towards offering consumer choice and building tutored preferences, it is clearly not sufficient.³¹

From here we may turn to the problem of False Consciousness. This is the problem that arises when the publicly offered reasons for supporting some research program do not in fact fit the actual reasons that do support it. I contend that the situation surrounding GM crops fits this description. Proponents of GM crops offer a number of reasons why the public ought to favor them. They say, for example, that GM crops will increase yield and make crops cheaper for consumers.³² GM crops will provide foods that are healthier, they say, such as cholesterol-free oil, sweeter and more colorful fruits, more starchy potatoes, and foods that do not cause allergic reactions.³³ With the spread of GM crops, we are told, we will be able to use less fertilizer by engineering wheat to fix nitrogen in the soil. Finally, GM crops can serve as a means to give much-needed nutrients to poor people in the third world, thereby combating malnutrition.³⁴ The claim is that GM crops will go some distance towards letting people, especially the world's poor, control their own lives

While all of these things may be possible, it is very important to note that they are, in fact, quite a ways off, and not just around the corner, as is often suggested. More damning, perhaps, and more relevant to our present concern, is the fact that while these items may all serve the common good, they are not in fact the reason much GM research has been done, nor are they likely to become so unless there is a large profit to be made. Pinstrup-Andersen and Schioler themselves admit this in their more sober moments when they note that, "the major players in (the GM) field have not geared their research towards yield increases in developing countries but towards solving the problems of farmers in wealthy countries."³⁵ The reason for this is that the "major players" are largely multi-national corporations who make chemicals (usually pesticides and herbicides) as well, and again, as Pinstrup-Andersen and Schioler note, at the present time, "the seeds and chemicals

go hand in hand: there is little sense in one without the other.”³⁶ It seems clear that Altieri is right when he says that the developments in the GM field have been “profit, not need, driven.”³⁷ Given these facts, we see that GM crops are in much the same boat as the genomes project—both represent a case of false consciousness, where the reasons for pursuing the projects offered by their proponents are far from the reasons that the project is actually pursued. This is not to say that these goals cannot be reached, but only that there is little reason to think we shall reach them any time soon, and even less reason to think so if serious changes in the structure of scientific practice are not made.

The final obstacle to well-ordered science that we shall consider is the problem of Parochial Application. Recall that this is when the principles that we use to support one research program or application of some scientific findings would also support, perhaps to a higher degree, another research program or application that is not presently undertaken. The discussion of GM crops is ripe with such cases. I shall focus on two particular cases that I think are quite clear—attempting to use GM crops to provide more nutrients to people in poor countries and attempting to give people in poor countries more control over their lives. I start with the former.

Poor people in many developing countries suffer not only from a lack of calories, but also a shortage of vitamins and minerals. This is a result of a lack of a balanced diet. If these people are to be healthy and develop properly, they need to receive more nutrients in their food. So, we may take as our goal increasing the level of nutrients in the diets of poor people. The reason that many poor people in the developing world have a diet low in vitamins and minerals is that their diet consists primarily of rice, which is low in nutrients. So, one way to improve the diet of these people would be to genetically modify rice so that it contains a greater amount of the necessary vitamins and minerals. So called ‘golden rice’ is the first step on this program.³⁸ So far this program has had very limited success, producing only a type of rice that is “not particularly common, and (with a) flavor and appearance that leaves something to be desired.”³⁹ Additionally, this product has not been very practical. The diets of the people most likely to benefit from it do not contain the level of fats necessary for the nutrients from golden rice to be absorbed, and it would be necessary to eat over a kilogram of rice a day to receive the recommended daily allowance of vitamin A.⁴⁰

So far, then, this approach to our problem has not paid off. We should not yet conclude that it is hopeless. It is yet possible that we will improve these techniques and overcome the difficulties. But, even if this is so, it is not clear that this is the path best licensed by the principle that guides this research, ‘work to provide more nutrients to poor people in developing counties.’ As Altieri points out, “one must . . . realize that (vitamin) deficiency is not best characterized as a problem, but a symptom. . . . People do not exhibit vitamin A deficiency because rice contains too little vitamin A, but rather, because their diet has been reduced to rice and almost nothing else.”⁴¹ Pinstrup-Andersen and Schioler respond to this argument by noting that the poor cannot easily find or pay for this varied diet.⁴² While this may be true,

it seems likely that if the same energy and millions of dollars that had been spent merely on the development of golden rice had instead been spent on methods to improve local agriculture, perhaps by other means, then this problem may already have been solved. That other methods have not been seriously undertaken should make us worry that perhaps here we are facing not just a problem of parochial application, but also false consciousness.

