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MARKET PRINCIPLES FOR PESTICIDES

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Pesticide use is one of the great evils of the modern environmental movement.[1] Pesticides threatened a "Silent Spring" in Rachel Carson's 1962 book of the same name[2] by removing song birds from American towns. Carson's book was enormously influential—former Vice President Al Gore, for example, cited it as an important part of his environmental awakening in

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[1] *See* BJØRN LOMBORG, THE SKEPTICAL ENVIRONMENTALIST 215 (Cambridge Univ. Press 2001) (1998) ("This message has been the legacy of Carson and has remained one of the major underpinnings of the environmental movement: our fear of chemicals."); *id.* at 226 (reporting that "75 percent of all Americans are extremely concerned or very concerned about pesticides").

[2] RACHEL CARSON, SILENT SPRING 103 (1962).

his campaign manifesto, *Earth in the Balance: Ecology and the Human Spirit*.[3] The threat continues today: A "circle of poison"[4] causes "workers, families, and communities" to be "slowly . . . poisoned by pesticides" in the developing world.[5]

Pesticide regulation was "reformed" in the aftermath of Carson's book, adding environmental considerations to the regulators' list of concerns and shifting regulatory power from the United States Department of Agriculture to the newly created Environmental Protection Agency ("EPA").[6] EPA's 1972 final cancellation of DDT's United States registration was widely touted as a great victory for the environment.[7] Environmental Defense, one of the major environmental pressure groups today, continues to tout its role in the DDT ban on its web site as an example of how citizen action can make a difference in policy.[8]

The new regime did produce major changes in regulatory behavior. Since 1972, EPA and pesticide manufacturers spent millions of dollars and years of effort to "re-register" most active ingredients under the new environment-friendly federal rules, canceling the registrations of some widely used chemicals and leading manufacturers to withdraw registrations on others.[9] New international agreements extend the benefits of this regime to

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[3] AL GORE, EARTH IN THE BALANCE: ECOLOGY AND THE HUMAN SPIRIT 3 (1992) ("I particularly remember my mother's troubled response to Rachel Carson's classic book about DDT and pesticide abuse, *Silent Spring*, first published in 1962. . . . She emphasized to my sister and me that this book was different—and important.").

[4] DAVID WEIR & MARK SHAPIRO, CIRCLE OF POISON: PESTICIDES AND PEOPLE IN A HUNGRY WORLD (1981).

[5] James H. Colopy, *Poisoning the Developing World: The Exportation of Unregistered and Severely Restricted Pesticides from the United States*, 13 UCLA J. ENVTL. L. & POL'Y 167, 167 (1994/1995).

[6] *See* Andrew P. Morriss, *Pesticides and Environmental Federalism: An Empirical and Qualitative Analysis of §24(c) Registrations*, in ENVIRONMENTAL FEDERALISM 137-45 (Terry L. Anderson & Peter J. Hill eds., 1997) (summarizing history of pesticide laws).

[7] *See, e.g.*, Jerry L. Anderson, *The Environmental Revolution at Twenty-Five*, 26 RUTGERS L.J. 395, 420-21 (1995) ("Taking DDT completely out of the stream of commerce has resulted in a tremendous improvement in environmental quality and species protection." (citation omitted)).

[8] Environmental Defense still prominently features its work on DDT on its web site. *See* ENVTL. DEFENSE, 2002 ANNUAL REPORT, *available at* http://www.environmentaldefense.org/documents/2506_R2002.pdf (last visited Aug. 30, 2003).

[9] WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW 480-87 (2d ed. 1994) (reviewing cancellations and other impacts of changes in registration to include environmental considerations); *see also* CHRISTOPHER J. BOSSO, PESTICIDES AND POLITICS: THE LIFE CYCLE OF A PUBLIC ISSUE 200 (1987); Morriss, *supra* note 6, at 144-45 (describing problems with registration and re-registration programs).

other countries, pushing bans on "persistent" pesticides elsewhere to complement the United States' actions.[10]

This sounds like a successful example of a centralized command and control regulatory regime. And yet, there are reasons to doubt that central planning[11] produced success. Overall, pesticide use is growing in developing

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[10] *See* Erin Perkins, *The Stockholm Convention on Persistent Organic Pollutants: A Step Toward the Vision of Rachel Carson,* 2001 COLO. J. INT'L. ENVTL. L. & POL'Y 191, 191-92, 194-96, 197-99 (describing negotiation of Persistant Organic Pollutants ("POPs") treaty).

[11] For a general discussion of central planning in the environmental context, see IAN WILLS, ECONOMICS AND THE ENVIRONMENT: A SIGNALLING AND INCENTIVES APPROACH 103-120 (1997). Farm programs generally fit this definition and environmental regulations have increased the central planning component. This can be seen in the increasingly mandatory nature of agricultural regulation. "During the past thirty years, federal regulation of the resources used in agriculture has shifted from giving technical and educational support to farmers to make voluntary decisions on conservation practices to imposing criminal penalties on farmers for carrying out what had been routine farm practices." John K. Hosemann, *Agriculture and the Environment: A Thirty-Year Retrospective, in* AGRICULTURAL POLICY AND THE ENVIRONMENT 174 (Roger E. Meiners & Bruce Yandle eds., 2003).

Others might disagree with us that the Federal Insecticide, Fungicide, and Rodenticide Act ("FIFRA") is a central planning regime, something we plan to address in detail in future work. Professor J. B. Ruhl, for example, a thoughtful critic of agriculture and the environment, writes:

> In short, so long as the label instructions are followed, the applicator is properly certified and the applicator follows worker safety and recordkeeping requirements, FIFRA imposes no direct restrictions or requirements on farms. While this does not amount to a complete safe harbor for farm use of pesticides, FIFRA's hands-off approach to farms—the primary users of pesticides—pales in comparison with the CAA's and the CWA's regulatory approach to their targeted industries. Under FIFRA, with regard to farmers, no permits are required, no environmental or efficiency performance standards are imposed, no technology-based standards are applied, no regular public reporting of pesticide applications is required, and no monitoring of pesticide levels in soils, runoff, or groundwater is required. Although some states regulate pesticide applications more aggressively than does FIFRA, it is fair to say that the nation has no comprehensive regulatory framework governing farm use of pesticides.

J.B. Ruhl, *The Environmental Law of Farms: 30 Years of Making a Mole Hill Out of a Mountain,* [2001] 31 Envtl. L. Rep. (Envtl. L. Inst.) 10,203, 10,215 (2001). Despite this laxity, we contend that FIFRA is central planning because it rests upon a regulator determining the products that may be applied to particular crops and the conditions under which those products may be used. EPA does not, however, tell manufacturers how much of each product to produce or dictate to farmers when they must apply particular products. That EPA has not adopted a planning regime that includes such details does not make what it does any less of a centrally planned regime. The debate between "market socialists" and market economists in the 1930s and 1940s over proposals to substitute planned economies that relied on markets for some aspects of decision making to solve technical planning problems established this. *See* FRIEDRICH A. HAYEK, THE ROAD TO SERFDOM (1944).

countries.[12] United States' pesticide use changed in content, but remains substantial in volume.[13] Critics of pesticide policy, including many of the speakers at this symposium, are concerned that pesticide problems are worsening.[14] Surprisingly, thirty years after the Federal Insecticide, Fungicide, and Rodenticide Act ("FIFRA") reforms and the victory over DDT, the critics are not yet prepared to declare victory. Even worse from the perspective of environmental pressure groups is the change in attitude toward DDT, a substance whose name invokes extraordinary invective,[15] where the current picture is not quite what the advocacy groups predicted. The *New York Times* recently joined public health advocates in favoring the continued use of DDT to combat malaria in developing countries.[16] As a result, environmental pressure groups have been forced to retreat from their goal of a global ban on DDT.[17]

Is command and control regulation of pesticides a success story? We contend that it is not. Instead we argue that the regulatory structure created by FIFRA is inferior to the outcomes obtainable under a market approach to pesticides. To make our argument, we first outline current pesticide use and reasons farmers continue to use them in Part I. We then describe the principles that inform a market approach to environmental problems in Part II, followed by a discussion on how decisions about pesticide use are made, something that the current regulatory structure largely ignores. Next, in Part

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[12] *See, e.g.*, World Resources Institute Report 1998-1999.

[13] *See, e.g.*, Ruhl, *supra* note 11, at 282-83 (discussing increase in use and citing primary sources).

[14] *See, e.g.*, Pep Fuller & Thomas O. McGarity, *The Bush Administration's Cautious Approach to Listing New Persistent Organic Pollutants and the Future of the POPs Convention*, 28 WM. & MARY ENVTL. L. & POL'Y REV. 1 (2003); Kristina Thayer & Jane Houlihan, *Pesticides, Human Health and the Food Quality Protection Act*, 28 WM. & MARY ENTL. L. & POL'Y REV. (forthcoming Winter 2004) (2004); *see also* JOHN WARGO, OUR CHILDREN'S TOXIC LEGACY: HOW SCIENCE AND LAW FAIL TO PROTECT US FROM PESTICIDES (2d ed. 1996). It is not at all clear that the litany of harms is correct. *See* LOMBORG, *supra* note 1, at 226-48 (discussing evidence on pesticides and concluding that stopping pesticide use would save twenty lives per year at a cost of $20 billion per year and 26,000 increased deaths from cancers). For a critique of environmental groups' anti-pesticide campaigns, see JONATHAN H. ADLER, ENVIRONMENTALISM AT THE CROSSROADS: GREEN ACTIVISM IN AMERICA 38-40 (1995).

[15] *See, e.g.*, Patrick Parenteau, *She Runs with Wolves*, 21 VT. L. REV. 743, 747 (1997) ("DDT was not just a pest killer, it was an eagle killer, an osprey killer, a peregrine falcon killer, an indiscriminate killer.").

[16] *Fighting Malaria with DDT*, N.Y. TIMES, Dec. 23, 2002, at A24.

[17] *See* Don Mayer, *The Precautionary Principle and International Efforts to Ban DDT*, 9 S.C. ENVTL. L.J. 135, 175-78 (2002) (describing negotiations over DDT provisions in POPs treaty).

III, we briefly outline four examples that illustrate the problems with centralized regulatory solutions and the superiority of decentralized approaches to environmental problems. We conclude in Part IV by offering some policy principles for pesticides.

The reader should note that this Article is not a comprehensive statement of the case against central planning in pesticides, something that space considerations prevent here and which we hope to provide in the future. Rather, because of the power of the pesticide "fables" that currently dominate the current debate,[18] our goal is simply to suggest that there are alternatives to FIFRA and other one-size-fits-all rules, such as the ban on DDT production, that need to be considered.

I. PESTICIDE USE

People use a lot of pesticides each year, and a significant proportion of pesticides applied are used in the United States. In the United States alone, estimates are that more than seven hundred million pounds of pesticides are used by farmers each year, at a cost of over $4 billion.[19] It appears technically

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[18] We echo Jonathan Adler's application of the word "fable" to environmental history. *See* Jonathan H. Adler, *Fables of the Cuyahoga: Reconstructing a History of Environmental Protection*, 14 FORDHAM ENVTL. L.J. 89, 146 (2003). Adler, writing the first comprehensive account of the famed 1969 fire on the Cuyahoga River, described the fire as a "fable" because the term connotes,

> a fictitious narrative that nonetheless conveys an important truth. *See, e.g.*, MERRIAM-WEBSTER'S COLLEGIATE DICTIONARY 415 (10th ed. 1998) (defining a fable as "a fictitious narrative or statement: as," among other things, "a narration intended to enforce a useful truth."). The fables of the Cuyahoga are narratives of the river's plight which purportedly explain the evolution of federal water pollution controls.

Id. at 93 n.14. Adler concludes that:

> [w]hile it is relatively easy to identify the failings of existing fables, it is difficult to construct an alternative narrative that does not present problems of its own. History, unlike a fable, is nuanced and complex.... There are many threads which may be woven together to generate many different fables. Some will be more consistent with the data than others. None will be a perfect fit.

Id. at 146. Our alternative fables, set forth below, lack the nuance and complexity of the complete story of each of these episodes. Our point is not to write the definitive history of each of these—something the space limitations of a single symposium article would not permit—but to illustrate some of the several important truths that the dominant versions of these fables do not include.

[19] David Pimentel et al., *Environmental and Economic Effects of Reducing Pesticide Use in Agriculture*, 46 AGRIC., ECOSYSTEM & ENV'T 273, 273 (1993). *But see* John R. Finney, *Optimizing the Use of Pesticides*, 42 PESTICIDE SCI. 69, 69 (1994) ("there is general

feasible to significantly reduce the amount of pesticides used.[20] Why then are so many pesticides used?[21] We find that this is a puzzle for the command and control proponents in the pesticide literature, because it requires them to reconcile farmers and ranchers' behavior, the deliberate introduction into the environment of pesticides, which is, to them, a bad thing, with their Jeffersonian view of small farmers as morally privileged.[22] Central planning advocates often resolve the puzzle by postulating that farmers and ranchers who use pesticides do so because they are tricked by chemical companies, ignorant of the consequences of pesticide use, or, in the case of "corporate" farmers,[23] are deliberately sacrificing the general welfare for corporate profits.[24]

Pesticides are an input into agriculture and are used because they produce a sufficient increase in crop yield, including crop quality, to at least cover the cost to the decision maker of using them. In short, farmers use pesticides because they make more money when they use them than when

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agreement that, in the absence of pesticides, global crop yields would be at least 30% lower overall").

[20] Pimentel et al., *supra* note 19, at 273 ("Several studies suggest that it is technologically feasible to reduce pesticide use in the US by 35-50% without reducing crop yields.").

[21] By far the most important use of pesticides in the United States is in agriculture, using approximately eighty percent of pesticides used in the United States. David Pimentel et. al., *Environmental and Social Costs of Pesticides: A Preliminary Assessment, in* 1 CRC HANDBOOK OF PEST MANAGEMENT IN AGRICULTURE 721 (David Pimentel ed., 2d ed. 1990). There are other important uses, such as pest control in homes, but we will focus on agricultural use since it is the target of much of the criticism.

[22] *See* Peter J. Hill, *What's So Special About the Farm?, in* AGRICULTURAL POLICY AND THE ENVIRONMENT, *supra* note 11, at 1, 12-13 (discussing role of family farm ideology in agricultural policy making).

[23] Environmental pressure groups have trouble with family farmers' use of pesticides in particular, because they glorify small scale agriculture, much as the anti-tobacco movement has trouble with determining how to treat tobacco farmers. For one of the few environmental writers to write critically of small farms, see Deborah L. Donahue, *Justice for the Earth in the Twenty-First Century,* 1 WY. L. REV. 373 (2001). For a more nuanced, but still critical view of farms and the environment, see Ruhl, *supra* note 11, at 10,203 ("The plain truth is that farms pollute groundwater, surface water, air, and soils; they destroy open space and wildlife habitat; they erode soils and contribute to sedimentation of lakes and rivers; they deplete water resources; and they often simply smell bad.").

[24] *See, e.g.,* GORE, *supra* note 3, at 184 (recounting "short term" perspective that leads to heavy pesticide use).

> People who lease the land for short-term profits often don't consider the future. From fence row to fence row, they strip-mine the topsoil and move on. And even if you own the land, it's hard to compete in the short term against somebody who doesn't care about the long term.

Id. at 3.

they do not.[25] Their willingness to spend substantial amounts, such as $8.5 billion in 1996, is convincing evidence that farmers find pesticide use profitable.[26] Any pesticide policy that hopes to have an impact on pesticide use will have to take this fact into consideration rather than relying on assumptions of farmer ignorance or disregard for the environment. Unfortunately, most of modern pesticide policy does not do so.[27] We will return to that point shortly, but let us consider the use decision in more detail first.

