
Property Rights and Genetic Engineering: Developing Nations at Risk

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ABSTRACT: *Eighty percent of (commercial) genetically engineered seeds (GES) are designed only to resist herbicides. Letting farmers use more chemicals, they cut labor costs. But developing nations say genetically engineered seeds cause food shortages, unemployment, resistant weeds, and extinction of native cultivars when “volunteers” drift nearby. While GES patents are reasonable, this paper argues many patent policies are not. The paper surveys GE technology, outlines John Locke’s classic account of property rights, and argues that current patent policies must be revised to take account of Lockean ethical constraints. After answering a key objection, it provides concrete suggestions for implementing its ethical conclusions.*

Even after thousands of years, seeds from Egyptian tombs have remained viable. Believing they were magical, our ancestors knew that whatever threatened seeds threatened them. We know it too. Farmers in developing nations say their lives and food are threatened by genetically engineered seeds (GES). Condemning biotechnology profits and GES-induced extinctions of indigenous crop species, they attack policies such as granting patents to GES, not labelling GE food, and following World Trade Organization protections of GES. Representatives of 18 African nations recently charged, at a UN Food and Agriculture Organization meeting: “gene technologies...will undermine our capacity to feed ourselves.”¹

This paper addresses one prominent subset of GES conflicts, those over property rights. After providing background on GES and outlining John Locke’s classic account of property rights, the paper argues that current patent policies regarding life forms, like genes, must be revised to accommodate Lockean ethical requirements – that society claims to accept. The paper answers a key objection to these arguments, then suggests several practical strategies for implementing its ethical conclusions.

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1. BACKGROUND: CHEMICAL CONNECTIONS

In its broadest sense, “genetic engineering” includes uncontroversial techniques, like selective breeding. In its narrower sense, used here, GE refers to gene splicing – techniques for inserting DNA fragments from one organism’s genes into the chromosomes of another, thereby changing its genetic makeup. In 80 percent of all GES crops, such splicing is done only to make them herbicide resistant; the remaining 20 percent of GES crops are engineered to resist disease.² No commercially used GES crops increase yield or drought tolerance,³ in part because such engineering is more difficult than designing pesticide resistance. Enabling farmers to apply more chemicals, pesticide-resistant GES reduce labor costs. At least in developed countries, Monsanto’s Roundup-Ready (RR) soy, for example, has lower production costs than non-RR soy, largely because of lower labor costs.⁴ Because 80 percent of GES crops are bioengineered only for pesticide resistance, it is not surprising that the top 5 biotech companies (Monsanto, Astra-Zeneca, DuPont, Novartis, and Aventis) are chemical companies. They control nearly 100 percent of the GES market and 25 percent of the commercial seed market.⁵

At least since 1996 when Monsanto launched its first GES, RR soy, it has dominated GES markets. Largely because of its “flagship” product, Roundup, it annually grosses more than US \$5.5 billion, more than the GNP of most developing countries. RR soy accounts for 58 percent of total GM crops, followed by transgenic corn, cotton, and canola. Argentina, the US, and Canada are the main GES users. In Argentina, 95 percent of all soybeans are transgenic; in the US, 54 percent. From 1996 to 2000, global GES cropland rose 2500 percent, to 100 million acres. One-fourth of US crop land is planted in GES. Globally, an area larger than the UK is planted just with herbicide-resistant GES soy, corn, and canola. Not counting other Monsanto profits, year-2000 sales of Roundup were \$3 billion, mostly for use on legally protected RR GES crops.⁶

Proprietary GES technologies are legally safeguarded through patents. Like copyrights, they are intellectual property rights (IPR) – rights to control production and use of things, like songs, for a limited time, like 17 years. Because IPR can be shared without reducing abilities to use them, economists call them “nonrivalrous goods.” Historically, society gave inventors IPR in exchange for public disclosure (making new knowledge available) and avoiding trade secrecy. Today, however, many countries like the US allow IPR to keep inventions from the market. In the US, since the 1980 Supreme Court decision, *Diamond v. Chakrabarty*, biotech companies have been patenting genes and other biological materials.⁷ In Europe, World Trade Organization agreements protect them.⁸ Violating such patents and agreements brings heavy costs, as when Monsanto claimed Canadian Percy Schmeiser used RR Canola without a license. The court fined him Can \$20,000. Insisting he had neither planted nor used Roundup on it, Schmeiser said the RR plants were “volunteers” that blew in from neighbors’ fields.⁹