From this example it is easy to move on to our second case. Both sides in the debate agree that we should make it our goal to provide the poor of the world with the means to control their lives, but they disagree widely over how this is to be done.⁴³ While some see GM crops to be the best method to do this, and suggest that we put significant energy into the project, others propose, rather, that we follow the path of agro-ecology.⁴⁴ There is some reason to think that the stated goal would in fact support agro-ecology more fully than GM crops. Consider: at the present time, poor people in the developing world are subject to the whims of weather, insects, and disease in growing their crops. GM crops may offer solutions to some of these problems. However, these solutions are partial at best, and cannot be considered long-term in the cases of disease and insects, where adaptation will certainly take place, perhaps quite quickly. GM crops also do nothing to stop, and perhaps even promote, the dangers associated with monocultures.⁴⁵ Additionally, using GM crops replaces the dangers of standing at the whims of weather with the dangers of standing at the whims of multi-national corporations, foreign aid programs, and seed dealers. It is not at all clear that the poor will end up with more control if this path is followed.

But there are alternatives. Agro-ecology, for example offers many of the same benefits of GM crops (such as a reduced use of chemical fertilizer, protection from insects, etc.) but does it in a way that does not depend on the whims of foreign aid or multi-national corporations, and does not promote the spread of monocultures. Additionally, it seems that agro-ecology is more likely to help provide a varied diet. While we should not conclude *a priori* that agro-ecology would be favored by the tutored preferences of the developing world, it does seem that there is some reason to think that this is so, and that it better suits our stated goal of providing the poor of the world a way to control their own lives. We should not assume, then, that GM crops will be the best way to meet these problems.

STEPS TOWARDS A MORE WELL ORDERED AGRICULTURAL POLICY

I shall now, very briefly, sketch what I take a well ordered science should say in regards to GM crops. First, it is important that all who are affected by the use of GM crops be represented in the deliberation over them. This should include not only scientists and the heads of chemical and bio-tech corporations, but also farmers, consumers, and other interest groups. Of particular need of representation are poor people from the developing world, whose voices are often ignored, and those who face risks from the use of such products such as Bt⁴⁶ corn without benefit, such as organic farmers. For this deliberation to be effective, it will be necessary that it be

public, and result in a publicly controlled research program and standards. While we probably do not want to forbid private work in this area, (allowing multiple approaches can, in the right circumstances, give us more options, so long as one approach is not allowed to become artificially dominant) strong and clear safety and ethics standards decided on by all interested parties can and should be placed on all private sector research. Additionally, a serious educational campaign will have to be undertaken to help the deliberators develop tutored preferences, ones that do not reflect baseless fears or prejudices, but that also acknowledge the real dangers and possible alternatives such as agro-ecology. Once we are clear what our goals are, it seems likely that a well ordered science would allow significant research to be done on GM crops, but that they would be given a much smaller role than some of their proponents believe they ought to have. Rather, it seems that many of our goals, when we see them clearly and avoid false consciousness, can be better met by other means, such as agro-ecology and a more just distribution of wealth. I cannot hope to develop these ideas more fully here.

We have seen, then, several ways how the present situation surrounding GM crops falls far short of the ideal proposed by a well ordered science. While I cannot hope to say what, exactly, a well ordered science should say about GM crops, I have tried to at least sketch some ideas. Though there seems to be little hope of such a scheme being put in to place in the near future, I still take this to be an important step.