At the risk of grossly oversimplifying the decision making process, let us consider the alternatives a farmer faces in growing her crops. First, our farmer must decide what to grow, as a great deal of agricultural land will support more than one type of crop. As "[s]election of a particular crop to grow is likely the single most important pest management decision a grower will make,"[28] this has a significant impact on pesticide use. For example, crop land in northern Ohio where one of us lives can be used to grow both soybeans and corn (and other things too). Land can also be left fallow, to "rest" it and improve its productivity, because crop prices do not support its use, because weather prevents timely planting, due to payments to take it out of production for conservation purposes, or many other reasons. Second, when should the farmer plant? Delaying planting can reduce the need to use herbicides, for example, but also reduces yields.[29] Third, having decided what to grow, our farmer must decide how intensively she will farm her land. Should she plant "hedgerow to hedgerow" or leave buffer strips that protect

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[25] Pimentel et al., *supra* note 19, at 274 ("Dollar returns for the direct benefits to farmers have been estimated to range from $3 to $5 for every $1 invested in the use of pesticides . . . ."). Farmers also use pesticides as a form of insurance, to reduce risk. *See* J. Palti, *Farmers' Perceptions of Pest and Disease Control, in* ADVISORY WORK IN CROP PEST AND DISEASE MANAGEMENT 20 (J. Palti & R. Ausher eds., 1986); Craig D. Osteen, *The Policy and Economic Issues of Pest Control and Energy Use, in* ENERGY IN PLANT NUTRITION AND PEST CONTROL 271-72 (Zane R. Helsel ed., 1987) (discussing impact of risk aversion on pesticide use).

[26] JORGE FERNANDEZ-CORNEJO & SHARON JANS, DEP'T OF AGRIC., PEST MANAGEMENT IN U.S. AGRICULTURE 1 (Agric. Handbook No. 717, 1999).

[27] *See* Donald T. Hornstein, *Lessons from Federal Pesticide Regulation on the Paradigms and Politics of Environmental Law Reform,* 10 YALE J. ON REG. 369, 392 (1993) ("it is important to underscore what pesticide regulation is not: it is not a body of law that addresses in any strategic way the underlying prevalence of pesticides in American agriculture, nor is it a body of law designed to minimize pesticide use"). We disagree with much of Prof. Hornstein's analysis, but agree with his assessment of the lack of a systematic approach in pesticide law.

[28] M. Barrett & W.W. Witt, *Alternative Pest Management Practices, in* ENERGY IN PLANT NUTRITION AND PEST CONTROL, *supra* note 25, at 197, 197.

[29] *Id.* at 204.

streams and neighboring land from "drift" of any chemicals she might apply to the land? Should she use fertilizers to increase productivity? Should she spray herbicides to control weeds, use bioengineered crop strains to allow enhanced herbicide use, substitute labor for chemicals and have weeds removed by hand, change tilling practices to affect weed growth, or some combination of the above? Should she spray for insects whenever she sees a destructive species in the field or use a sophisticated computer model to predict when the economic threshold has been reached that justifies spraying?[30] If she sprays, should the pesticide be applied by hand? By plane? By tractor? What should she spray? Or should she drop chemical use altogether and become an organic farmer? Even if we pretend that these decisions need be made only once per season, when many of them must be made almost daily, it is easy to see that pesticide use is merely a small part of a complex set of business decisions that farmers must make.

Pesticides are an expensive input[31] and farming is a low margin business.[32] It seems unlikely, therefore, that farmers would routinely make uninformed and incorrect decisions about pesticide use that cost them money. Certainly farmers that did routinely make bad decisions about pesticides would be throwing away money, either by needlessly applying an expensive input to their land or by allowing weeds or insects to unnecessarily and unprofitably reduce their crop yields. Those farmers would be at a competitive disadvantage compared to farmers who made smarter decisions about pesticides and, in time, would be driven out of business. The market should work and optimal pesticide decisions should result.

This picture is not quite right, however. There are three major problems with the simple market story. First, the economic calculations of farmers are subject to massive distortion from government agricultural programs. Second, pesticides have impacts beyond the fields in which they are applied, what economists usually call "externalities." These impacts may mean that farmers' decisions, based on the costs and benefits of pesticides to farmers and optimal from each individual farmer's perspective, are not socially opti-

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[30] *See* C.H. Blazquez et al., *Remote Sensing by Aerial Infrared Colour Photography as an Aid in Monitoring Crops for Pests and Diseases, in* ADVISORY WORK IN CROP PEST AND DISEASE MANAGEMENT, *supra* note 25, at 103, 103-06 (describing several such systems).

[31] *See, e.g.*, H. Frankel, *Pesticide Application: Technique and Efficiency, in* ADVISORY WORK IN CROP PEST AND DISEASE MANAGEMENT, *supra* note 25, at 132, 156 ("Pesticides must be used at their lowest effective doses, because they are expensive . . . .").

[32] *See generally,* Ruhl, *supra* note 11 (discussing farm economics in the context of environmental issues).

mal as social costs and benefits may diverge from private costs and benefits.[33] Third, pesticides serve an important function for farmers beyond killing pests; using pesticides serves as a form of insurance for farmers.[34]

Nonetheless, there is a powerful incentive not to throw money away on inputs that do not add value. The technological feasibility of reducing pesticide use is not the only issue; the economic feasibility is also important. For example, even Dr. Pimentel and his colleagues, who argue pesticide use could be substantially cut, concede that doing so would require additional expenditures of $1 billion.[35] In particular, pesticides are a substitute for labor in many instances.[36] Spraying an herbicide on a cotton field is a substitute for using manual labor to remove weeds.[37] There are social and environmental impacts of the substitution in addition to the possible social costs of using the herbicide that need consideration in any attempt at a cost-benefit analysis. Farm labor, for example, is dangerous, unpleasant work often performed by children.[38] Limiting the availability of herbicides for cotton will most likely lead to increased child labor, increased injuries to children working in the fields,[39] and decreased availability of education for farm worker children[40] as farmers substitute labor for chemical weed control. Hand weeding also has

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[33] *See, e.g.*, Pimentel et al., *supra* note 19, at 274 (noting indirect costs).

[34] *See* J.D. Mumford, *A Study of Sugar Beet Growers' Pest Control Decisions*, 97 ANNALS APPLIED BIOLOGY 243, 248 (1981) ("Insurance was the principle reason for using insecticides for 44 of the farmers interviewed [of 60]."); *see also* Hornstein, *supra* note 27, at 397-98 (describing insurance theory of pesticide use).

[35] Pimentel et al., *supra* note 19, at 283.

[36] Maurice B. Green, *Energy in Pesticide Manufacture, Distribution and Use*, *in* ENERGY IN PLANT NUTRITION AND PEST CONTROL, *supra* note 25, at 165, 176-77 (noting that pesticides substitute capital and energy for labor); Osteen, *supra* note 25, at 267 ("Pesticides have displaced more labor-intensive methods of pest control such as cultivation."); K.M. Jones et al., *Spray Application Technology*, 31 PLANT GROWTH REG. 173, 174 (2000) (noting that labor costs led to adoption of hydraulic, air-blast equipment in place of hand lances because the former were "faster and less labour intensive"); *see also*, Pimentel et al., *supra* note 19, at 281 ("It would be possible to reduce herbicide use on corn by up to 60% if the use of mechanical cultivation and rotations were increased.").

[37] G.A. MATTHEWS, PESTICIDE APPLICATION METHODS 4 (3d ed. 2000) ("Herbicide use has increased most where labour costs are high, there is a peak labour demand, or where mechanical hoeing will cause damage to the young crop.").

[38] *See* HUMAN RIGHTS WATCH, FINGERS TO THE BONE: UNITED STATES FAILURE TO PROTECT CHILD FARMWORKERS (2000), *available at* http://www.hrw.org/reports/2000/frmwrkr/.

[39] Frank B. Cross, *Paradoxical Perils of the Precautionary Principle*, 53 WASH. & LEE L. REV. 851, 871-72 (1996).

[40] *See* Teresa Young Reeves, *Harvest of Danger: The Child Farmworker in the United States*, 8 HUMAN RIGHTS BRIEF 12, 14 (2001) ("According to a 1991 study by the U.S. Department of Education, the impact of the farmworker lifestyle on education showed 80 percent of adult migrant farmworkers function at a fifth grade literacy level or less.").

environmental costs as it causes "general disturbance of [the] soil" that "can increase erosion of some soils."[41] Deciding whether the social costs outweigh the social benefits of pesticide use is thus not an easy task—and much more difficult than much of the central planning pesticide literature suggests.

Modern pesticide policy is built around fixing the so-called externality problems through a centralized, command and control regulatory regime.[42] Pesticides may only be used if EPA, the central regulator, determines that they may.[43] In evaluating pesticides, EPA considers the crop losses that will result if a particular pesticide is not available, the environmental impact of the pesticide's use, and the human health effects.[44] It then grants permission for specific uses,[45] requires specific language explaining the proper methods of use on the pesticide's label,[46] and prohibits the use of the pesticide for anything other than the approved uses.[47] At least in theory, EPA balances the benefits and costs, allowing only pesticides that produce a net benefit.[48] Reasonable people, and unreasonable people too, might disagree over particular cost-benefit calculations or interpretations of toxicity data, but the data should confine those disagreements to a relatively narrow band.[49] They often do not because of the deep value differences between agricultural interests and environmental pressure groups over issues such as how to factor in uncertainty.[50]

Unfortunately, this approach neglects the economic calculations made by farmers about pesticide use. Simply announcing a rule and the penalties for disobeying it are insufficient to change behavior in many instances.[51]

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[41] MATTHEWS, *supra* note 37, at 4.
[42] *See* David Haddock, When Are Environmental Amenities Policy Relevant? (2003) (Working Paper, Northwestern University School of Law, on file with authors).
[43] *See* 7 U.S.C. § 136(a) (2000) ("registration pesticides"); 7 U.S.C. § 136(p) (2000) (including emergency registration provisions); 7 U.S.C. § 136(v) (2000) (including special local needs registrations).
[44] *See* Osteen, *supra* note 25, at 277-79 (discussing alternative pesticide availability as a factor in EPA's decision making).
[45] *See* 7 U.S.C. § 136(a) (2000).
[46] RODGERS, *supra* note 9, at 470-79 (discussing labeling requirements).
[47] There are a host of other regulations as well, requiring those using particular pesticides to be licensed to do so, allowing minor variations on uses to deal with emergencies or special local needs but the basic structure of the program is as described.
[48] RODGERS, *supra* note 9, at 449-55 (discussing registration process).
[49] We recognize that some farmers make rational economic calculations to avoid pesticide use. *See* J. BISHOP GREWELL & CLAY J. LANDRY, ECOLOGICAL AGRARIAN: AGRICULTURE'S FIRST EVOLUTION IN 10,000 YEARS 17-18 (2003).
[50] *See generally* BOSSO, *supra* note 9.
[51] Anyone who doubts this should simply reflect on the continued existence of various crimes

Rather, pesticide policy needs to recognize that farmers use pesticides primarily because they make more money when they do so than when they do not.[52] Farmers may be mistaken about particular facts that influence their decisions, but they are unlikely to be either systematically fooled by chemical companies or so ignorant as to make systematic errors in favor of excessive pesticide use.[53]

Where there are information problems that lead to over-use, correcting the underlying information problem is almost always more effective and less expensive than other means of solving the problem[54]—if only because identifying the problem presumes that the regulator has already obtained the information the farmer needs. Even the much lamented shift to "corporate" farming[55] cuts in favor of such solutions over command and control solutions.

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despite laws forbidding them, including crimes dangerous to the participants. *See* Randy Barnett, *Bad Trip: Drug Prohibition and the Weakness of Public Policy*, 103 YALE L.J. 2593 (1994) (reviewing STEVEN B. DUKE & ALBERT C. GROSS, AMERICA'S LONGEST WAR: RETHINKING OUR TRAGIC CRUSADE AGAINST DRUGS (1993)).

[52] *See, e.g.*, Barrett & Witt, *supra* note 28, at 226 ("To the farmer, the most important analysis is the return on the investment in weed control costs.").

[53] We do not contend that farmers never make mistakes. There is ample evidence that they do. *See, e.g.*, M. Barrett & W.W. Witt, *Maximizing Pesticide Use Efficiency, in* ENERGY IN PLANT NUTRITION AND PEST CONTROL, *supra* note 25, at 235, 245 (noting that calibrations are frequently incorrect on farmers' equipment). What we are arguing is that such errors are rarely systematically in the direction of unnecessary use of an expensive product. Thus, for example, the calibration errors noted above have thirty-two percent of farmers applying ten percent or more below the intended rate and thirty percent of farmers applying ten percent or more above the intended rate, a rough equivalence. *Id.* Moreover, the fact that more precise calibration is possible does not mean it is economically feasible. Calibrating equipment has a cost and will only be done to the extent it repays the cost of doing so. Farmers who overspray and could have a net increase in profits if they calibrated their equipment more precisely will suffer economically compared to those who do calibrate their equipment more precisely. *See, e.g.*, B.S. Butler & L.E. Dode, *Effects of Application Methods in Energy Use, in* ENERGY IN PLANT NUTRITION AND PEST CONTROL, *supra* note 25, at 235, 263-65. Farmers who overspend on calibration, however, will also suffer economically compared to those who do not. *Id.*

Prof. Hornstein hypothesizes that farmers may use excessive pesticides due to the existences of prisoner's dilemmas, tragedies of the commons, or externalities. *See* Hornstein, *supra* note 27, at 396. In the absence of data demonstrating that these effects are present, we argue that they are an inadequate basis for policy.

[54] *See, e.g.*, Mumford, *supra* note 34, at 250 (noting English sugarbeet growers accurately assess risk of loss from a virus but overestimate efficacy of pesticide treatments).

[55] *See, e.g.*, Donahue, *supra* note 23, at 376 ("Our devotion to the family farm and ranch, which dates to Thomas Jefferson's time, continues to provide the gloss on, if not the impetus for, most of our national and state agricultural policies."). *But see* Hosemann, *supra* note 11, at 173-74, 185 (arguing increasing scale of farming improves environmental quality while giving an example of lessened impact of planting and harvesting due to increased scale of operations).

Corporations, as their critics constantly point out,[56] are about making money and throwing away money on unnecessary inputs is not something that markets reward.[57]

Modern pesticide policy says almost nothing about the first problem, however. Almost every aspect of a farmer's decision making is distorted by government-led agricultural programs.[58] Which crop to plant, how intensively to farm, whether to let fields lie fallow in some years, and whether to maximize output are all questions that a rational farmer cannot make without considering agricultural programs.

The net effect of these programs is an increase in pesticide use. For example, the cotton price support program increases pesticide use by ten percent according to one estimate.[59] Soybeans are heavily subsidized,[60] leading more farmers to plant them than would otherwise[61] and are also a crop with extensive pesticide use.[62] Corn production is increased by the sugar program, which raises the price of sweeteners, thereby raising corn production to produce more corn sweeteners.[63] The ethanol program also increases

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[56] *See, e.g.*, Beth Stephens, *The Amorality of Profit: Transnational Corporations and Human Rights*, 20 BERKELEY. J. INT'L L. 45, 46 (2002).

[57] The "six sigma" approach to quality control is a good example of the rewards of close attention to costs through reducing defects. *See, e.g.*, George Eckes, *Making Six Sigma Last (and Work)*, IVEY BUS. J., Jan.-Feb. 2002, at 77, 77 (describing how six sigma quality control process "has helped save billions of dollars while improving customer satisfaction ratings and stock prices as well"). For a general description of how companies focus on quality control to save money, see Michael Arndt, *Quality Isn't Just for Widgets*, BUS. WK., Jul. 22, 2002, at 72.