GES-related policies have generated at least four sets of ethical concerns. *Scientific* concerns include inadequate GES testing, driven partly by companies’ unwillingness to

share proprietary information,¹⁰ and GES research priorities.¹¹ Since corporations fund about 90 percent of GES work, and universities, about 10 percent,¹² GES biotechnology typically has not been used to increase crop yields, nutrition, or drought tolerance but instead for profitable, but risky, pesticide-resistant products. Yet annually a million children die from nutritional deficiencies. Another 350,000 go blind from vitamin-A deficiencies. *Health* concerns, a second worry, include cancer, antibiotic resistance, fatal allergies,¹³ and unknown effects. Regarding cancer, the US National Academy of Sciences recently concluded that allowable pesticide residues, on US foods, will cause a million premature, fatal cancers in the next 75 years.¹⁴ Yet GES crops have higher pesticide residues than non-GES, and Roundup's main ingredient, glyphosate, has been linked to increases in non-Hodgkins lymphoma.¹⁵ Other GES effects are illustrated by the deaths and disabilities caused by food-supplement DL-tryptophan, produced by a genetically engineered bacterium.¹⁶ Another health worry is horizontal gene transfer. Because diseases like Ebola, AIDS, Lyme, and Mad Cow appear to have moved genetically from animals to humans, some say 20 percent of GES, with engineered genes from viral pathogens, might create new viral strains having unknown properties.¹⁷ Third, GES-related *environmental threats* include problems like Roundup's plant-and-animal toxicity, even at low doses (10 ppm).¹⁸ GES crops also cause food-chain biomagnification of pesticides, as when feedlot cattle eat silage laden with transgenics and high pesticide concentrations.¹⁹ GES gene transfer, in the field, has already created herbicide-resistant weeds and extinguished indigenous cultivars.²⁰ *Global food sustainability* is a fourth concern because GES not only drive out indigenous species but often produce lower yields. The dominant GES crop, RR soy, has yields 4-11 percent lower than non-GE soy.²¹ Although developed nations want the lower labor costs of GES, in the developing world, current GES increase costs by increasing seed prices, chemical dependence, and unemployment.²² By 1999, 12 companies, many with US Department of Agriculture funding, had more than 25 patents to make GES either sterile or chemically dependent.²³

2. PROPERTY, THE CORE OF GES-RELATED PROBLEMS

The most basic ethical argument of those who defend current GES policies (such as exclusive patents, charging those who use GES, and imposing GES risks without consent) appeals to property rights. Without GES property (patent) rights, Monsanto, for example, would have no exclusive, monopolistic rights to use, sell, license, and manufacture RR Canola, and GES farmers would not be required to pay Monsanto an annual royalty of at least \$15 per acre.²⁴ Industries like Monsanto claim property and patent rights are fair compensation for their biotech-engineering costs. But many scientists say life forms, like germ plasm and cell lines, should be shared – not patented.²⁵ Like environmentalist Aldo Leopold,²⁶ they say biological resources are not private property. Leopold told the story of Odysseus, returning from the Trojan wars, who hanged many slave girls suspected of misbehavior in his absence. Although we criticize the Greeks for treating slaves and women as property, Leopold says our descendants will criticize us for treating land as property.

Should we treat GES mainly as property? Answering convincingly requires presupposing some common ground on which people of different political persuasions can agree. That “something” is arguably John Locke’s classic, common-sense account of property rights. More than any other thinker, Locke is the authority used to justify patenting biological resources, in part because most common law, the US Constitution, the Declaration of Independence, Marxists, capitalists – and everyone “in between” – accept Locke’s view of property.²⁷ He argued that labor creates property rights, and most Locke scholars, like MacPherson, Nozick, and Strauss, say he supports unlimited appropriation of property, provided it is not acquired fraudulently.²⁸ Following Locke and his dominant interpreters, patent proponents say people have property rights to GES inventions because they made them and are owed a return on their research investment. While obviously inventors deserve some such return, this paper argues that if people correctly understand and accept Locke, they should question current GE patents. Surprisingly, however, virtually all those who criticize GES patents either outright reject property-rights defenses of patents, or ignore Locke.²⁹ Begging the question, they fail to help resolve the GES-patent impasse, since most people, including patent proponents, accept and use (what they say is) Locke’s account. This paper addresses proponents’ own arguments – on their own terms.

Mark Sagoff, perhaps the only anti-GES-patent philosopher who uses Locke,³⁰ employs his distinction – between manipulating an already-created thing, versus laboring to create it – to argue GES cannot be patented. Yet most patents are for manipulations of something, not pure creations, so Sagoff’s arguments err in undercutting most patents. Is there a Lockean argument against current forms of GES patenting that, unlike Sagoff’s, actually works – one that patent proponents would be forced to accept, if they are consistent?

The argument here has three main premises. (1) Locke makes all property (thus GES) subject to requirements of the “original community” and natural law. (2) Locke’s “first proviso” requires that, when people’s labor creates property rights over resources, “as much and as good” must remain for others. (3) Because labor cannot give resources (like GES) their full value, they remain largely common property, subject to community control.