NOTES

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1. Philip Kitcher, *Science, Truth, and Democracy* p. 133.
2. *Ibid.*, p. 133.
3. I would like to note that I have nothing in particular against the corporate form of business and think that it is likely to be a necessary part of any large-scale industrial society, at least in some form. To my mind the problems that exist with corporate behavior are best dealt with through laws governing corporate set-up and liability rather than largely empty railing at the evil of corporations as such.
4. Kitcher, "Reply to Helen Longino," *Philosophy of Science*, 69, (Dec. 2002) p. 569.
5. Kitcher, *Science, Truth, and Democracy* p. 118. For a helpful overview of the idea of deliberative democracy see Samuel Freeman, "Deliberative Democracy: A Sympathetic Comment," *Philosophy and Public Affairs*, 29 No. 4, 2000, pp. 371–418.
6. *Ibid.*, p. 117.
7. Helen Longino, "Science and the Common Good: Thoughts on Philip Kitcher's *Science, Truth, and Democracy*," *Philosophy of Science*, 69 (Dec. 2002) p. 565.

8. Kitcher, *Science, Truth, and Democracy*, p. 118.
9. *Ibid.*, p. 118.
10. *Ibid.*, pp. 118–121.
11. *Ibid.*, p. 123.
12. *Ibid.*, p. 129. The “Nonrepresentational Ratchet” is a mechanism where an early lack of representation can lead to a preference for a path that continues to favor one group even when adequate representation is established. This is due to the ease of continuing down an established path of inquiry, even if another may be more optimal in some important ways.
13. *Ibid.*, p. 129.
14. *Ibid.*, p. 130.
15. Thanks to Hugh Lacey for pointing out the need to make this point clear.
16. Kitcher, *Science, Truth, and Democracy*, p. 131.
17. *Ibid.*, pp. 130–131.
18. *Ibid.*, p. 132.
19. This list of questions is largely derived from those in Pinstrup-Andersen and Schioler, p. 2, and Miguel A. Altieri, *Genetic Engineering in Agriculture*, p. vii.
20. Altieri, p. 4. Again I would like to note that I have no general objection to profit-making by corporations and think that it is almost certainly a necessary part of a large-scale industrial society. My interest here is only in seeing to what degree the natural and appropriate profit-seeking behavior of corporations might conflict with science being well ordered.
21. Pinstrup-Andersen and Schioler, p. 92.
22. *Ibid.*, p. 5.
23. Altieri, pp. 5–7.
24. Pinstrup-Andersen and Schioler, p. 109.
25. *Ibid.*, p. ix, 4, Altieri, pp. 46–47.
26. Pinstrup-Andersen and Schioler, p. 111.
27. Thanks to Hugh Lacey for bringing out the need to be clear on this point.
28. Altieri, p. 18.
29. *Ibid.*, p. 19.
30. Pinstrup-Andersen and Schioler, p. 85.
31. Oddly enough, Pinstrup-Andersen and Schioler seem to hold that while labeling is a good idea in the west, we cannot expect companies to meet such standards in the developing world. This seems to be clearly at odds with their claim that the poor should be given the choice whether to use GM crops or not. If one does not know that one is using GM crops, it is hard to see how one has a choice in the matter. I do not know how to reconcile this apparent contradiction. It seems to me to be only one of several tensions in their book. See Pinstrup-Andersen and Schioler, p. 132.
32. *Ibid.*, p. 51.
33. *Ibid.*, p. 94.

34. Ibid., pp. 52–55.

35. Ibid., p. 92.

36. Ibid., p. 44.

37. Altieri, p. 4.

38. Pinstrup-Andersen and Schioler, p. 53.

39. Ibid., p. 53.

40. Altieri, p. 7.

41. Ibid., pp. 5–6.

42. Pinstrup-Andersen and Schioler, p. 138.

43. *ibid.*, p. 5, and Altieri, p. 3.

44. Altieri, p. 33.

45. Altieri, p. ix.

46. Bt Corn is corn that has been genetically modified to contain the *Bacillus Thuringiensis* toxin, which is toxic to many insects that feed on crops. Bt is naturally occurring and has long been used as a natural pesticide by organic farmers. There is significant worry that wide-spread use of Bt corn will result in the quick development of Bt-resistant insects thereby depriving organic farmers of one of the few pesticides which they can use.