[58] *See* BOSSO, *supra* note 9, at 63-64 ("Federal agricultural policy, whether Democratic or Republican in origin, in many ways unwittingly promoted heavier pesticides use.").

[59] Pimentel et al., *supra* note 19, at 280.

[60] The 2002 farm bill, for example, offered a support price of $5.00/bushel for soybeans, whose market price had been $4.10-4.40/bushel the year before. By comparison, the support price for corn was only $1.98/bushel compared to market prices the preceding year of $1.85-1.95. The support price for wheat was set at $2.80/bushel compared to prior year market prices of $2.75-2.85/bushel. *See* David Rogers, *House Passes Massive Farm Bill*, WALL ST. J., May 3, 2002, at A12. Soybeans' subsidy of thirteen to twenty-two percent over market, compared to corn's subsidy of two to three percent above market and wheat's subsidy of 1.7% to -1.5%. *See id.*

[61] *See, e.g.*, Peter Harriman, *Conversions to Farmland Threaten S.D. Environment*, ARGUS LEADER, Apr. 8, 2003, at A4 (describing how federal agricultural programs for soybeans are harming wildlife habitat in South Dakota), *available at* 2003 WL 6770627.

[62] Pimentel et al., *supra* note 19, at 281.

[63] *See* Ctr. for Responsive Politics, *The Politics of Sugar: The 1990 Farm Bill*, *at* http://www.opensecrets.org/pubs/cashingin_sugar/sugar05.html (last visited Aug. 31, 2003) (noting that corn producers receive $548 million per year in benefits from the sugar subsidy program's increase in sugar prices' influence on corn sweetener sales).

corn production.[64] As corn is one of the most chemical intensive crops, these subsidies also boost pesticide use.[65] Indeed, the four crops accounting for the vast majority of American pesticide use—corn, cotton, soybeans, and wheat[66]—are all heavily subsidized. The structure of many farm programs also encourages intensive use of limited land rather than less-intensive use of more land,[67] thus promoting use of inputs that raise yield, such as pesticides and fertilizers, and discouraging practices that minimize the impacts of those inputs, such as leaving buffer strips[68] between fields and streams. "Each farmer's rational response [to acreage based programs] could be but one thing—take the cash, and then maximize profits by producing as much as possible on the unrestricted acreage."[69]

Failing to recognize the importance of agricultural programs on farmers' decisions to use and not use pesticides dooms those programs to failure. A centralized regulatory scheme can work only when regulators have access to and consider the relevant information set.[70] Can it succeed at more limited objectives? Pesticide registration can certainly keep some harmful products from the market if it is built around appropriate data requirements and has sufficient technical resources to evaluate the data it requires.

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[64] The ethanol program uses approximately seven percent of the United States' corn crop. Gary D. Liebcap, *Agricultural Programs with Dubious Environmental Benefits: The Political Economy of Ethanol, in* AGRICULTURAL POLICY AND THE ENVIRONMENT, *supra* note 11, at 89, 90. For critiques of the environmental consequences of the ethanol program and discussion of the special interest politics underlying it, see *id.* (describing ethanol program and its environmental impacts); Jonathan H. Adler, *Clean Politics, Dirty Profits: Rent Seeking Behind the Green Curtain, in* POLITICAL ENVIRONMENTALISM: GOING BEHIND THE GREEN CURTAIN 1, 9-13 (Terry L. Anderson ed., 2000).

[65] Zane R. Helsel, *Pesticide Use in World Agriculture, in* ENERGY IN PLANT NUTRITION AND PEST CONTROL, *supra* note 25, at 179, 189 (writing that corn is one of the top two crops for herbicides and is the top crop for insecticides).

[66] FERNANDEZ-CARNEJO & JANS, *supra* note 26, at 3 ("In 1995, four crops—corn, soybeans, cotton, and wheat—accounted for more than 85 percent of the herbicides used, and two crops (corn and cotton) accounted for nearly 65% of the insecticides used.").

[67] BOSSO, *supra* note 9, at 29 (noting that "[c]ontrols were placed on acreage, not production" meant farmers increased intensity of farming on acres planted. (quoting HARRISON WELLFORD, SOWING THE WIND 253 (1972))); Hosemann, *supra* note 11, at 173 ("On balance, government-sponsored research, direct government subsidy payments to farmers, and commodity price guarantees have resulted in high-tech, high-yield intensive agriculture.").

[68] Graham A. Matthews & Neale Thomas, *Working Towards More Efficient Application of Pesticides,* 56 PEST MGMT. SCI. 974, 975 (2000) ("The aim of these buffer zones is to protect sensitive ecological areas, especially water surfaces downwind of fields sprayed with pesticide.").

[69] BOSSO, *supra* note 9, at 29.

[70] WILLS, *supra* note 11, at 103-20 (describing limits of central planning approach to environmental problems).

The question is not whether it is theoretically possible to identify harmful chemicals in advance, however, but whether the net impact of screening new products will be positive. Registration is expensive—a single new product is estimated to cost $40 to $80 million to develop.[71] As a result, companies introduce fewer new products than would be introduced in the absence of registration. If most of the products avoided are worse than existing products, this would not be a problem. If, on the other hand, newer pesticides are better for the environment than older ones, slowing innovation could be harmful as it delays the introduction of environmentally safer products. There is some evidence that newer products are generally preferable on environmental grounds to older products,[72] suggesting that the slowing of innovation caused by the expense of registration is harmful to the environment.

To briefly summarize, pesticide use is a complex decision made by individuals in response to a variety of factors.[73] Among the most important of these factors is the impact of agricultural programs that change farmers' decisions about how to conduct their businesses. To successfully influence pesticide use, regulatory programs must take into account these factors, and the current command and control structure does not do so effectively, and cannot be expected to because of the special interests that dominate agricultural and environmental policy.

II. FREE MARKET ENVIRONMENTALISM

An alternative to central planning is reliance on decentralized institutions, including the common law and markets. The market approach to environmental issues is based on a few simple principles. These include:

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[71] Roger Anthony Downer, The Impact of Spray Modifiers on Pesticide Dose Transfer 2 (1998) (unpublished Ph.D. dissertation, University of Portsmouth); Green, *supra* note 36, at 176 ($74 million estimate).

[72] *See infra* note 114.

[73] Frankel, *supra* note 31, at 132.

> Optimal application methods can be defined only when account is taken of all factors influencing the dispersal of the pesticide over its target surface, and its deposition and adherence to that surface. Also to be taken into consideration are the characteristics of the pest, its mobility and site on the host, as well as environmental conditions, such as temperature, relative humidity and air movement.

Id.; *see also* Mumford, *supra* note 34, at 243 ("A farmer's pest control decision is determined by his goals (which influence the decision rules by which he chooses control actions), the range of protection measures of which he is aware and able to employ, and his perceptions of the hazard posed by pests and the effectiveness of controls . . . .").

- Market incentives spur individuals to conserve resources and protect environmental quality;
- Private property rights encourage stewardship of resources;
- Polluters should be liable for the harm they cause others; and
- Government subsidies often degrade the environment.

Let us consider briefly why each of these principles is important for improving environmental quality.

Free market environmentalism falls on the Coasian side of the Coase-Pigou divide.[74] Coasian analysis emphasizes "contract and property-rights enforcement and relies on market successes" while Pigovian analysis focuses on market failures and government action to correct those failures.[75] The great advantage of the Coasian approach is that it need not solve the central planner's problem of simultaneously preventing regulatory capture and gathering sufficient information to be able to select the appropriate policy. By emphasizing decentralized markets and neutral legal principles, Coasian solutions sidestep these hard problems; problems that, as our next section illustrates, are important obstacles to coherent pesticide policy. Pigovian analysis, on the other hand, requires a great deal of knowledge to calculate optional subsidies and taxes to induce people to conform to the calculated social optimum behaviors.

A. *Market Incentives*

It is a common practice in environmental literature to blame markets for environmental problems. For example, market critics often note that polluters use the atmosphere or rivers as "free" disposal services, causing pollution. Although such things occur, it is also important, but less common, to consider whether markets play a role in protecting the environment as well.

Markets can help the environment in two crucial respects. First, when resources are allocated by markets, resource owners are subject to the discipline of the marketplace

> because the wealth of the property owner is at stake if bad decisions are made. Moreover, if private owners can sell their

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[74] *See* Bruce Yandle, *Public Choice and the Environment: From the Frying Pan to the Fire*, *in* POLITICAL ENVIRONMENTALISM: GOING BEHIND THE GREEN CURTAIN, *supra* note 64, at 31, 34-35.

[75] *See id.* at 33-39 (elaborating on distinction between two approaches).

> rights to use resources, the owners must not only consider their own values, they must also consider what others are willing to pay. In the market setting, it is the potential for gains from trade that encourages cooperation.[76]

Markets thus allow resource use to change based on changing conceptions of value, force resource owners to consider the long-term value of their assets and the impact of their actions upon that value, and offer individuals who disagree with others' resource allocation decisions the opportunity to bid the resources away from those with whom they disagree about appropriate use.[77]

Second, when markets are involved, transactions benefit from the market's power to convey information in a concise, low-cost format.[78] Markets solve what Nobel Laureate Friedrich Hayek called the "information problem."[79] Making decisions about resources requires knowing a great deal of information about alternative uses of those resources. For example, if someone is trying to decide whether or not to buy a particular car, the buyer must know what her alternatives are for transportation. Could she ride public transit to her destinations instead? Which model car offers the best combination of features (mileage, leg room, safety, amenities such as CD players and leather seats) for her needs? Markets assist in making such evaluations by reducing much of the information to easy-to-understand prices. The prospective car buyer does not need to know about the alternative uses of the resources that go into making a car stereo, she only needs to know the price of that option to make a decision about whether her desire for a car stereo can be met. A central planner, on the other hand, would have great difficulty

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[76] TERRY L. ANDERSON & DONALD R. LEAL, FREE MARKET ENVIRONMENTALISM 4 (rev. ed. 2001).

[77] Hill, *supra* note 22, at 1 ("In a market economy, competing claims are resolved through bids and offers between owners and potential owners. Individuals who believe they have a better use for a resource can gain control of that resource by offering to pay more than its opportunity cost.").

[78] Friedrich A. Hayek, *The Use of Knowledge in Society*, 35 AM. ECON. REV. 519 (1945).

[79] *Id.* at 519-20.

> The peculiar character of the problem of a rational economic order is determined precisely by the fact that the knowledge of the circumstances of which we must make use never exists in concentrated or integrated form, but solely as the dispersed bits of incomplete and frequently contradictory knowledge which all the separate individuals possess. The economic problem of a society is . . . a problem of the utilization of knowledge [which is] not given to anyone in its totality.

Id.

assembling information on all car buyers' level of interest in car stereos, the alternative uses of those resources, the cost of production, and other factors. Thus, markets offer a key advantage—they efficiently process information and allow decentralized decision making.

The final advantage of markets is that when information changes, through new discoveries or through changes in values, markets can quickly convey those changes through price changes. Those price and value changes in turn offer entrepreneurial opportunities to make a profit by exploiting the changes. Thus, for example, if a particular product is discovered to be environmentally harmful and at least some people value the environment, an entrepreneur can make a profit by offering an alternative that is less harmful than the old product.[80]

B. *Private Property*

Markets do not always work, however. Polluters do treat the air and water as a disposal resource when they can do so at a lower cost than paying to dispose of wastes. The problem is not, however, that polluters are misusing their property, but that they are misusing resources owned by others. This is a particular problem when the resource is "unowned" or held in some form of common property without well-defined use rights amongst the owners.[81] For example, if no one "owns" a stream's water quality, a factory owner will take that attribute of the stream by using it as a waste disposal source. It is the

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[80] For a general discussion of the role of entrepreneurs in solving environmental problems, see TERRY L. ANDERSON & DONALD R. LEAL, ENVIRO-CAPITALISTS: DOING GOOD WHILE DOING WELL (1997) [hereinafter ANDERSON & LEAL, ENVIRO-CAPITALISTS]. Anderson and Leal define "enviro-capitalists" as

> entrepreneurs using business tools to preserve open space, develop wildlife habitat, save endangered species, and generally improve environmental quality. These entrepreneurs are meeting the growing demand for recreational and environmental amenities. To do this, enviro-capitalists must invent new products, attract venture capital, contract with resource owners, and market their products.

Id. at 3.

[81] *See generally* Bruce Yandle & Andrew P. Morriss, *The Technologies of Property Rights: Choice Among Alternative Solutions to Tragedies of the Commons*, 28 ECOLOGY L.Q. 123 (2001) (examining different alternative solutions to tragedies of the commons and technology specific problems).

lack of property rights, however, not their existence, that is responsible for the problem. Where water quality rights are private property, the owners can take actions to protect their property rights and water quality is protected.[82]

Unfortunately, in agriculture "property rights have been dramatically attenuated . . . ."[83]

> Such attenuation of rights has made it possible for politicians, farmers, and environmentalists to ignore the full opportunity costs of their actions. Instead of bidding for control of resources through the marketplace, interested individuals and groups must bid in the political arena. But resource control in that arena is tenuous at best. Resource rents, including the flow of income from commodity production and the amenity rents desired by environmentalists, are continually up for grabs. Under such a system competing claimants face an incentive structure that encourages them to attempt to have property rights redefined in their favor. And the threat of redefinition that takes rights away from an existing holder means politicians can engage in an ongoing process of selling protection.[84]

More generally, public "ownership" of resources such as the atmosphere and the oceans can be considered an example of the tragedy of the commons. All such tragedies

> raise two questions: who has what rights and what are the costs associated with defining and enforcing those rights? Where rights are clearly defined and easily enforced, as in the case of surface land, there is no tragedy, because entry is limited by the owner's fence. If party A dumps his garbage on party B's land, party B can enforce his right against trespass. On the other hand, where rights are not well defined or easily

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[82] *See* Roger Bate, *Protecting English and Welsh Rivers: The Role of the Anglers' Conservation Association*, *in* THE COMMON LAW AND THE ENVIRONMENT 86 (Roger E. Meiners & Andrew P. Morriss eds., 2000).
[83] Hill, *supra* note 22, at 1.
[84] *Id.* at 13.

> enforced, as with the right to clean air, trespass is much more difficult to prevent.[85]

The key to solving these problems is thus finding the least cost method of ensuring that private property rights can be specified and are cheaply enforceable. Well-specified and defensible private property rights are critical to the functioning of markets. As creating and enforcing private property rights in environmental goods enhances the ability of markets to protect the environment, an important part of the market approach is facilitating the creation and enforcement of private property rights.

C. *Paying for Damages*

Defending property rights requires that those who harm the property of another pay damages for doing so. Courts can also enjoin future harmful activity. Ordinary principles of tort, contract, and property law provide a means for holding rights violators liable.[86] Payment for harm caused is critical because it provides an incentive for considering the impact of one's conduct on others.

There are limits, however. Damages are owed for harms to actual rights, not for emotional distress over injuries to the property of another. Harms must also be proven, not merely speculative. These limits can cause problems on the frontiers of science because causation is difficult to prove in some cases. (Such problems also afflict central planning solutions, however, since regulators must resolve at least some of the same causation problems to know how to regulate.) Some impacts, such as chemical residues in Antarctic wildlife, may be difficult to remedy directly through tort actions: the wildlife is unowned, the link to any particular person's conduct is difficult to prove, and the harm to the wildlife, as opposed to the mere presence of the residues, may be hard to prove.