Locke’s (and the classic) justification for private-property acquisition is the labor theory: People are entitled to hold, as property, whatever they produce by their labor, intelligence, and effort.³¹ Locke argues that because people own their bodies, they own the products of their labor. By “mixing” their labor with goods from the biological commons, Locke says people can own them, provided two conditions, or provisos, are met: (1) There is “enough and as good” commons left for others. (2) People use the property and do not let it waste or spoil. In the early days, when there was enough land for all, Locke said squatters’ labors established property rights to resources.³² But inventing money, said Locke, enabled people to exchange resources for metal, to sidestep his spoilage proviso (2), and thus agree “to disproportionate and unequal Possession of the Earth.”³³ While property-rights advocates invoke the “disproportionate and unequal Possession” claim, they typically forget that Locke still requires people to meet proviso (1), to leave “as much and as good.”

According to Locke's labor theory, *need*, *efficiency*, and *desert* justify acquiring property rights.³⁴ Regarding *need*, Locke says if labor did not generate property rights, people would starve while waiting to work out property agreements; regarding *efficiency*, people may "have the materials of plenty," says Locke, "yet for want of improving it by labour, have not one hundredth part of the conveniences we enjoy;" efficiently pursuing needed goods requires property rights generated by labor.³⁵ Regarding *desert*, Locke says laborers merit property rights over things because their labor created much property value:³⁶ "Labour makes the far greatest part of the value of things, we enjoy... The ground which produces the materials is...but a very small part of it."³⁷

How should people treat GES, if they accept Locke's view that labor generates property rights?³⁸ Those who defend the unrestricted-acquisition interpretation typically argue that Locke's consent to the use of money (in exchange for labor) justifies "disproportionate and unequal possession of the earth," including life forms, because people can pay others to "work" resources for them.³⁹ Thus biotech companies can pay scientists to engineer genes. They also say Locke's first proviso ("as much and as good" left for others) allows unlimited accumulation because large property owners can compensate those having unequal access to resources.⁴⁰ Thus biotech companies can compensate those disadvantaged by GES patents. Does this unrestricted-acquisition argument succeed? It fails, first, because GES companies arguably have not fully compensated developing nations for unequal access,⁴¹ especially in a GES market annually worth several hundred billion dollars;⁴² indeed, developing nations arguably are worse off because of GES.⁴³ It fails, second, because although most Locke scholars correctly say he justifies private-property rights, beyond what is necessary for individual use, they ignore his 5 limits on property rights, all of which challenge current GES patenting: (1) his "law of nature," (2) his labor theory, (3) preservation; (4) Christian charity, and (5) virtue. Regarding (4), Locke says children should be taught to "freely give away what they have," to avoid acquisition; regarding (5), he says humans' desires "for more than they need" is the root of all evil – that love of domination expresses itself in acquisition, the "first original of most vicious habits."⁴⁴ Because (4) and (5) are more personally, than policy, relevant, here we consider only (1)-(3).

2.1 Locke's Law of Nature

Locke's discussion of property begins by emphasizing that preservation is the "law of nature," that all the earth is "common" property given by God.⁴⁵ This means he must explain how common property can become private property. It also means that Locke scholars, including Harvard's Robert Nozick, err when they simplify Locke and speak of "unowned" rather than "common" biological property.⁴⁶ They ignore "the common state," the "original community," in which humans together own Earth's goods.⁴⁷ Locke says this commons is governed by "the law of reason and common equity...the law of nature...[which] willeth the peace and preservation of all mankind."⁴⁸ Even after people become members of a civil commonwealth, Locke says common properties,

like the “Fish any one catches in the Ocean,”⁴⁹ are governed by the law of “reason and common equity,” the natural law which “still takes place.”⁵⁰ Although property may become subject to civil government, Locke says this natural law of “preservation” continues: Legislators’ “power, in the utmost bounds of it, is limited to the public good of the society.... The law of nature stands as an eternal rule to all men, Legislators as well as others.”⁵¹ Although gene manipulation and patents were centuries away, Locke warns that “no man could ever have a just power over the life of another, by right of property.”⁵² “The same Law of Nature that does by this means give us Property does also bound that Property.”⁵³

Responding to Locke, GES-patent defenders might say that because people consented to using money – thus to “unequal possession” of resources;⁵⁴ societal consent trumps natural law and justifies exclusive property rights.⁵⁵ But such a response is self-contradictory. In allowing societal law to trump natural law, these objectors separate the two, thereby losing the Lockean natural-law foundation that grounds civil law, including property rights. If Lockean natural law disappeared, after the introduction of societal laws and money, legal property rights could not be enforced, protected, and amended in a non-arbitrary way. Only if legal property rights are subject to “reason and common equity” – Locke’s natural law – would there be rational grounds for securing and correcting them. Something like Locke’s natural law, undergirding civil law, thus either limits and protects GES property rights, or it does neither. Rejecting his “natural law” of preservation, reason, and equity – so as to reject limits on property rights – also requires rejecting rational grounds for protecting those rights. Besides, there would be no rational way to resolve conflicting legal-property-rights claims. Moreover, if societal consent alone justified property rights, and if rights to common resources, like land or genes, required the consent of all, it is difficult to see why – and how – a majority would consent to unlimited appropriation or to exclusive private rights over them. If not, something like Locke’s natural law must limit property rights and justify their societal regulation.⁵⁶ Locke also says that because people live in society in part to ensure enforcement of natural-law rights, government has natural-law duties to “regulate the right of property” in ways promoting human preservation.⁵⁷ If GES patents threaten Third-World preservation, consistent Lockean must either remove the threat, or somehow compensate for it. They have done neither.

2.2 Resource Value and Labor

Another reason to doubt Lockean support for monopolistic property rights (to things like GES) is that no humans labored to create full GES value. Locke himself claims that “‘tis Labour indeed that puts the difference of value on everything.”⁵⁸ If so, and if human labor did not create GES, but only engineered or purified them, it can neither put all the value on GES nor merit exclusive rights to them. Admittedly Locke erroneously believed resources on which humans had not labored had little value. But he also emphasized that some portion of resource value, not created by human labor, prevents unlimited, labor-based, property rights.⁵⁹ The same is true of GES. As Mill, Proudhon, and others recognized, owners cannot claim rights to uncreated portions of

common resources, because their labor did not create them. Proudhon asks: “We want to know by what right man has appropriated wealth which he did not create, and which Nature gave to him gratuitously.... The creator of the land does not sell it; he gives it; and, in giving it, he is no respecter of persons.”⁶⁰ Henry George reasons similarly: “If production give to the producer the right to exclusive possession and enjoyment, there can rightfully be no exclusive possession and enjoyment of anything not the production of labor.”⁶¹ If not, there are no exclusive property rights to GES, as now alleged in countries like Denmark, Switzerland, and the US.

Even for parts of GES created by human labor, there are property-rights constraints. To the extent that GES labor is cooperative, inadequately compensated, traded in a complex economy, or dependent on common resources, it is less private – less amenable to private-property rights. Ethically flawed market transactions also can limit GES property rights, just as they limit land title. Almost no title is ethically clean, without fraud, market manipulation, or conquest by force. In California, land titles go back to the Mexican government, which took them from the Spanish king, who received them from the pope, who divided them between Spain and Portugal. Most resource-property rights go back, “not to a right which obliges, but to a force which compels.”⁶² If “force and fraud have reigned supreme” in history,⁶³ and if factors like monopoly tilt GES playing fields, then few alleged owners have completely ethical, “clean” title to GES. If not, exclusive patents are questionable. Besides, GES work depends on a common uncreated resource, to which the first proviso gives others equal opportunity – “as much and as good.” Under this proviso, increasing population and decreasing resources preclude exclusive property rights, if they thwart others’ equal opportunity to obtain food and survive. If so, Locke’s natural law, labor theory, and first proviso limit rights to GES property and patents.

2.3 Patents and Preservation

For Locke, the ultimate limit on property is whether it is used to “increase the common stock of mankind,”⁶⁴ whether it follows natural law – increases opportunities to preserve life – and the first proviso (“as much and as good”). He explicitly says government power is “limited to the public good of the society” and has “no other end but preservation.... The obligations of the law of nature cease not in society but only...have...penalties...to enforce their observation.”⁶⁵

If society must promote the natural law of preservation, policies regarding GES property and patent rights must satisfy natural-law demands to “preserve all humankind.”⁶⁶ Such a “preservationist ethics,” however, contradicts standard Lockean interpretations justifying disproportionate property holdings, even when they harm others. Obviously the historical Locke gave little attention to limiting property rights to biological resources, in part because he failed to foresee their scarcity and GES technologies. Yet Locke’s own words show his account logically requires whatever limits on property are necessary to “preserve all humankind.”

3. AN OBJECTION

If the preceding arguments are correct, classic accounts of Lockean property rights, from MacPherson, Nozick, Strauss, and others, are partially wrong because they ignore Locke's first or equal-opportunity Proviso, his preservationist natural law, and logical consequences of his labor theory.⁶⁷ How might GES-patent proponents respond? Among many reactions,⁶⁸ perhaps the most important is the low-risk objection (LRO): Because GES-related risks are low, they are no threat to Lockean preservation of life.⁶⁹ As President Bush put it: "study after study has shown no evidence of danger"; former Clinton-Agriculture Secretary Dan Glickman alleged: "test after rigorous scientific test" has demonstrated no proof of GES harm.⁷⁰

Such LRO claims have both ethical and logical problems. Logically, LRO confuses absence of evidence (for GES-related risks) with evidence of absence. It commits the fallacy of appeal to ignorance, assuming that failure to prove harm establishes safety. LRO also relies on a massive category mistake, on what British ethicist G.E. Moore⁷¹ called the "naturalistic fallacy." One commits this fallacy by reducing ethical questions (e.g., ought industries use GES in developing nations without their consent?) to scientific questions (e.g., are GES-related risks minimal?). This reduction errs in presupposing that GES issues are scientific, not also ethical – that one need not debate ethical default rules for behavior under GES-related uncertainty.⁷² Even if GES risks are low, stakeholders (those affected) have rights to decide whether the risks are worth the benefits, or whether associated benefits can be realized in alternative ways. By using the naturalistic fallacy to reframe GES issues as purely scientific, GES proponents give themselves rights to make allegedly "scientific" decisions for the people. When GES issues are defined as partly ethical, as affecting welfare, GES experts and industries have no special rights to decide them. LRO thus succeeds only if, ahead of time, GES issues are defined via the naturalistic fallacy.