The existence of uncompensated harms due to such complications is not determinative of whether market solutions can function, however. The question must always be a comparative institutional one, as the same factors that cause problems for tort solutions may also cause problems for planned

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[85] ANDERSON & LEAL, *supra* note 76, at 13.

[86] *See* Roger Meiners & Bruce Yandle, *Common Law and the Conceit of Modern Environmental Policy*, 7 GEO. MASON L. REV. 923, 926-46 (1999) (discussing the common law approach).

solutions. Further, while some harms from a particular action may not be compensable under current tort law, those harms may be linked to other compensable harms. Thus, for example, if drift of a pesticide from one field to another increases harm to birds who inhabit the boundary areas between fields, the harm to the birds may be prevented by the requirement that the pesticide user compensate the neighboring field owner for the harm to his crops caused by the drift.[87] It may not, however, and it is important to acknowledge that not all harms can be compensated, because causation problems will exist. Uncompensated harms are themselves entrepreneurial opportunities for plaintiffs' lawyers, and, over time, entrepreneurs will reduce the set of uncompensated damages.

D. *Subsidies*

Government action has important implications for individual actions because many government programs create incentives, intentionally or unintentionally, for environmentally destructive behavior.[88] Generally, government subsidies have been widely recognized as major obstacles to environmental quality.[89] Such programs succeed in the political arena because they provide concentrated benefits while diffusing their costs over a wide population.[90]

Subsidies and regulations allow "people to ignore the opportunity cost of their actions,"[91] often leading to environmental degradation. Early predator control programs, for example, created incentives to kill wolves through the payment of bounties, justifying this as creation of a public good (removal of predators).[92] In fact, these programs proved destructive to the environment by disrupting the ecosystem in the Mountain West, leading to massive increases in herds of animals that the predators previously controlled.[93] The increased

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[87] *See infra* Part III.D.
[88] *See generally* GOVERNMENT VS. ENVIRONMENT (Donald R. Leal and Roger E. Meiners eds., 2002).
[89] *See generally* Matthew Brown, *Banking on Disaster: The World Bank and Environmental Destruction*, *in* GOVERNMENT VS. ENVIRONMENT, *supra* note 88, at 145 (describing impact of World Bank subsidies on environmental projects).
[90] Hill, *supra* note 22, at 6.
[91] *Id.* at 2.
[92] *See* HANK FISCHER, WOLF WARS 10-23 (1995) (describing eradication programs).
[93] *Id.* at 26-28 (describing environmental impact of increased prey herds).

herds overgrazed important environmental resources, such as Yellowstone National Park, causing serious environmental damage.[94]

The problem with subsidies is that political decision making often fails to take environmental values into account. As there is no mechanism to force political decision makers to consider the costs of their actions, they often opt for subsidizing activities without doing so. Thus, for example,

> Government dams have contributed to the demise of salmon and the loss of wild rivers, and logging on national forests has reduced water quality because not all of the costs are borne by the decision makers. The nature of government funding generates another type of third-party effect by concentrating the benefits on special interest groups while diffusing the costs over a large segment of the population.[95]

The dams subsidize flood control for people down river, electricity for favored customers, and recreation for those who prefer lakes to wild rivers. Logging on federal land at below market prices subsidizes employment in some communities and domestic wood products industries over foreign industries at the expense of consumers. Thus, eliminating subsidies will improve environmental quality by allowing environmentally correct decisions instead of pushing well-financed, politically-favored decisions.

E. *Summary*

To summarize, markets can protect the environment when property rights are well-defined and defensible. The incentive to do so is independent of the preferences of individual resource owners because market prices reflect the values of all those willing to pay for any use of the resource. Those who value environmental attributes of resources thus have the opportunity to outbid those who do not. Environmental values will not always prevail in such bidding contests, but they will influence decision making through their expression in the marketplace.

Resource owners whose property is damaged by the actions of others have the incentive to seek damages from those who harm their property.

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[94] *Id.*

[95] ANDERSON & LEAL, *supra* note 76, at 20.

Injunctive relief is also an important aspect of protecting property rights. Damages awards and injunctions prevent people from taking actions that harm the property of others.

Distortions that often harm the environment occur when resources are controlled through the political process or where the government subsidizes destructive activity. Political decision making does not have to take into account the preferences of alternative users since it allocates resources based on non-market factors. If investing resources in the political process can yield private benefits, individuals will compete for control of politically determined resources. Lowering the price of environmentally destructive activity through subsidies will result in more of such activity than would exist in a free market. Eliminating the subsidies can thus enhance environmental quality.

III. FOUR ALTERNATIVE PESTICIDES FABLES

Having set out the argument that pesticide use is an economic decision and outlined the market approach to environmental problems, we now turn to our four examples of pesticide policies and the lessons that can be drawn from each for pesticide policy.

We offer these alternative fables not because they "prove" our approach is better than FIFRA's central planning approach, but because they illustrate the issues differently than the dominant DDT fable. The existing approach to pesticides is so ingrained in the literature that we must begin with first principles to describe an alternative. Doing so requires us to illustrate that the issues we contend are important are real. The next step in the debate is to examine data more systematically to determine how best to approach pesticide problems. At this stage, however, we must first establish that there are issues other than the alleged routine poisoning of children, farmworkers, and birds.

A. *Early Pesticides & Legislation*

Pesticide use is a relatively recent innovation. Before the development of the modern organic pesticides in the 1940s,[96] pesticide use was relatively

[96] *See* Green, *supra* note 36, at 165 ("Pesticides in the modern sense date from the discovery during World War II of the phenoxyacetic herbicides and the organochlorine and organophosphorus insecticides.").

limited.[97] There are two reasons for this. First, prior to the modern era, pest problems were less severe. Second, some early pesticides were less effective and others more acutely toxic than modern pesticides.

Pest problems were less severe in the past because specialized agriculture is rather new in human history. For thousands of years, our ancestors eked out a miserable livelihood scratching the dirt and hunting animals (and each other) to generate the food they needed to survive.[98] There was little trade or specialization. Since there was limited trade, early agricultural practices generally relied on relatively mixed crop patterns as each area had to produce much of its own food.[99] As a result, before specialized agriculture appeared, pest problems were, aside from things like plagues of locusts of Biblical proportions,[100] reasonably local problems.[101]

If, however, instead of having a few apple trees out back along with a mixture of other crops, a farmer now owns an orchard with hundreds of trees and her next door neighbors do as well, because they live in country best suited for apple production, the community now has a quite different set of pest problems than their ancestors experienced due to lack of diversity in the crops they rely on for their livelihood.

The growth of large scale, mono-crop agriculture,[102] something accelerated by the vast network of farm subsidy and other regulatory programs, made pest problems more severe.[103] Solving them revolutionized American agriculture.[104] In an area covered in apple trees, pests in one farmer's trees

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[97] BOSSO, *supra* note 9, at 29 (describing disadvantages of early pesticides).
[98] *See* JARED DIAMOND, GUNS, GERMS, AND STEEL: THE FATE OF HUMAN SOCIETIES 86 (1998).
[99] BOSSO, *supra* note 9, at 28 (describing pest control advantages of crop rotation).
[100] *See Exodus* 10:13-14, 19.
[101] Y. Elkana et al., *Crop Protection Advice: Its Place in the General Scheme of Farming and of Farm Advice, in* ADVISORY WORK IN CROP PEST AND DISEASE MANAGEMENT, *supra* note 25, at 7, 8 ("Crop protection is not an important factor in low-level, subsistence farming where production proceeds in a more or less stable agro-ecosystem, and epidemic disease or pest outbreaks are rare.").
[102] *See* BOSSO, *supra* note 9, at 23-24, 28-29 (describing the "revolution" in agriculture that followed World War II and the impact on farm techniques that followed).
[103] *See* MATTHEWS, *supra* note 37, at 3 ("Modern farming practices have more intensive production of relatively few crops over large areas . . . ."); George W. Irving, Jr., *Agricultural Pest Control and the Environment,* 168 SCIENCE 1419, 1419 (1970) ("American agriculture has evolved a monoculture system. . . . [T]he large acreages of wheat, corn, or citrus orchards provide inviting environments for pests and diseases of the crops . . . ."); Osteen, *supra* note 25, at 267 ("New production systems that increased reliance on monoculture and plant cultivars susceptible to pest damage may have encouraged pesticide use . . . ."); Pimentel et al., *supra* note 19, at 277.
[104] *See* BOSSO, *supra* note 9, at 26.

could now eat their way through the entire apple crop—wiping out the means of survival.[105] Worse, bugs in neighbors' trees would happily munch their way into other farmers' orchards as well, not recognizing the property lines between the orchards. The increasing scale of agriculture and specialization in food production raised standards of living[106] and produced some environmental improvements, such as reducing the amount of land in cultivation.[107] Unfortunately it also made what had been local or small threats from a pest invasion that attacked one piece of the food supply into major problems for specialist producers.[108]

Entrepreneurs responded by selling solutions: pesticides. Although there are anecdotes about pesticides being used in ancient Greece and the Roman Empire,[109] the major use of pesticides began in the mid-nineteenth century. Some early pesticides were substances like "Paris Green" and "London Purple," inorganic poisons that required high enough doses to cause acute medical problems for people who ate food with the pesticides still on them.[110]

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[105] Elkana et al., *supra* note 101, at 8 ("The higher the yield and income the farmer aims at, the higher the risks he has to take in his practices, and the greater the need for crop protection advice.").

[106] *See, e.g.*, Green, *supra* note 36, at 172 (noting that in the United States one agricultural worker can produce enough food to feed himself and sixty additional people, using only two hectares of land, while, on average, in developing countries one agricultural worker can produce only enough food to feed himself and two other people using about eight hectares of land); Indur M. Goklany, *Agricultural Technology and the Precautionary Principle, in* AGRICULTURAL POLICY AND THE ENVIRONMENT, *supra* note 11, at 107, 116 (describing benefits of modern agricultural technology).

[107] Had technology, and therefore crop yields, been frozen

> at 1961 levels, then producing the same amount of crops as was actually produced in 1998 would have required a more than doubling of agricultural land area. . . . This estimate optimistically assumes that the productivity of the added acreage would be the same as that of the original land. . . . Imagine the devastation that would have occurred had agricultural technology been frozen at 1961 levels, while mortality rates continued to drop worldwide in response to advances in public health, hygiene, and medicine, pushing up population. Massive deforestation, soil erosion, greenhouse gas emissions, and losses of biodiversity would have occurred with the more than doubling of the amount of land diverted to agriculture.

Goklany, *supra* note 106, at 110-11.

[108] *See* Pimentel et al., *supra* note 19, at 279 (noting that there has been an increase in insecticide use on corn due to elimination of crop rotation on forty percent of the American corn crop).

[109] Downer, *supra* note 71, at 1 ("Records of the use of olive oil extracts for blight control by the Greek philosopher Democrates date from 470 B.C. Vine pests were controlled with sulfur fumes by Cato in Italy in 200 B.C.").

[110] Green, *supra* note 36, at 165 ("Pesticides before [World War II] were either inorganic compounds such as sulfur, lead arsenate or Bordeaux mixture, or were naturally occurring

Others were "secret formulas" peddled by scam artists that did not do much at all.[111]

This situation meant there were three problems with pesticides that became popular in the late 1800s and early 1900s. First, the pesticides that worked were often capable of causing acute health problems, including death, if people ingested them. These were "Hobbesian" pesticides: nasty, brutish, and acutely toxic. This prompted concerns about residues on foods, a concern largely addressed by improving processing to remove the usually visible residues.[112]

Second, some of the pesticides did not work. As with similar problems with the patent medicine industry, the solution was labeling to allow pesticide users to know what was in their products and who had made the product.[113] Thus, labeling reduced the opportunities for scam artists.

Third, in the view of some farmers, people were not using enough pesticides. In economic terms, some people were "free riding" on their neighbors' purchase and effort to treat their crops. In particular, in the Pacific Northwest, some apple farmers were not spraying, relying instead on their neighbors to control the pest problem.[114] Those who were spraying sought help from the government to force their neighbors to spray and some of the early state pesticide laws did exactly that: every apple grower had to spray.

At that time, most of the problems we associate with pesticides today were not being considered—egg shell thinning among bald eagles, trace pesticide derivatives in tissue samples from remote areas, and long-term health effects were not known and were not perceived as problems. The problems that were recognized were also primarily local—it was a neighbor

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organic compounds such as nicotine or pyrethrum."); *see also* BOSSO, *supra* note 9, at 29 (discussing early pesticides and terming early pesticides "rather inefficient, comparably expensive" and terming them "rather brute instruments").

[111] JOHN PERKINS, INSECTS, EXPERTS AND THE INSECTICIDE CRISIS: THE QUEST FOR NEW PEST MANAGEMENT STRATEGIES 3-4 (1982) ("The commercialization of the insecticide industry was accompanied by substantial fraud including adulterating legitimate products and making extravagant claims for absolutely worthless junk.").

[112] BOSSO, *supra* note 9, at 47-53 (discussing early residue controversies).

[113] BOSSO, *supra* note 9, at 48 ("Farmers feared increasingly that their purchases might be ineffectual or outright dangerous, while chemical makers worried about 'unbridled competition' and less scrupulous competitors.").

[114] This section draws on Roger E. Meiners & Andrew P. Morriss, *Agricultural Commons Problems and Responses: Sick Hogs at the Trough, in* AGRICULTURAL POLICY AND THE ENVIRONMENT, *supra* note 11, at 19, 29-31 (discussing free rider problem in agricultural pest control).

who likely caused the problem for a farmer, not someone in another state or country.

So what? After all, we do not often use lead, arsenic, or mercury anymore as active ingredients in pesticides and we know a great deal more about long distance transport of pesticides and their impact on wildlife. So why care about what happened in 1910 in Washington State to apple growers? There are three lessons to be learned from this episode:

1. Pesticide Problems Always Have a Local Dimension—They Start with an Individual Making a Decision to Use or Not Use a Pesticide

There may be other dimensions to the problem, but all pesticide problems start with an individual decision to use or not use a pesticide, except when we collectively act to force the use of pesticides. When pesticide use is the result of individual decisions, we need to understand the economic reasons individuals make the decisions they do.

Pesticides serve an important need for farmers, but their useful attributes are not necessarily their problematic attributes. A pesticide that kills only the target pest, for example, is a superior product in some dimensions for both the farmer and the manufacturer to a broad spectrum pesticide that also kills useful insects or plants.[115] Yet broad spectrum pesticides were themselves a response to a problem—only a small proportion of an insect population is typically at a vulnerable stage of their life cycle, so persistent pesticides allowed a single application to reach a larger percentage of the population.[116] They also reduced farmers' exposure by reducing the number of applications necessary.[117] Now that we know more, however, persistence is no longer seen as a purely positive attribute of a product. Changed information sets mean changed preferences.

Pesticide technology continues to evolve and the characteristics of pesticides change over time. New application techniques made possible by new technology reduce the amount of pesticides needed to control pests[118]

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[115] MATTHEWS, *supra* note 37, at 1 (noting replacement of older broad spectrum pesticides with "newer more active or selective chemicals"); *see* Pimental et al., *supra* note 19, at 275 (noting improvement in toxicity of pesticides).

[116] BOSSO, *supra* note 9, at 30 (noting advantages of persistence for farmers); MATTHEWS, *supra* note 37, at 20-21.

[117] BOSSO, *supra* note 9, at 29.

[118] *See, e.g.*, Downer, *supra* note 71, at 4 (noting development of "patch spraying programs" made possible through use of global positioning systems).

and new pesticides often require lower application rates.[119] In short, newer is often greener. As we design regulatory regimes for pesticides, we therefore must be careful that we do not distort the market incentive that took us from the Hobbesian world of Paris Green to the less acutely toxic, more effective products available today.