LRO proponents also make problematic assumptions. One is that GE and non-GE biological materials are essentially equivalent.⁷³ Yet given case-specific GES uncertainties and inadequate testing, this assumption is not obviously true. Another frequent LRO assumption is that GES-related consequences are innocent until proved guilty. As Phil Angell of Monsanto put it, in 1999: "Monsanto should not have to vouchsafe the safety of biotech food. Our interest is in selling as much of it as possible. Assuring safety is the FDA's job."⁷⁴ This assumption is a fallacious appeal to ignorance. Given GES-related uncertainties, it presupposes GES-related consequences are harmless; yet uncertainty precludes knowing, one way or the other. Given uncertainty, instead society must choose ethical default rules for GES. Patent proponents also often assume GES-related threats include only immediate, easily observed fatalities. If they see no acute effects, they assume there are no problems. This is like what physicist Hal Lewis (1990) did, when he ignored latent cancers from radiation exposure and said the Chernobyl nuclear accident caused only 31 deaths. Award-winning philosopher Larry Laudan made the same Chernobyl claim.⁷⁵ Yet even the pro-nuclear US Department of Energy puts short-term Chernobyl deaths at 30,000; members of the medical community say Chernobyl-induced, premature, long-term,

statistical casualties will reach 475,000.⁷⁶ GES proponents make similar errors if they fail to test GES adequately, observe no immediate fatalities, then proclaim its safety. If they follow the procedure of “don’t look, don’t find,” they beg the question of GES-related safety. They also assume only risk magnitude, not also democratic consent, determines patent acceptability. If patents put people at risk, they have consent rights.

4. IMPLEMENTING GES ETHICS

If current policies regarding GES patents fail to meet classic Lockean requirements, like the first proviso, how might they be improved? In general, nations like Canada and the US could follow some of the safeguards already enacted in the EU.⁷⁷ To avoid the naturalistic fallacy and to meet LRO, one might promote labelling GE food, a policy not followed in the US,⁷⁸ guaranteeing case-by-case, industry-financed GES risk assessments; and ensuring that assessors and stakeholders ethically deliberate about GES default rules, like the precautionary principle.⁷⁹ To promote recognition of Locke’s preservationist natural law, GES patent-holders could develop and donate biotechnologies for Third-World use, sell GES-related herbicides there at lower profit margins, and help train Third-World scientists and attorneys in biotechnology, public health, and intellectual property. They also could disavow “terminator” biotechnology, antibiotic-resistance genes, and using GES patents in developing nations without stakeholder consent.

To promote recognition of Locke’s labor theory, government could allow biotechnology/chemical companies only limited “use rights” (not exclusive patent rights) to GES, require compensation to stakeholders for GES-related risks, and have companies share profits from special varieties of GES (such as basmati rice or jasmine rice) with their countries of origin. Use rights might restrict GES profits to some plus-cost percentage. They might be interpreted, in part, through GES stakeholder-review boards, analogous to citizen boards currently used to help regulate hospitals and utilities. Regarding the first Proviso (“as much and as good”), universities, government, and industries could fund comprehensive health, environmental, economic, ethical, and political assessments – necessary for compensating GES-related harms, especially in developing nations. Taxes on GES-patent revenues would be one way to raise such research funds.⁸⁰

Practical strategies for implementing GES-related ethical reforms obviously need to be worked out in detail, by the practitioners and those affected. But their general goal is what Gordon Conway⁸¹ calls the “Doubly Green Revolution.” It aims at not only economic and agricultural success, but also environmental and ethical progress. If preceding arguments are right, this revolution requires citizens and GES patent holders to implement the very Lockean property rights they already claim to accept.

REFERENCES

1. Anderson, Luke (1999) *Genetic Engineering, Food, and Our Environment*, Chelsea Green, White River Junction, VT, p. 55. See also Pinstrup-Anderson, Per and Schioler, Ebbe (2000) *Seeds of Contention*, Johns Hopkins University Press, Baltimore, pp. 60-64.
2. Halweil, Brian (2000) Transgenic crop area surges, in: Brown, L.R. ed. *Vital Signs*, Worldwatch, Washington, DC, p. 1118.
3. Lacey, Hugh (2002) Assessing the value of transgenic crops, *Science and Engineering Ethics* **8**: 497-511. See also Hollander, Rachelle (2002) Social genomics, *Science and Engineering Ethics* **8**: 485-88.
4. See, e.g., Barnes, Jeff W. and Oliver, Lawrence R (2003) Cultural practices and glyphosate application, *Weed Technology* **17**: 429-440. Bullock, David S. and Nitsi, Elisavet I. (2001) Roundup ready soybean technology and farm production costs, *American Behavioral Scientist* **44**: 1283-1301. Norsworthy, Jason K. and Oliver, Lawrence R. (2001) Effect of seeding rate of drilled glyphosate-resistant soybean, *Weed Technology* **15**: 284-292.
5. Rural Advancement Foundation (1999) *Seedless in Seattle*. Rural Advancement Foundation International News Release, November 26. Robbins, John (2001) *The Food Revolution*. Conari, Boston, p. 309.
6. Minderhoud-Jones, Marilyn (2001) Monsanto: Rewriting the script, *Biotechnology and Development Monitor* **48**: 13-14. See Robbins, pp. 311-15.
7. 477 US 303. Resnik, D.B. (2004) *Owning the Genome*, SUNY Press, Albany 2004, pp. 31- 62; Dreyfus, R. (1989) General overview of the intellectual property system, in: Weil, V. and Snapper, J. *Owning scientific and technical information*. Rutgers University Press, New Brunswick, NJ.
8. Conway, Gordon (2000) Genetically modified crops, *Conservation Ecology* **4**: 2. See Carey, N. (1996) Why genes can be patented, *Nature* **379**: 484. Krimsky, Sheldon (2003) *Science in the Private Interest*. Rowman and Littlefield, Lanham, MD.
9. Philipson, Martin (2001) Agricultural law, *Biotechnology and Development Monitor* **48**: 2-5.
10. Dalton, Rex and Diego, San (2002) Superweed study falters, *Nature* **419**: 655.
11. Shrader-Frechette, Kristin (1994) *Ethics of Scientific Research*. Rowman and Littlefield, Savage, MD.
12. Gerpacio, R (2003) The Roles of the public sector versus the private sector in R&D and technology generation, *Agricultural Economics* **29**: 319-330.
13. Bernauer, Thomas (2003) *Genes, Trade, and Regulation*. Princeton University Press, Princeton.
14. National Research Council (1996) *Understanding Risk in a Democracy*. National Academy Press, Washington, DC, p. 335.
15. Harden, Lent and Eriksson, Michael (1999) A case-control study of Non-Hodgkin Lymphoma and exposure to pesticides, *Cancer* **85**: 1353-60.
16. Raphaels, P. (1990) Does medical mystery threaten biotech? *Science* **249**: 619. Love, L. (1993) Pathological and immunological effects of ingesting L-Tryptophan, *Journal of Clinical Investigation* **91**: 804-11. See Anderson, pp. 17-18.
17. Conway. Robbins, pp. 312-313.
18. Abdel-Mallek, A. et al. (1994) Effect of glyphosate on fungal population, *Microbial Research* **149**: 69-73. World Health Organization (1994) *Glyphosate*. UN Environment Programme, Geneva, Switzerland. Anderson, pp. 24-25.
19. Taylor, Steve L. (2001) Safety assessment of genetically modified foods, *Journal of Nematology* **33**: 178-182. Skerritt, John H. (2000) Genetically modified plants, *AgBiotechNet* **2**: 1-8. Conway. See Robbins, pp. 312-314.
20. Bernauer, pp. 28-43, 85. Singh, R. and Hymowitz, T. (1999) Soybean genetic resources and crop improvement, *Genome* **42**: 605-616. See Shrader-Frechette, Kristin and McCoy, Earl