2. The "Right" Answer to Environmental Problems Evolves over Time with Changed Circumstances and New Knowledge

Our views of pesticide use as a social problem have come full circle—people used to worry that pesticides did not kill enough bugs and that not enough people used them. Now we worry that they kill too many things and that too many people use them. This illustrates a larger point that views of appropriate actions with respect to the environment change over time. For example, we are spending private and public money to restore the wolf to areas that in earlier years we spent private and public money to eradicate. Similarly, raptors such as hawks were the target of eradication efforts in the eastern United States in the twentieth century;[120] more recently we listened to Rachel Carson's concern about the impact of pesticide residues on raptor health.[121] We now devote resources to protecting eagles and hawks.

We might say, and we can certainly hope, that we are smarter today than our ancestors were, or at least that we know more about the environment, and so are capable of making better decisions today. However, our great, great-grandparents were neither stupid nor environmental barbarians. They made choices that we may no longer agree with about matters we now call environmental management, but given how scarce resources were for them, we know their decisions were made with care. We should presume that future generations may also make different choices than we make and will know more than we do. Our grandchildren may look back with chagrin at some of our choices, just as we do with respect to some of our grandparents' choices.

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[119] *See* Green, *supra* note 36, at 170 (noting that "[t]here is a definite trend towards higher activity in the most recently discovered pesticides" and noting lower application rates of new chemicals).

[120] *See* Andrew P. Morriss & Roger E. Meiners, *The Destructive Role of Land Use Planning*, 14 TUL. ENVTL. L.J. 95, 128-29 (2000) (discussing raptor eradication programs as an example of changed environmental mores and success of private conservation).

[121] *See* CARSON, *supra* note 2, at 110-19.

We are not suggesting that future generations will brush their teeth with DDT powder. The policy prescription that results from this is simply that we should be cautious about adopting one-size-fits-all solutions premised on our knowing what we think now to be the final word on a subject. This is not an argument for what is commonly called the "precautionary principle"[122] but rather an argument for allowing diversity in environmental practices, premised on the notion that out of the experience with a wide range of practices will emerge new knowledge about the most appropriate practices for various circumstances.

We must tolerate environmental practices we disagree with and tolerate different individuals and different societies making their own choices about the environment, in general, and about pesticides, in particular. By "tolerate" we mean to distinguish between the kind of activity described at this Symposium where the National Resources Defense Council ("NRDC") sought to prevent federal foreign aid agencies from funding use of pesticides banned in the United States in foreign aid programs[123] and the attempts to coerce other countries into making tradeoffs of risk and benefit to suit us, for example, by strong-arming them into banning particular pesticides in their countries.[124] The former can be legitimate as American taxpayers ought not

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[122] *See generally* INDUR GOKLANY, THE PRECAUTIONARY PRINCIPLE: A CRITICAL APPRAISAL OF ENVIRONMENTAL RISK ASSESSMENT (2001) (critiquing application of the precautionary principle in environmental debate and arguing principle requires action rather than delay in some circumstances); *see also* Cross, *supra* note 39, at 870-76, 886-93 (discussing precautionary principle and pesticides).

[123] *See, e.g.*, Thomas Lovejoy, *Global*, 17 AMICUS J., Jan. 1996, at 40 (describing NRDC's role); Ward Sinclair, *Grounding the Medfly Warriors: Lawmakers Protest Use of Banned Pesticide in Guatemala Project*, WASH. POST, May 29, 1987, at A23.

[124] *See* Roger Thurow, *A Choice of Evils: As a Tropical Scourge Makes a Comeback, So, Too, Does DDT*, WALL ST. J., July 26, 2001, at A1, A6 ("[E]motions reached a boiling point" over the issue, with some groups pushing for an all-out ban. "'It was getting to the stage of 'Look at these environmentalists, they don't care about black babies dying in Africa,'' says one negotiator, who backed an all-out ban." (citation omitted)); Nityanand Jayaraman, Greenpeace International, *Greenpeace and Other Indian Voluntary Sector Perspectives on the POPs Problem in Asia in the Context of Larger Issues, at* http://www.chem.unep.ch/pops/POPs_Inc/proceedings/bangkok/JAYA.html (last visited Sept. 1, 2003) ("The international negotiations on POPs offers us a chance to rid the planet of DDT once and for all."). Of course, we need not tolerate others causing us harm, which is important because there are serious problems of long distance transport, wildlife accumulation and other impacts of pesticides outside the area where they are used. *See* Pierre Mineau, *Birds and Pesticides: Are Pesticide Regulatory Decisions Consistent with the Protection Afforded Migratory Bird Species under the Migratory Bird Treaty Act?*, 28 WM. & MARY ENVTL. L. & POL'Y REV. (forthcoming Winter 2004).

to subsidize activities elsewhere that our political process rejects as against our interests. The latter is illegitimate because it attempts to prevent other societies from using their own resources to make their own tradeoffs concerning these issues.

Most importantly, we must recognize that most of the time, pesticides' impacts and measures to control them involve tradeoffs. For example, some soil conservation practices increase the need for pesticide use.[125] Modified spray techniques to reduce drift, such as using coarser droplets to reduce drift, produce other problems including poor impaction and retention characteristics of the droplets.[126] Pesticide use saves fossil fuel and reduces the amount of land needed to produce food.[127] Granular pesticides reduce drift[128] but increase threats to birds.[129] Pesticides make fruits and vegetables cheaper, improving health from increased consumption of fruits and vegetables.[130]

Recognizing that products A and B each have some good and some bad attributes, for example, means that trading off A for B is rarely a simple decision that will be appropriately made the same way in every circumstance.[131] Yet the central planning approach to pesticides does exactly that.

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[125] *See* Pimentel et al., *supra* note 19, at 278.

[126] Downer, *supra* note 71, at 6, 8 (noting "conflict of interest between goals of maximizing efficacy vs that of minimizing environmental contamination"); *see also* MATTHEWS, *supra* note 37, at 17 (noting tradeoffs); Matthews & Thomas, *supra* note 68, at 975 (noting that coarser spray used to minimize off-target drift reduces efficacy of application within the field).

[127] *See* MATTHEWS, *supra* note 37, at 1 ("Without modern technology (including the use of pesticides) tripling world crop yields between 1960 and 1992, an additional twenty-five to thirty million square kilometres of land would have had to be cultivated with low-yield crops to feed the increased human population . . . ."); Green, *supra* note 36, at 174 ("[The] use of pesticide may result in considerable overall savings in fossil fuel energy as well as of land."). Green provides several examples. Assuming a ten percent yield reduction of pesticides were not used on corn, for example, he calculates that pesticides save 570 million gallons of oil. Similarly, no till cultivation, which requires increased herbicide use, can save eight gallons of oil per hectare. *Id.* at 175.

[128] B.J. Butler & L.E. Bode, *Effects of Application Methods on Energy Use, in* ENERGY IN PLANT NUTRITION AND PEST CONTROL, *supra* note 25, at 259, 261; Finney, *supra* note 19, at 69.

[129] *See* Mineau, *supra* note 124.

[130] LOMBORG, *supra* note 1, at 10 ("[S]crapping pesticides would actually result in *more* cases of cancer because fruits and vegetables help to prevent cancer, and without pesticides fruits and vegetables would get more expensive, so that people would eat less of them.").

[131] The same is true of organic produce and what we might call "chemically enhanced" produce. The latter is superior to the former on several dimensions, including but not limited to cosmetic standards. For example, it is good to have fewer worms in apples, because that leads to fewer worms in applesauce, lower processing costs (avoiding the labor needed to remove the worms), and so lower prices for applesauce. Organic foods serve an important market segment, albeit one that is expanding from a small base. That does not mean,

3. Be Wary of Public Good Arguments

The Washington State apple growers who successfully sought to force their neighbors to spray toxic chemicals on their trees were not chemical crazy. Their arguments were essentially the same as the arguments used to justify a wide range of environmental programs today. They did not make the case in exactly these terms, but the essence of the argument was there. The control of pests benefits not only landowners who control pests on their land but also benefits their neighbors, who suffer fewer losses from pests as a result. It benefits all citizens, because it ensures a good steady crop of apples for everyone.

In economics jargon, the private benefit of spraying one's apple trees is less than the social benefit, but the cost of spraying is borne entirely by the farmer who does the spraying. Indeed, these arguments continue to be made about pesticide use.[132] As a result, the rational apple farmer did not spray "enough"—since he could not capture the full benefit of his actions. This argument appears regularly in the environmental economics literature. For example, it is often claimed that private landowners will not preserve enough habitat because they do not capture the full benefit of the increased wildlife diversity the habitat makes possible.[133] Change the words and it is the same argument for almost any program. In short, private benefits and private costs are almost never the same as social benefits and social costs, however those

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however, that mandating organic production techniques is justified on environmental grounds.

[132] *See, e.g.*, Osteen, *supra* note 25, at 269-71 ("With a mobile pest, a farmer might underestimate the damage per pest because some of the damage occurs elsewhere. In essence, the mobile pest is a negative common property resource which causes social and private optimums to diverge . . . ."); J. Palti & R. Ausher, *The Place of Pest and Disease Management in the Agricultural Economy, and Its Legal Framework*, *in* ADVISORY WORK IN CROP PEST AND DISEASE MANAGEMENT, *supra* note 25, at 3, 4 ("The principle reasons why pest and disease control in crops is so often a matter of public interest [include] . . . . [p]est and diseases appearing in one farmer's field may well endanger the crops of his neighbors.").

[133] *See, e.g.*, Patrick Parenteau, *Rearranging the Deck Chairs: Endangered Species Act Reforms in an Era of Mass Extinction*, 22 WM. & MARY ENVTL. L. & POL'Y REV. 227, 249 (1998) ("Habitat loss is a classic externality." (citation omitted)); *see also* Donald J. Boudreaux et al., *Talk Is Cheap: The Existence Value Fallacy*, 29 ENVTL. L. 765 (1999) (arguing that contingent valuation, an attempt to place values on common environmental assets, is flawed and should be rejected as a policy making guide to protect environmental law). *But see* ANDERSON & LEAL, ENVIRO-CAPITALISTS, *supra* note 80, at 4-8 (describing in detail how International Paper made significant profits by managing its timber lands for habitat and selling access to recreational users).

might be defined. As a result, we can generate a theoretical public good argument to justify almost any state action.[134]

Our point here is that we should be wary of such justifications and demand thorough exploration of the factual basis of public good arguments whenever we encounter them, because such arguments appear to justify mutually contradictory, but always coercive, actions dependent on what are often rather flimsy factual assumptions and assertions.

B. *Subsidizing Spraying*[135]

The discovery of modern organic pesticides during World War II created a new set of cheap and effective tools. As these first modern pesticides were both broad spectrum pesticides and significantly safer to users than their "Hobbesian" predecessors, they were soon used on a wide range of insect and weed pests. As a result,"[pesticide] [u]sage increased fivefold between 1950 and 1978."[136] The earlier free-rider problem remained, however, and agricultural scientists were anxious to apply their new tools against "public" pests such as the gypsy moth as well.[137] The increased availability of aircraft for spraying after the war opened up the possibility of attacking forest pests and made large scale spraying an option.[138]

USDA sprayed some acreage itself, including public lands. These USDA pesticide spray programs expanded significantly in the 1950s.[139] One major focus of the USDA programs was gypsy moth control, leading to the spraying of millions of acres of trees in the northeast with DDT.[140] Fire ants in the

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[134] Professor Steven Bradford made a similar point concerning prisoners' dilemmas: as "the only economics or game theory that most law professors and law students know, and therefore they think that every policy issue in the world involves a prisoner's dilemma." C. Steven Bradford, *As I Lay Writing: How to Write Law Review Articles for Fun and Profit*, 44 J. LEGAL EDUC. 13, 21 (1994) (citation omitted). His tongue-in-cheek advice was "[o]nce you've created a prisoner's dilemma, you can forget about it. You've justified whatever type of regulation you want to propose, and economics is no longer a problem." *Id.* at 22 (citation omitted). The same seems to be true of externality and public good arguments.

[135] This section draws heavily on Andrew P. Morriss & Roger E. Meiners, *Property Rights, Pesticides & Public Health: Explaining the Paradox of Modern Pesticide Policy*, 14 FORDHAM ENVTL. L.J. 1 (2002) and BOSSO, *supra* note 9, at 79-108.

[136] RODGERS, *supra* note 9, at 399 (citation omitted).

[137] *See infra* notes 147-56 and accompanying text.

[138] Oliver L. Wardman & Miles R. Thomas, *Aerial Applications of Pesticides in the United Kingdom: 1978 to 1998*, 56 PEST. MGMT. SCI. 237, 237 (2000).

[139] *See* BOSSO, *supra* note 9, at 81-106 (discussing USDA widespread spraying to control the gypsy moths and fire ants and the resulting public opposition in the 1950s).

[140] BOSSO, *supra* note 9, at 82.

southeast also got attention from USDA, with the 1957 Fire Ant Eradication Act leading to a plan to "treat" twenty million acres, with the federal government picking up half the expense to control this pest.[141] USDA argued that fire ants were a major threat to agricultural production, animals, and even human life.[142] By the end of the 1950s, however, government spray programs began to provoke some public opposition and the government had begun to restrict some uses of some chemicals, including DDT.[143]

As one might expect, the first publicly-sponsored spraying programs addressed the most urgent needs. As time went on, however, the bureaucrats who benefitted from the expanded sizes and budgets of their agencies and those who profited from the programs found reasons to expand beyond those needs to more marginal cases. This expansion created opposition because as the scale of spraying expanded, so too did the unintended side effects for non-target species and other negative impacts.[144]

One important reason for the problems with the public spray programs was the lack of accountability of the agencies involved for the harm they caused. Because USDA was not liable for the harms it caused to private interests, as where it harmed wildlife and domestic animals, USDA did not consider those effects in deciding when and how to spray. To take but one example, USDA often used large scale application methods, such as aerial application, to apply pesticides to huge acreages.[145] This is precisely the worst way to apply pesticides if you are concerned with minimizing environmental side effects. For example, the appropriate dose varies from field to field.[146] Uniform spraying thus results in overapplication to some fields. Instead of large scale applications, spot spraying is an important means of reducing environmental losses from pesticides.[147] Had USDA been liable for its

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[141] BOSSO, *supra* note 9, at 87-88.
[142] CARSON, *supra* note 2, at 162.
[143] BOSSO, *supra* note 9, at 97-98, 100-01.
[144] *Id.* at 84-85.
[145] *See, e.g., id.* at 82 (describing the aerial application of DDT in the case of the gypsy moth). USDA also played an important role in developing aerial application methods. *See id.* at 30 ("The USDA refined aerial spraying techniques during the war, which brought a revolution of its own because farmers no longer needed to walk along the furrows, laboriously applying arsenicals or leads by hand.").
[146] J. Palti & R. Ausher, *Crop Value, Economic Damage Thresholds, and Treatment Thresholds, in* ADVISORY WORK IN CROP PEST AND DISEASE MANAGEMENT, *supra* note 25, at 48-49 ("[F]ield-to-field variation will necessitate separate prognoses for each field and orchard, even when these are close neighbours [sic].").
[147] *See* F. Van Den Berg et al., *Emission of Pesticides into the Air,* 115 WATER, AIR, & SOIL POLLUTION 195, 196 (1999).

trespass to the dissenting property owners whose property it sprayed, it would have been forced to scale back the large scale applications in favor of spot spraying. As a result, respecting property rights of land owners could have produced a major improvement in environmental consequences without any central direction or even consensus on the rationale for opposing the spray programs. In short, had property rights been respected, even a few "cranks" could have prevented the environmentally damaging and costly, large scale, aerial spray programs.

As the negative impacts began to become clear, USDA's partners began to refuse to participate. For example, when a Georgia veterinarian reported that a dieldrin spray aimed at fire ants caused the deaths of more than one hundred cattle, increasing numbers of farmers across the south refused to pay for their share of spraying costs.[148] Even the Alabama legislature withdrew funding for spraying in 1959 over concerns about the impact on the state's wildlife population.[149] USDA responded with a "sale" on spray programs, cutting the price by offering the chemicals for free to those who would take them[150] and continuing to spray in some areas without local consent.[151] This opposition meant that USDA was reaping less of a political reward for its spray activities, leading to reduced agency interest in the programs, but the programs had by now created their own supporters: chemical companies selling pesticides to USDA, applicators applying them, and spray program bureaucrats administering enhanced budgets.

The most famous spray campaign example is USDA's Long Island attack on the gypsy moth, a critically important piece in the development of the modern environmental political movement. During the 1950s, USDA decided to spray millions of acres on Long Island, despite scant evidence of gypsy moth presence.[152] In some respects, and considering the general atti-

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[148] BOSSO, *supra* note 9, at 102.
[149] *Id.*
[150] *Id.* ("[I]n Texas the USDA literally gave heptachlor away to any property owner willing to use it.").
[151] *Id.* (quoting a USDA spokesman).
[152] The government's own experts' testimony at the trial during which Long Island residents attempted to block the spray program established that the threat from gypsy moths on Long Island was minimal. The director of the Plant Pest Control Division of USDA, for example, testified that prior to the spraying the infestation on Long Island was "light and scattered." C.C. Alexander, Notes on DDT Case 18 (1958) (unpublished manuscript on file with authors and available at the Cornell University Library) (testimony of Emory D. Burgess). Nonetheless, USDA sprayed 600,000 acres to deal with forty-seven foci of infestation. *Id.* Testimony at the same trial also established that using aerial spraying, USDA could not avoid spraying the property of individuals who objected, as well as streams and ponds. *Id.* at 6, 8

tude of the times, this program was undertaken for "environmental" reasons: USDA wanted to save the forests on Long Island from the voracious gypsy moth.[153]

From the point of view of Long Island residents, USDA's methods left a great deal to be desired.[154] First, the spray used was a mixture of DDT and oil, which stuck to the trees, and blanketed the area.[155] Unfortunately, it also stuck to cars, swimming pools, and houses.[156] Residents claimed there were large fish kills caused by the indiscriminate spraying of ponds and streams as well as forests.[157] Human health concerns relating to contaminated milk from cows grazing on sprayed fields were also raised.[158] These objections culminated in the 1957 suit filed by Robert Cushman Murphy, an authority on birds and curator-emeritus of the Museum of Natural History, together with a group of other Long Island residents seeking to enjoin the spraying program. Using common law property and tort theories, the plaintiffs challenged USDA's ability to deprive them "of property and possibly lives without due process of law and [take] their private property for public use without just compensation" and claimed the spraying program was a "trespass upon the persons and property of the plaintiffs . . . ."[159]

The plaintiffs lost the first suit and the spraying continued.[160] In rejecting the plaintiffs' claim for relief, the trial judge ruled that the support of public agencies for the spray program outweighed the plaintiffs' property rights.[161] The judge found that "[s]uch a formulation of informed opinion could not be ignored . . . and the research conducted by the trained staffs of both Federal and New York State departments was directed to an intelligent program designed to deal with the realities of a perplexing situation."[162] With a

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(testimony of Boyd R. Opheim and Alexander Barrett Klots) (A USDA employee testified that "it would be inconvenient and expensive to eradicate gypsy moths by ground sprays, though not impossible."). Another witness testified that ground spraying cost $25 per acre compared to $1 per acre for aerial spraying. *Id.* at 18 (testimony of Emory D. Burgess). The contracts for the aerial spraying were arranged in Washington, not on Long Island. *Id.* at 21 (testimony of William L. Popham).

[153] BOSSO, *supra* note 9, at 84-85.

[154] *Id.* at 82.

[155] *Id.*

[156] THOMAS R. DUNLAP, DDT: SCIENTISTS, CITIZENS, AND PUBLIC POLICY 87 (1982).

[157] *Id.*

[158] *See id.*; *see also* Murphy v. Butler, 362 U.S. 929, 930 (1959) (Douglas, J., dissenting).

[159] Murphy v. Benson, 151 F. Supp. 786, 789 (E.D.N.Y. 1957).

[160] *Id.* at 792; BOSSO, *supra* note 9, at 83.

[161] *Murphy*, 151 F. Supp. at 792.

[162] *Id.*

significant public benefit shown by agency testimony and the failure of the plaintiffs to show that there was a threat of irreparable damage to them in excess of what the community would suffer from the gypsy moth, the judge refused the injunction.[163]

The group tried again the following year, armed with more evidence of dangers of DDT exposure.[164] The court dismissed the plaintiffs' claims yet again, this time holding that they only complained of an "annoyance" rather than alleging sufficient harm to warrant damages.[165] Their annoyance was outweighed by the greater good of the spray program: "The rights of individuals are not limitless. Individuals must yield to the requirements of the public as a whole."[166] Although the plaintiffs appealed, the Second Circuit Court of Appeals quickly held the case moot on the grounds that the spraying program was over for the year.[167]

The trial record gives some insights into the marginal benefit of the government spray programs at this point: by the government's own estimates at trial, it dealt with a "light and scattered" set of fewer than fifty infestation foci of gypsy moths by spraying six hundred thousand acres at a cost of at least $600,000.[168] This is an extraordinary sum since, even using the government's own cost figures for ground spraying costs, the entire problem could have been avoided if those forty-seven foci occupied fewer than twenty-four thousand acres.[169] Since a "light and scattered" infestation could hardly have been anything close to twenty-four thousand acres, the government chose a means of conducting the program that harmed the Long Island plaintiffs and cost it more money than the alternative. Why? We can only speculate that the opportunity to spray met other needs for USDA, such as rewarding the contractor who did the spraying.

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[163] *Id.*

[164] *See* Murphy v. Benson, 164 F. Supp. 120 (E.D.N.Y. 1958).

[165] *Id.* at 126, 129.

[166] *Id.* at 128.

[167] Murphy v. Benson, 270 F.2d 419, 420 (2d Cir. 1959). The Supreme Court denied certiorari, although Justice William O. Douglas dissented from the denial, arguing the issue was not moot because spraying could resume and the damage from DDT was not understood well enough for the courts to dismiss the possibility of danger. Murphy v. Benson, 362 U.S. 929, 931-35 (1960) (Douglas, J., dissenting).

[168] *See* Alexander, *supra* note 152, at 18 (testimony of Emory D. Burgess).

[169] The government estimated ground spraying costs at $25 per acre. Alexander, *supra* note 152, at 18. Since the government was spending $600,000 on aerial spraying, anything less would have been a savings. Dividing $600,000 by $25/acre yields twenty-four thousand acres. So long as the government had to spray less than twenty-four thousand acres to get the forty-seven foci, it would have saved money.

In economic terms, USDA's overall behavior is easy to understand. Congress and the agency had incentives to maximize the net political benefits of spraying. The first spray programs were conducted where the marginal political benefits of spraying were largest, such as controlling malaria and other insect-borne diseases. As the program expanded, however, spraying extended into areas with lower marginal political and environmental benefits such as gypsy moth control. Similarly, the spraying programs were first done where the marginal political costs of spraying were lowest (over swamps) and expanded into areas where the marginal political costs increased (inhabited areas). Even if nothing else had changed, this dynamic would have eventually led to the spray programs' expansion to a point where the benefits fell below the costs of continuing to expand the program, including the opportunity cost of foregone alternative uses for the tax money spent on the spray programs. Increased public opposition, as the public learned of the health and environmental damages the sprays could be causing, brought a more rapid decline in the total political benefits. As a result, Congressional and agency support for them also fell.

There are two important lessons from the spray programs of the 1950s and 1960s: respect property rights and publicly-provided goods are often oversupplied, with negative consequences for the environment.

1. Respect Private Property Rights

The programs caused major problems because the government refused to respect private property rights. If USDA had been required to respect property owners' rights, it could not have continued its mass eradication programs of aerial spraying once the environmental costs became clear. Only by overriding property rights was the environmental damage caused possible.

This illustrates a crucial point about government action: governments are effective because they can coerce people, and coercion is sometimes cheaper than buying agreements. Coercion lowers the price of coordinating activity. As environmental economist Ian Wills notes, "[i]t is government's coercive power that makes the difference; planners have no other major advantage over market exchange in coordinating production and consumption."[170] Respecting property rights, by requiring governments to obtain consent or compensate rights holders for takings of private property, is a

[170] WILLS, *supra* note 11, at 104.

critical constraint on the capture of the coercive power of government by special interests.[171]

2. Oversupply of Publicly Provided Goods

The natural consequence of providing the spray as a public good meant that the programs would continue to expand as USDA bureaucracy and interest groups that benefitted from the programs sought to keep the benefits they received from the political process. As a result, we need to think seriously about agencies being captured before entrusting policy decisions to them. When policies offer benefits concentrated on a few while dispersing the cost over many, we should expect to see such captures resulting in undesirable program expansion. The government spray programs are a clear example of this problem. An important protection against such over-expansion of government programs is forcing the government to respect property rights. Where governments must compensate property owners for lost rights, actions taking the rights are put "on budget" and considered by the agencies involved.[172]

C. *DDT & Malaria*[173]

Malaria is a significant public health problem today in much of the developing world.[174] DDT is a particularly valuable weapon in the fight

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[171] *See* RICHARD A. EPSTEIN, TAKINGS: PRIVATE PROPERTY AND THE POWER OF EMINENT DOMAIN 332 (1985); *see also* Royal C. Gardner, *Invoking Private Property Rights for Environmental Purposes: The Takings Implications of Government-Authorized Aerial Pesticide Spraying*, 18 STAN. ENVTL. L.J. 65 (1999) (examining the implications of property takings challenges in response to government aerial sprayings).

[172] *See* Andrew P. Morriss & Richard L. Stroup, *Quartering Species: The "Living Constitution," the Third Amendment, and the Endangered Species Act*, 30 ENVTL. L. 769, 807-08 (2000) (describing importance of putting environmental programs "on budget").

[173] *See generally* Morriss & Meiners, *supra* note 135 (expanding the material presented here).

[174] Hundreds of millions of people suffer from malaria and millions of families lose infants to malaria—one researcher termed it the equivalent of "filling seven Boeing 747s with children, and then crashing them, every day." Amir Attaran et al., *Balancing Risks on the Backs of the Poor*, 6 NATURE 729, 729 (2000). Malaria kills a child every thirty seconds. Children who survive malaria past infancy "suffer an average of six bouts each year, making [it] the most common cause of school absenteeism." UNITED NATIONS CHILDREN'S FUND, ROLLING BACK MALARIA 4 (1999), *available at* http://www.unicef.org/publications/pub_rollback_malaria_en.pdf (last visited Sept. 16, 2003). Adult sufferers miss an average of ten working days a year. Martin H. Villet, *Malaria Epidemic in KwaZulu-Natal and DDT: The Facts* (2000), email posted on Malaria Foundation International, *at* http://www.malaria.

against malaria and other insect-borne diseases.[175] Unfortunately, the ban on DDT use in many countries and growing international pressure to end its use[176] and manufacture worldwide have allowed malaria to make a comeback. The result is that a disease on the way to extinction is back in strength.

Controlling malaria requires controlling mosquitoes because the disease is transmitted by parasites carried by mosquitoes.[177] The key to malaria control is thus to kill infected mosquitoes before they can transmit the parasite to humans through bites, not using DDT handicaps these malaria control efforts. Before DDT was in use, malaria was estimated to infect three hundred and fifty million people in 1952.[178] With the use of DDT, the infection rate fell by ninety-seven percent by 1969, largely because of DDT sprayed inside homes and on mosquito breeding sites.[179] Now, after the wide use of DDT was discontinued for environmental concerns, the disease is nearly back to where it was fifty years ago.[180] The British medical journal, *The Lancet,* recently reviewed the evidence on the impact of stopping the use of DDT and concluded that when DDT spraying is ended, malaria's incidence

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org/news227.html (last visited Sept. 15, 2003).

[175] Attaran et al., *supra* note 174, at 729 (noting that DDT is "one of the few affordable, effective tools against the mosquitoes that transmit malaria").

[176] For example, environmental pressure groups have succeeded in making DDT unavailable for malaria control in many countries, while conceding that DDT's usefulness against malaria requires "special attention and caution." Klaus Topfer, Working Together for a POPs Treaty for the Next Millennium, Opening Remarks at the Third Session of the Intergovernmental Negotiating Committee for a Treaty on Persistent Organic Pollutants (Sept. 6, 1999), *at* http://www.pops.int/documents/press/prel_spch/SpeechTopfer.htm. The number of countries using DDT has been whittled down to nineteen. *See* INT'L POPS ELIMINATION NETWORK, DDT & MALARIA: ANSWERS TO COMMON QUESTIONS 1 (2001), *at* http://ipen.ecn.cz /index.php?z=&L=en&k=download&r=default&id=6 (last visited Sept. 15, 2003). The pesticide is produced in only two countries and is becoming difficult to obtain. *Id.* The UN seeks a global ban by treaty. Governing Council Dec. 13C, U.N. Env't Programme, 19th Sess., paras. 2, 4 (1997), *available at* http://www.chem.unep.ch/pops/ gcpops_e.html ("[I]nternational action, including a global legally binding instrument, is required to reduce the risks to human health and the environment arising from the release of the twelve specified persistent organic pollutants [including DDT].").

[177] *See* Titus Bradley, *Malaria and Drug Resistance, at* http://www.micro.msb.le.ac.uk/224/ Bradley/Bradley.html (last visited Sept. 7, 2003).

[178] UNITED NATIONS CHILDREN'S FUND, *supra* note 174, at 6.

[179] *Id.*

[180] *Id.*

rises markedly.[181] The disease has returned to areas in which it previously had been eradicated.[182]

DDT is not the only means of combating malarial mosquitoes. The other means are strikingly less effective, however. The current international anti-malarial effort, Roll Back Malaria ("RBM"), for example, uses "insecticide-treated mosquito nets, mosquito coils, repellents and other materials; early detection, containment and prevention of malaria epidemics; and strengthening of local capacity to monitor malaria in affected regions."[183] The difference between RBM and DDT use is clear from RBM's goal: merely to reduce infant mortality from the disease, not its incidence, by fifty percent by 2010.[184] Compared to the ninety-seven percent reduction in disease achieved decades ago with DDT, RBM's goal seems painfully inadequate. Moreover, the alternatives promoted by RBM cost more and are less effective than DDT.[185] For example, mosquito sleeping nets cost $5 to $10 each,[186] making them expensive for people in countries where per capita personal income is measured in the hundreds of dollars per year. And, because the nets require continual retreatment (soaking the nets in insecticide, something that must be done by the nets' owners), there is increased human exposure.[187]

One reason DDT appeared to be so harmful in the 1950s and 1960s was due to its widespread use in heavy dosages, mostly from government spray campaigns but also from overuse by private sprayers who had not learned proper application techniques. Heavy doses produce more environmental

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[181] D.R. Roberts et al., *DDT House Spraying and Re-Emerging Malaria*, 356 LANCET 330, 331 (2000) ("When a malaria-endemic country stops using DDT, there is a cessation or great reduction in numbers of houses sprayed with insecticides, and this is accompanied by rapid growth of malaria burden within the country.").

[182] *Id.*

[183] UNITED NATIONS CHILDREN'S FUND, *supra* note 174, at 8.