- (1993) *Method in Ecology*. Cambridge University Press, Cambridge. Skerritt. Robbins, pp. 349-350.
21. E.g. Holzman, David (1999) Agricultural biotechnology, *Genetic Engineering News* **19**: 8.
 22. See Bernauer, pp. 28-43. Gould, Fred and Cohen, Michael B. (2000) Sustainable use of genetically modified crops in developing countries, *Agricultural Biotechnology and the Poor* **1**: 139-146. Gerpacio.
 23. Anderson, pp. 32, 66-68, 88.
 24. Philipson.
 25. Krimsky, pp. 30, 60-63; Shrader-Frechette 1994.
 26. Leopold, Aldo (1949) *A Sound County Almanac*. Oxford University Press, New York, p. 237.
 27. Hargrove, Eugene (1983) Anglo-American land-use attitudes, in: Scherer, Donald and Attig, Thomas (eds.) *Ethics and the Environment*, Prentice-Hall, Englewood Cliffs, NJ. Wood, N. (1984) *John Locke and Agrarian Capitalism*, University of California Press, Berkeley. Lemos, R. (1975) Locke's Theory of Property, *Interpretation* **5**: 226ff. Rogers, Patrick (1993) The transition to civil society, *Southwestern Philosophical Studies* **15**: 67-73. Chotas, Jiri (2002) Locke and Kant on the right to private property, *Filosoficky-Casopis* **50**: 47-70.
 28. See note 39 and Tully, James (1993) *An Approach to Political Philosophy*. Cambridge University Press, New York. Chappell, Vere. *Essays on Early Modern Philosophers, Volume 9: John Locke*, Garland, Hamden. Wolf, Clark (1995) Contemporary property rights, Lockean provisos, and the interests of future generations, *Ethics*, **105**: 791-818. Shrader-Frechette, Kristin (1993) Locke and limits on land ownership, *Journal of the History of Ideas* **54**: 201-219. Caldwell, Lynton K. and Shrader-Frechette, Kristin (1993) *Policy for Land*. Rowman and Littlefield, Savage, MD, pp.791-818.
 29. See, e.g., Magill, Gerard (2004) *Genetics and Ethics*. St Louis University Press, St. Louis. Burley, Justine (1999) *The Genetic Revolution and Human Rights*, Oxford University Press, New York. Shapiro, Michael, Spece, Roy, Dresser, Rebecca and Clayton, Ellen Wright (2003) *Bioethics and Law*. Thompson-West, Chicago. Resnik. Magnus, David, Caplan, Arthur and McGee, Gleen, eds. (2002) *Who Owns Life?*, Prometheus, Amherst, NY. Bernauer. Bowring, Finn (2003) *Science, Seeds, and Cyborgs*. Verso, New York. Pinstrip-Anderson and Schioler. Reiss, Michael (1996) *Improving Nature?* Cambridge, New York. Committee on Genetically Modified Pest-Protected Plants (CGE) (2000) *Genetically Modified Pest-Protected Plants*, National Academy Press, Washington, DC. Committee on Intellectual Property Rights in the Knowledge-Based Economy (2004) *A Patent System for the 21st Century*, National Academy Press, Washington, DC. Committee on Intellectual Property Rights in the Knowledge-Based Economy (CIP) (2003) *Patents in the Knowledge-Based Economy*, National Academy Press, Washington, DC.
 30. Sagoff, Mark (1996) *Animals as Inventions*. University of Maryland Institute for Philosophy and Public Policy, Baltimore. See Wilson, Jack (2002), Patenting organisms, in: Magnus, Caplan, and McGee, pp. 25-58.
 31. Becker, L.C. (1977) *Property Rights*, Routledge and Kegan Paul, Boston. Beatley, Timothy (1994) *Ethical Land Use*, Johns Hopkins Press, Baltimore.
 32. Locke, John (1960) *Two Treatises of Government*, ed. Peter Laslett. Cambridge University Press, Cambridge, pp. 27, 30, 31; second treatise hereafter cited as: Locke, and first treatise as Locke I.
 33. Locke, pp. 36-37, 50. George, H. (1955) *Progress and Poverty*, Country Life Press, New York. Smith, Steven G. (2002) The worth of owning, *Public Affairs Quarterly* **16**: 155-172.
 34. Locke, p. 50. Olivecrona, K. (1974) Locke's theory of appropriation, *The Philosophical Quarterly* **24**: 230. Becker. Beitz, C. (1980) Tacit consent and property rights, *Political Theory* **8**: 487-502. Davis, M (1987) Nozick's argument for the legitimacy of the welfare state, *Ethics* **97**: 576-594. Gibbard, A. (1976) Natural property rights, *Nous* **10**: 77-86. Vaughn, K. (1978) John Locke and the labor theory of value, *Journal of Libertarian Studies* **2**: 311-326. Miller, David (1980) Justice and property, *Ratio* **22**: 1-14. Waldron, J. (1983) Two worries about

K. Shrader-Frechette

- mixing one's labour, *The Philosophical Quarterly* **33**: 37-44. Kramer, Matthew H. (1997) *John Locke and the Origins of Private Property*, Cambridge University Press, New York. Simmons, John A. (1998) Maker's rights, *Journal of Ethics* **2**: 197-218.
35. Locke, p. 28.
 36. Locke, paragraphs 32, 34, 41. Schwartzbach, S. (1988) Locke's two conceptions of property, *Social Theory and Practice* **14**: 154ff.
 37. Locke, paragraphs. 40-42.
 38. Post, D. (1986) Jeffersonian revisions of Locke, *Journal of the History of Ideas* **47**: 147-157. Handlin, O. and Handlin, L. (1989) Who read John Locke? *The American Scholar* **58**: 545-556. Goldie, Mark (1999) *The Reception of Locke's Politics*, Pickering & Chatto, London. Lemos.
 39. Locke, p. 50. Macpherson, C.B. (1962) *The Political Philosophy of Possessive Individualism*, Clarendon Press, Oxford. Strauss, Leo (1953) *Natural Right and History*, University of Chicago Press, Chicago. Holland, H.S. (1913) Property and personality. In: Gore, C. (ed.) *Property*, Macmillan, London, pp. 170-192. Schlatter, R. (1951) *Private Property*, Rutgers University Press, New Brunswick, NJ. Minogue, K. (1980) The concept of property, in: Pennock, J. and Chapman, J. (eds.) *Property*, New York University Press, New York. Du Rand, C. (1966) The reconstitution of private property. *Social Theory and Practice* **12**: 337-50. Squadrito, K.M. (1979) Locke's view of dominion, *Environmental Ethics* **1**: 255-258. Block, Walter (1998) Environmentalism and economic freedom, *Journal of Business Ethics* **17**: 1998-99. Robbins, Lionel (1998) *A History of Economic Thought*, Princeton University Press, Princeton.
 40. Mautner, T. (1982) Locke on original appropriation, *American Philosophical Quarterly* **19**: 260. Du Rand. Ellerman, D (1985) On the labor theory of property, *Philosophical Forum* **16**: 320. Macpherson.
 41. Bernauer. Ali Brac De La Perrifre, Robert and Seuret, Frank (2001) *Brave New Seeds*, Zed Books, New York. Pinstrup-Anderson and Schioler, pp. 137-140.
 42. Bernauer, pp. 2ff.
 43. Ali Brac De La Perrifre and Seuret.
 44. Locke, John (1823) Essay, some thoughts concerning education, in *Works of John Locke*, London, pars. 103-110.
 45. Locke, pp. 25-127. Wenar, Leif (1998) Original acquisition of private property, *Mind* **107**: 799-819.
 46. Nozick, Robert (1974) *Anarchy, State, and Utopia*, Basic Books, New York, p. 174. Resnik, p. 36.
 47. Locke, pp. 4, 27, 28.
 48. Locke, pp. 6, 8. Cranston, Maurice (1957) *John Locke*, London, pp. 64-67, 208-209.
 49. Locke, p. 30.
 50. Locke, pp. 8, 30.
 51. Locke, pp. 135, 120. Macfarlane, L. J. (1970) *Modern Political Theory*, Nelson, London, p. 59.
 52. Locke, I, p. 42.
 53. Locke, p. 31.
 54. Locke, p. 50.
 55. Locke, p. 6. Tully. Scanlon, Thomas (1981) Nozick on rights, liberty, and property, in: Paul, J. (ed.) *Reading Nozick*, Rowman and Littlefield, Totowa, NJ, p. 126. Krinsky pp. 61-65.
 56. Locke, p. 45.
 57. Locke, p. 50.
 58. Locke, p. 40. Simmons, pp. 197-218.
 59. Locke, p. 40.
 60. Proudhon, P. (1898) *What Is Property?*, William Reeves, London, pp. 103-104. Mill, J. S. (1909) *Principles of Political Economy*, Kelley, Fairfield, NJ, pp. 5-6.
 61. George, p. 336; Becker, ch. 4.
 62. George, p. 342. Mautner, p. 267.
 63. Mautner, p. 267.

64. Locke, pp. 6, 25, 37 and I, p. 92. O'Neill, O. (1976) Nozick's entitlements, *Inquiry* **19**: 476. Leader, Sheldon (1999) Participation and property rights, *Journal of Business Ethics* **21**, no. 103: 97-109. Wolf 1995. Lea, David R. (1994) Lockean property rights, *Journal of Social Philosophy* **25**: 117-132. Tully. Vere 1992.
 65. Locke, p. 135. Held, V. (1976) John Locke on Robert Nozick, *Social Research* **43**: 175. Winfrey, J. (1981) Charity vs. justice: Locke on property, *Journal of the History of Ideas* **42**: 432. Wolf.
 66. Locke, pp. 6, 7, 11, 16, 23, 60, 79, 135, 159.
 67. Shrader-Frechette 1993.
 68. See Shrader-Frechette, Kristin (2003) *Environmental Justice: Creating Equality, Reclaiming Democracy*, Oxford University Press, New York.
 69. Taylor.
 70. Anderson, p. 96.
 71. Moore, G. E. 1951. *Principia Ethica*, Cambridge University Press, Cambridge.
 72. See National Research Council (1994) *Science and Judgment in Risk Assessment*, US National Academy of Sciences, Washington, DC.
 73. See, e.g., Dobarganes, M. Carmen, Marquez-Ruiz, Gloria and Perez-Camino, M. Carmen (1993) Thermal stability and frying performance of genetically modified sunflower seed (*Helianthus annuus* L.) oils, *Journal of Agricultural Food Chemistry* **41**: 678-681.
 74. Robbins 2003, p. 353
 75. Laudan, Larry (1994) *The book of risks*. Wiley, New York.
 76. Savchenko, V.K. (1996) *The Ecology of the Chernobyl Catastrophe*, Parthenon, London. Campbell, P. (1995) Chernobyl's legacy to science, *Nature* **380**: 653. See Shrader-Frechette 2003.
 77. See Bernauer, pp. 42-55.
 78. See Pinstrup-Anderson and Schioler, pp. 111-112, 128-133.
 79. Shrader-Frechette, Kristin (1991) *Risk and Rationality*. University of California Press, Berkeley.
 80. See Conway. Davis, P. and Onstead, D. (2000) Seed mixtures as a resistance management strategy, *Journal of Economic Entomology* **93**: 937-948.
 81. Conway.
-