[184] *See* Roll Back Malaria homepage, *at* http://www.rbm.who.int/newdesign2/ (last visited Sept. 15, 2003).

[185] Villet, *supra* note 174. Delegates to a World Health Organization conference on DDT use in Africa in Harare, Zimbabwe in 2000, for example, issued a statement expressing the "deep concerns of the participating member states on the possible economic and health implications of any restriction made on DDT use for malaria control." Malaria Found. Int'l, *Delegates' Report of the Regional Consultation to Prepare African Countries Towards Reduction of Reliance on DDT for Malaria Control*, Harare, Zimbabwe, Feb. 8-10, 2000, *available at* http://www.malaria.org/ddtreduceaf.html (last visited Sept. 15, 2003); *see also* The WHO Cabinet Project, *Roll Back Malaria Financial Situation* (Dec. 1, 1999), *at* http://mosquito.who.int/docs/3gpm_financial.htm (outlining the expenses of treating malaria without using DDT).

[186] UNITED NATIONS CHILDREN'S FUND, *supra* note 174, at 3.

[187] *See id.*

impact.[188] Even if DDT is sprayed from the air for mosquitoes, the volume and frequency used today is far less than common agricultural practices in earlier years.[189] The primary use today, however, is a much more limited one—an interior spray in houses in areas at risk for malaria.[190]

Why do so many people oppose the use of DDT to control a major health threat such as malaria? The most public opponents of DDT use, even if they concede a limited role for it in the present, are United States environmental pressure organizations.[191] Their case against DDT for malaria control is that any use will lead to expanded uses for illegitimate purposes.[192] Such an argument proves too much, however, since it is true of almost any potentially dangerous substance that a total ban can reduce harm from illegitimate use.[193] A more likely motive, however, is that the initial ban on DDT remains an important symbolic victory for environmental pressure groups. The ban of DDT in the United States took a lengthy and bitter fight and a major triumph for the new environmental movement. Indeed, the Environmental Defense Fund (now Environmental Defense), one of the most

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[188] Attaran, *supra* note 174, at 729 ("The fault for this lies in the massive agricultural use of DDT. Dusting a single 100-hectare cotton field, for example, can require more than 1,100 kg of DDT over 4 weeks."(citation omitted)).

[189] *See* Malcolm Gladwell, *The Mosquito Killer,* NEW YORKER, July 2, 2001, at 42, 50.

[190] Attaran, *supra* note 174, at 729 ("The current practice is to spray the interior surfaces only of houses at risk, leaving a residue of DDT at a concentration of 2 g/m2 on the walls, ceiling and eaves, once or twice a year. Half a kilogram can treat a large house and protect all its inhabitants."). Indoor spraying was already a crucial part of the antimalaria campaign by the 1950s. Gladwell, *supra* note 189, at 50.

[191] A review of websites offered by major environmental organizations (Audubon, EDF, NRDC and WWF) indicates nothing but an historical interest in DDT. It is simply to be listed as a chemical that everyone knows is bad. Greenpeace sponsors protests at the few factories in nations where DDT is still produced. Roger Bate, *Without DDT, Malaria Strikes Back,* SPIKED SCI. (Apr. 24, 2001), *at* http://www.spiked-online.com/Articles/ 000000005591.htm. The World Wildlife Federation is also pushing to eliminate all use of DDT. Richard Tren & Roger Bate, *When Politics Kills: Malaria and the DDT Story* 23 (2001), *at* http://216. 156.132.11/PDFs/Malaria.pdf. To be fair, there has been a quiet pulling back from the advocacy of a total ban by most environmental organizations which now argue for a transition to other "less damaging" pesticides.

[192] Roberts et al., *supra* note 181, at 331 ("[E]nvironmentalists are still seeking a global ban arguing that if DDT is produced for use in improving public health, it will also be used for agriculture and lead to global pollution of the environment."(citation omitted)).

[193] Indeed, the argument is strikingly similar to that made against the medical use of marijuana, or even studying such uses, a position many environmental pressure group members would presumably disagree with because of its implications for reducing individual freedom. *See, e.g., The War on Drugs: Fighting Crime or Wasting Time?,* 38 AM. CRIM. L. REV. 1537, 1560-61 (2001) (comments of Congressman Bob Barr in response to a question on why he opposes medical marijuana referenda in the District of Columbia).

effective groups, grew out of the initial campaign against DDT spraying on Long Island.[194]

There are others who benefit from restricting or eliminating DDT use, including the manufacturers of substitute pesticides, which are more expensive and less effective than DDT.[195] DDT is cheap because it has long since lost patent protection and can be made by anyone without payment of royalties.[196]

> This instance of environmental advocacy seems to have won approval of powerful pesticide companies because it allows them to sell their more expensive insecticides. The replacement of DDT by organophosphate, carbamate, or pyrethroid insecticides is commonly proposed even though price, efficacy, duration of effectiveness, and side-effects ([for example] unpleasant smell), are major barriers to their use in poor countries.[197]

There are several lessons from the malaria story.

1. Symbolic Politics Have No Place in Government Environmental Policy

Symbolism is a critical part of political discourse. Making decisions based on symbols is not unusual in political decision-making. Symbolic politics are, however, a strikingly bad means of allocating resources through the political process. In the case of DDT and malaria, for example, symbols kill.

Symbolic acts are, on the other hand, perfectly appropriate for individuals. Consumers can demand products that are pesticide-free, even if such products have no objective benefits[198] and are inferior to fruits and vegetables grown with pesticides in other dimensions, solely because they want to

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[194] DUNLAP, *supra* note 156, at 142-200 (discussing history of DDT suits and EDF).
[195] Attaran, *supra* note 174, at 730 (explaining that Malathion, the next cheapest alternative, costs three times as much to apply as DDT).
[196] *See* Morriss & Meiners, *supra* note 135, at 26.
[197] Roberts et al., *supra* note 181, at 331.
[198] We offer this example purely for the sake of argument. There may well be such benefits. Our point is that even if there are not, the act may still be a valid one as an individual symbolic action.

support pesticide-free agriculture as a symbolic gesture. In this case the individual bears the costs of her decision: if organic produce is not superior to non-organic produce, she will be paying more for an inferior product. The problem occurs when some people use government's coercive power to impose costs on others to achieve a symbolic act. In that case, the special interest group members do not bear the full costs of their actions, and consequently buy too much of the symbol. Where the symbols have real costs, as with DDT and malaria, this is unacceptable.

2. One-Size-Fits-All Policies Are Inferior to Federalism

Solutions that work for one place may not work for another, as local conditions matter. Local knowledge matters in many ways. For example, the vulnerability of groundwater to pesticide contamination "depends on the unique combination of local conditions."[199] As USDA pesticide official Allan Jennings noted in 1988, many pesticide problems vary from location to location creating "the issue of how to effectively restrict pesticide usage *where the problems exist.*"[200] Removing pesticide decisions to the lowest possible level is thus superior to centralizing them so long as local decision makers have adequate information available to them. Producing and disseminating information is, therefore, an important means of improving pesticide decision making.

D. *Drift*

The objective of pesticide delivery can generally be regarded as "the placement on targets of just sufficient of a selected active ingredient to achieve a desired biological result with safety and economy."[201] Unfortunately, pesticides applied to a crop on one property sometimes end upon another property, where they can cause harm.[202] Herbicides commonly used on cotton, for example, are harmful to corn. Applying a pesticide to one crop can result in harm to a neighboring field's crop when the pesticide drifts across the

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[199] Allan L. Jennings, *EPA Regulatory Thrusts and Impact on Pesticide Usage*, *in* IMPROVING ON-TARGET PLACEMENT OF PESTICIDES 31, 33 (Agric. Research Inst. ed., 1988).
[200] *Id.* at 34 (emphasis added).
[201] Downer, *supra* note 71, at 5 (citation omitted).
[202] Drift has significant environmental impacts:

boundary between the fields and gets on the wrong crop. Reduced yields are the most common result in those circumstances. Urban-rural boundaries also produce drift complaints where agricultural sprays contaminate urban gardens and property. Beyond losses in application, other emissions of pesticides that contribute to drift also occur, including emissions from the plant, and volatilization of the pesticide after application.[203] These losses can be substantial as well, with up to fifty to sixty percent lost in this fashion.[204] As with other problems with pesticides, reducing drift involves tradeoffs between solving one problem and increasing another.[205]

Disputes over drift have been a feature of agricultural life since spraying began.[206] Drift problems are the result of the relatively low efficiencies of pesticide application, whereby only small percentages of the active ingredient reach the target pests.[207] Many states have well-developed bodies of tort law dealing with drift damage. The surprising thing about pesticide drift cases is that there are so few of them, given the volume of pesticides applied to American crops. One reason for this is that many state governments provide services to help resolve disputes over drift.

One of the authors (Morriss) worked for the Texas Department of Agriculture ("TDA") during law school as an intern. TDA had then recently passed from the control of the rural wing of the state Democratic party, and a particularly obtuse Agriculture Commissioner named Reagan Brown, to the control of the left wing of the state Democratic party, with the election of Jim

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> A key issue is the risk of "spray drift" beyond the field boundary, especially if there is another crop susceptible to a herbicide, there is surface water or a ditch which could be contaminated by the pesticide, or there are bees downwind of insecticide-treated fields. Protection of hedgerows around fields is also of crucial importance to avoid contaminating the habitat of important populations of natural enemies. Field boundaries are also important habitats for game birds and conservation of other wildlife.

MATTHEWS, *supra* note 37, at 14 (citations omitted).

[203] *See generally* Van Den Berg et al., *supra* note 147 (discussing the various types of pesticide emissions and relevant dynamics).

[204] *Id.* at 213.

[205] MATTHEWS, *supra* note 37, at 19 ("There can be a conflict between optimising the spray quality for efficient application of a pesticide and endeavoring to minimise the risk of drift.").

[206] *See* Morriss & Meiners, *supra* note 135 (discussing drift cases).

[207] *See, e.g.*, MATTHEWS, *supra* note 37, at 18 (discussing this problem); G.A. Matthews, *Improved Systems of Pesticide Application*, 295 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON (SERIES B, BIOLOGICAL SCI.) 163, 163 (1981) ("Sometimes over 99% of the pesticide fails to reach the intended target.").

Hightower.[208] Hightower had made a name for himself by campaigning against the fire ant program's indiscriminate use of pesticides.[209] Hightower generally concentrated on positive aspects of the agency, such as increasing marketing of Texas produce.[210] He also inherited the main state pesticide regulatory efforts—then locked in a 1950s-era bureaucracy. Hightower wanted change in pesticide policy to satisfy his urban, environmentalist constituency, but he also needed to not alienate the agricultural community, which was highly suspicious of him, if he wanted to be reelected, so he tread fairly cautiously.[211]

As part of the internship, Morriss went on some pesticide investigations with the chief inspector, Al Hernandez. During a typical investigation, they would visit some neighboring farmers, one of whom alleged that the other's pesticides had drifted onto his fields, causing harm to his crops. This sort of thing was common as there were hundreds of such complaints a year resulting from having adjacent crops that required incompatible pesticides.

On each investigation, the same thing would happen. When everyone had gathered in a field to look over the alleged damage, and shook hands all around, each person would glance down at the others' hands. Usually everyone but Morriss would have a large, gold, Texas A&M ring.[212] Morriss's lack of a ring would most times cause a visible step back by the others, with a further step back when Hernandez would mention Morriss was a Yankee law student attending the University of Texas. The chill would only go away when Hernandez assured everyone that despite this failing, he considered Morriss "OK." The community of interest that the Aggie ring signified was critical to TDA's ability to play a constructive role in these situations.

Second, the TDA inspectors played the role of impartial arbiters and documentors of events—sometimes all it took was the inspector opining that it indeed did look like some broadleaf herbicide had gotten onto the cotton

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[208] For a general discussion of Hightower's approach, see Ronald B. Taylor, *Texas' New-Style Agriculture Commissioner Jim Hightower Carries His Message of a New Populist Movement Nationwide*, L.A. TIMES, Dec. 19, 1985, at 40.

[209] *See* William Schneider, *An Insider's View of the Election*, ATLANTIC ON-LINE, July 1988, *available at* http://www.theatlantic.com/politics/policamp/insider.htm; *see also* Jan Reid, *The Fire Ant*, TX. MONTHLY.COM, *available at* http://www.texasmonthly.com/ranch/readme/ants.php (last visited Oct. 24, 2003).

[210] Taylor, *supra* note 208.

[211] *Id.*

[212] For a discussion of the history of the Aggie ring, see The Ass'n of Former Students of Texas A&M Univ., *Aggie Website, at* http://www.aggienetwork.com/ring/timeline.aspx (last visited Sept. 15, 2003).

field as evidenced by the swath of sickly looking plants for a couple of hundred feet into the field or noting that nearby weather stations reported gusting winds on the day the applicator had sprayed the wheat field, to satisfy everyone that some compensation was owed.

Most of the incidents went no further—TDA served as recorder, which helped with insurance companies, and expert adjudicator, making sure that a bad crop was not improperly blamed on a neighbor instead of the drought or bad seed. Once in a great while, lawsuits were filed. In those cases, usually involving larger amounts of alleged damage, the tort system worked reasonably well.

The cases that did not fit within the "easy-to-solve-amongst-us-Aggies" paradigm were the urban exposure cases. These usually happened on the borders of town and country, where individuals experienced drift onto their gardens, laundry, houses, and persons. Missing from these cases was the reciprocal nature of rural life, where one drift incident went from my field to yours, the next from yours to mine, and so on. Townspeople might not use pesticides in their gardens, and certainly did not do so from airplanes, and felt understandably strongly about being sprayed with what they saw as dangerous poisons that they often felt no one had any business using.

Town and country cases were harder to resolve, in part because it was harder to resolve the value of the harm. Agreeing amongst farmers on the value of a ten percent reduction from ten rows of cotton is easier than agreeing about the value of the loss of an organic garden between an organic gardener who has gone to considerable trouble to create one and a farmer who thinks organic foods are for fools who do not value progress. TDA never figured out a good way to resolve those cases. The values asserted were incompatible and the most the agency could offer was to allow the parties involved to vent their feelings to the inspectors and, hopefully, facilitate the parties in working something out.

There are three lessons from our drift "fable."

1. Many Pesticide Problems Have Local Dimensions as Well as Potentially Having Broader Dimensions

Sometimes we focus on the global problem of residues in Antarctic penguins and forget that those residues generally got there by migrating off the property of someone who thought the pesticides were doing some good on her property. When those pesticides migrate, they often pass through the

property of an immediate neighbor long before dispersing into the environment and making their way to Antarctica and the penguins. Those local problems are not the complete set of problems, but they are the easiest set to solve. This suggests that perhaps we should begin with institutions that address local problems first before tackling the really hard ones. Solving the local problems also can significantly reduce environmental harm from pesticide use: solving boundary problems, for example, has major environmental benefits.[213]

2. Local Institutions Do a Good Job of Solving Local Problems Because Local Institutions Have Knowledge About Local Conditions—Knowledge That is Important to Understanding the Problem

The local TDA inspectors and the farmers knew the reputations of the different applicators, their equipment, soil conditions, and so on, information that enabled them to make judgments that were impossible for people in Austin, let alone Washington, D.C., to make. The people in Austin and Washington might have been smarter, known more science, or had more degrees, but they lacked the local knowledge needed to make good decisions in a cotton field near Floydada, Texas. Further, those farmers were right to look for an Aggie ring on TDA employees, and right to pull back when they did not see one. The lack of a ring meant someone was not part of their community and should not, could not have been trusted without some further indicia of trustworthiness. That person lacked the local knowledge necessary to solve their problems.

Markets can solve problems: entrepreneurs have come up with methods to prevent drift problems. New technologies to reduce drift include shrouds, wind foils, air-assisted sprayers, variable-rate nozzles, chemical additives to mixtures to that change spray characteristics, and others.[214] The possibility of

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[213] Finney, *supra* note 19, at 70.

> Perhaps the most dramatic short-term ecological improvements will arise from increased attention to the management of field boundaries and other uncropped land. These areas are crucially important to wildlife and sensitive management, often involving use of appropriate selective herbicides, can lead to rapid and sustainable improvements in species diversity.

Id.

[214] Downer, *supra* note 71, at 6; Matthews, *supra* note 207, at 171 ("In the future, on larger farms, there may be advanced vehicles with computer controls of flow rate, droplet size, charge: mass ratio and swath width, the appropriate chemical being selected in relation to the

solving these problems lures new entrants into the market.[215] Substantial improvements in controlling drift can be made by adopting these techniques. Other improvements are also reducing other environmental problems.[216]

In short, the environmental problems caused by pesticides are largely the result of off-target deposition. Drift onto neighboring crops is the most acute form of this;[217] bioaccumulation of the pesticide in non-target species is another. Reducing one, however, can lead to reductions in others as well. Moreover, the size of the losses from both application drift and post-application volatilization are sufficiently large given the price of pesticides, so that reducing them offers a significant opportunity for profit.

3. Value Conflicts are Hardest to Solve

An important lesson concerns the hard problems that come from conflicting values—both the urban-rural divide and the organic gardener-cotton farmer divide, are a product of fundamental conflicts in values. The contrasting images in the 1970s debates over pesticides of rural pesticide users volunteering to drink or bathe in their sprays to demonstrate their safety and organic produce advocates clad in natural fibers warning of "silent

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input of crop monitoring data.").

[215] *See, e.g.*, Harold C. Simmons, *The Role of Industry in Developing Innovative Spraying Equipment, in* IMPROVING ON-TARGET PLACEMENT OF PESTICIDES, *supra* note 199 (describing interest of Parker Hannifin Corp., a company with $2 billion annual sales, in market despite previous lack of experience in pesticides because of record in developing spray equipment).

[216] Finney, *supra* note 19, at 69.

> [N]ew products are being developed with physiochemical properties which will make them less mobile and less persistent in the environment. Substantial improvements are also being made to formulations and packaging, especially a trend away from liquids to solid granular formulations, which should significantly reduce accidental point-source contamination of the environment through spillage.

Id. Technological change also causes shifts in application methods. Aerial application, which produces more off-target deposition and drift than most other methods of application, became common after World War II. Improvements in ground spraying equipment led to a later decline in aerial application. Wardman & Thomas, *supra* note 138, at 243.

[217] One estimate suggested that thirty percent of the quantity applied is typically lost to drift in aerial foliar insecticide applications. OFFICE OF PESTICIDE PROGRAMS, ENVT'L PROT. AGENCY, A STUDY OF THE EFFICIENCY OF THE USE OF PESTICIDES IN AGRICULTURE 10, fig. 1 (1975). Ten percent is estimated to be lost to volatilization, leaching and surface transport, fifteen percent to application off the target crop, and forty-one percent to off the target insect, but on target crop. *Id.* Clearly there are major efficiencies to be gained by improving these figures.

springs" was not evidence that rural America was something out of the movie *Deliverance*[218] or that all those concerned with pesticides had yet to get over Woodstock. The dispute was caused by different value choices, different information sets, and different weighting of risks and benefits. Those are hard problems—and they are not made easier to solve by handing them to the federal government to resolve in a winner-take-all fashion through the political process. Such problems are best left to levels of government closer to communities likely to share values and to decentralized decision making that allows different solutions for different communities.

4. Federalism Works

Moreover, voluntary methods can reduce such conflicts. Application technique plays a significant role in the proportion of a pesticide application that reaches the pest and the proportion that ends up off-target and "in" the environment. Off-target drift is waste, something that all participants have an incentive to reduce. Doing so can even yield marketing benefits: Consumer pressure for lower chemical use has led to "Consumers Charters" in Australia, for example, in which growers pledge to reduce their use of chemicals and comply by reducing off-target waste.[219]

In addition to value conflicts, pesticide use presents problems for tradeoffs. Our final lesson from the drift fable is that tradeoffs exist.

5. Tradeoffs Exist

Controlling drift is a problem that requires trading off different aspects of control. Most obviously, stopping drift generally requires substituting the risk of less than complete coverage of the target field for the risk of drift. This can be accomplished by simple methods (stop spraying before the edge of the

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[218] DELIVERANCE (Warner Bros. 1972).

[219] Jones et al., *supra* note 36, at 176. Jones and his co-authors note that significant reductions in bioregulators can be achieved through research into more efficient application methods.

> There should be a reduction of the amount of active bioregulator ingredient used per hectare by at least 25% as a result of the use of more efficient spray application technology. Bioregulator application dosages could be reduced by a further 25% as a result of spraying at the most effective time. There is evidence to show that correct application timing can allow the reduction of the dosage of bioregulator used by up to 50%.

Id. at 179-80.

target field, do not spray when the wind is blowing hard) or more complex changes (altering droplet size). Less obviously, some of these methods can increase other environmental harms. Reducing off-site drift ("exo-drift"), for example, may entail techniques that increase on-site-but-off-target application ("endo-drift") through changes in droplet size that alter leaf retention.[220]

This is an example of larger problems in pesticide policy. The decisions are not simply dichotomous: food or environment, bugs or people, poison or savior. Using any particular pesticide is a choice not to undertake alternative actions. It is rare that any one choice is purely beneficial or harmful for the environment. Persistent pesticides reduce exposure to applicators but increase problems for wildlife; broad spectrum pesticides kill more pests but also have more impact on beneficial insects; no till agriculture reduces erosion but increases herbicide use. The "environmental" choice is likely to differ from place to place and time to time.

IV. PRINCIPLES

To put these lessons to work, we offer five principles for pesticide policy and environmental policy more broadly:

- Avoid the nirvana fallacy.
- Facilitate the use of local knowledge. Government's role is to facilitate information sharing and the development of local institutions.
- Recognize existing explicit and implicit property rights claims.
- Solve the easy problems first.
- Get the incentives right.

Using these principles would allow the development of a new pesticide policy that we argue would have less environmentally damaging consequences than our current policy.

The first step is to avoid both the false nirvanas of regulatory solutions and the despairing and equally false apocalyptic predictions that have haunted American pesticide policy. A realistic assessment of institutions is vital to an effective policy. Assuming that EPA will be able to amass and digest the

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[220] Matthews & Thomas, *supra* note 68, at 975 ("To avoid increasing endo-drift and also minimise the risk of downwind exo-drift there is a need for optimisation of droplet size within the crop and for ensuring that droplets impact on foliage within the treated area, so that minimal dosages are effective.").

relevant data and decide the status of every pesticide in use on every crop in a coherent and rational way in a very short time is one example of a nirvana fallacy. Assuming that pesticide users will simply stop using pesticides while this process goes on is another.

Moreover, even if EPA could respond coherently to such demands, centralizing regulatory decision making costs us the local knowledge that is critical to making good decisions. For example, allowing American preferences on DDT to dictate its use in malaria-ridden countries is a recipe for bad decisions. Within the United States, making decisions in Washington, D.C. (or Austin, Texas or Columbus, Ohio) loses important information available in Junction, Texas and Columbia Station, Ohio. Some information can be known in Washington, Austin, and Columbus—scientific information about the impact of a chemical on birds, for example. But knowing things about specific fields also makes a difference in the environmental impact of pesticide use. Pushing decision making towards local institutions is thus usually preferable to central planning. That does not mean that the federal government has no role. It can play an important part in facilitating information flow, developing information, and fostering local institutions.

Increases in knowledge take time and the recognition of the importance of issues. For example, not until the 1960s and 1970s did agricultural economists focus on the economic threshold for pesticide use.[221] Once such work began, however, it quickly grew more sophisticated.[222] More knowledge can mean problems are solved.

In addition to fostering local institutions generally, pesticide policy should foster the most local institution of all: property rights. We should be attempting to find ways to define new property rights where they do not exist. Technology can help with this;[223] the most important thing is to favor solutions that recognize existing property rights claims and foster the creation of new ones. Migratory bird problems, for example, might be addressed by giving title to specific bird flocks, identified through DNA sampling and microchip implants, to bird watchers. Other aspects of environmental protection for migratory birds have been solved through private initiatives built around property rights, such as the prairie pothole program run by

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[221] Osteen, *supra* note 25, at 268.
[222] *Id.* at 269.
[223] Richard S. Cahoon & Ron Herring, *Biotechnology, Intellectual Property, "Bioproperty" and Novel Schemes for Wild Biota Conservation*, *in* THE TECHNOLOGY OF PROPERTY RIGHTS (Terry L. Anderson & P.J. Hill eds., 2001).

Ducks Unlimited.[224] Governments can facilitate such solutions in a variety of ways.

We should not let the existence of hard problems that we cannot immediately solve prevent us from tackling the easy problems. There are many in pesticides, starting with the destructive role of agricultural subsidy programs around the world. Transforming the debate over such programs into an environmental issue could be helpful in overcoming the entrenched special interest that block change in the United States and abroad. Solving some of those problems, such as drift and overly-intensive farming in response to the subsidy program structure, may solve some of the harder problems for us.

Finally, the most important principle is to get the incentives right. Incentives matter and they can have a major impact. The agricultural chemicals business is highly competitive.[225] The development of new techniques that reduce pesticide use, saving the farmer money and reducing environmental impacts, is increasing as entrepreneurs recognize these techniques as a source of profits.[226] The competitive edge the companies gain is a powerful motivating force for improving pesticides by reducing environmental impacts. For example, over- and under-application is a problem where equipment is not precisely calibrated. "Monitors that sense speed and flow rate and have inputs for application width can continuously display the application rate. Servo-control units that automatically control the application rate with changes in travel speed are now available also."[227] Market pressures are also changing pesticide use, as consumers demand foods that meet higher standards of safety.[228] Pesticide companies can offer package services to control pests rather than simply selling particular chemicals, allowing them greater control over conditions of use and providing them with the opportunity to control for resistance development and other factors.[229]

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[224] *See* Jonathan H. Adler, *The Ducks Stop Here? The Environmental Challenge to Federalism*, 9 S.CT. ECON. REV. 205, 237 (2001).
[225] Green, *supra* note 36, at 176.
[226] *See, e.g.*, Blazquez et al., *supra* note 30, at 117 ("In the United States, large-scale adoption of [computerized pest management] schemes may be expected in the near future, as commercial firms move into the pest information delivery field at an accelerating pace.").
[227] Butler & Bode, *supra* note 128, at 264.
[228] *See, e.g.*, MATTHEWS, *supra* note 37, at 5 ("In practice, those marketing the produce (the supermarkets and food processing companies), are having a greater influence on pesticide use by insisting on specific management programmes.").
[229] *See* E.E. Bernet, *The Project Approach to Crop Protection*, 295 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON (SERIES B, BIOLOGICAL SCI.) 199 (1981) (describing Ciba-Geigy's approach to selling such package services).

V. CONCLUSION

For much of the last century, pesticide use in the United States has been regulated under a central planning approach. Whether it was apple growers in the Pacific Northwest not using enough pesticides or farmers in the 1970s using too many, governments at all levels have attempted to dictate use decisions based on the model of a central regulator assessing the situation and choosing what was "best" for individuals. Those decisions have been largely made in a vacuum ignoring the impact of other government programs on pesticide use, with a result of a contradictory mess.

Markets, property rights, and common law offer an alternative way to think about pesticide policy. Decentralizing decision making and focusing on incentive effects of government programs can solve some of our problems with pesticides without the undesirable impacts of the central planning approach.

THE FALSE CRISES OF RACHEL CARSON

Silent Spring at 50

Edited by Roger Meiners, Pierre Desrochers, and Andrew Morriss

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9. Agricultural Revolutions and Agency Wars: How the 1950s Laid the Groundwork for *Silent Spring*

Roger E. Meiners and Andrew P. Morriss

Silent Spring has acquired iconic status in the history of the environmental movement. Rather than just a popular science writer, Rachel Carson is virtually a secular saint, having been martyred by her death from cancer shortly after completing her *magnum opus*.[1] A half-century after publication of the book, most people agree that Carson and *Silent Spring* appear to have changed public opinion about pesticides in general and DDT in particular.

But, as Desrochers and Shimizu discuss in Chapter 3, debates about pesticides began long before Carson's book. In this chapter, we will show that *Silent Spring* is a populist expression of a struggle over the regulatory authority governing American food production between two federal agencies with dramatically different visions: the Food and Drug Administration (FDA) and the federal Department of Agriculture (USDA). This struggle took place at the same time as important technological changes in food production and delivery were remaking rural America. Just as agriculture underwent a dramatic productivity revolution that changed the face of American farming, marketing, new home appliances, and increased participation in the labor force by women radically changed the kinds of food Americans ate. The consumption of processed foods increased significantly, and, concomitantly, concern about the purity of those foods increased as well. (Food purity was central to the "guinea pig muckraking" discussed in Chapter 3.)

The combination of these trends with the agencies' turf conflicts created the conditions in which powerful parties with conflicting interests in pesticide policy would have clashed

regardless of whether Carson had written *Silent Spring*. Institutional entrepreneurs at the FDA used public concern over food safety, and the processing industry's desire for protection from public perception of food safety threats, to gain advantages in its struggle for power with USDA. This conflict aided in the organization of environmental pressure groups already coalescing over opposition to publicly funded pesticide spraying. *Silent Spring* was one more expression of conflicts unleashed by larger changes in agriculture.

DDT provided a particularly convenient target for both the FDA and the nascent environmental pressure groups because it was in widespread use. Its ubiquity and cheapness meant there were few organized interests to defend it. As a commodity in the 1950s, DDT was a low-margin product that competed successfully with higher margin, less effective, and more dangerous products.[2] As a result, agricultural chemical producers had little interest in spending resources to protect DDT. The primary costs of restrictions on DDT were ultimately borne not by American agricultural interests but by residents of developing countries where malaria and other diseases are persistent problems. Being poor, nonwhite, and far away, those people had little influence in the debate over DDT. Indeed, some environmentalists ultimately argued against DDT's use even for malaria control precisely because it lowered death rates in developing countries.[3]

In this chapter, we first sketch out the larger changes in agriculture and federal regulation of agriculture that set the stage for the debate over DDT in the late 1940s and 1950s. We then use the record of hearings held in 1950 and 1951 to explore how the competing interests at FDA and USDA used the issue in their larger struggle for control over the growing processed food market. Finally, we use these materials to put *Silent Spring* into a broader context, showing how conflicts over pesticides in the 1950s helped position *Silent Spring* to create a movement. Carson was not a voice in the wilderness; she had powerful allies in government and industry. We conclude by fitting this explanation into economist Bruce Yandle's "Bootleggers and Baptists" theory of regulation.

The Second Agricultural Revolution

Farms in 1930 were not much different from farms 50 years earlier.[4] Productivity had slowly improved through better tools and

better crops, but tractors would not outnumber horses and mules until 1950.[5] Most farms were diverse operations. Many farmers produced much of their own food and sold the surplus eggs, butter, milk, chickens, vegetables, and other products to local customers and retailers, as well as raising a primary cash crop.[6] This changed rapidly after the war, as increases in "the efficiency of production in almost every specialized area of agriculture and marketing of foods made it cheaper to buy almost any type of food than to grow one's own."[7] Even for farm families, commercial food processing replaced much of the home processing previously used to store food for the winter, partly as a result of increased labor force participation by women during the war.[8] An even faster transformation occurred in urban areas. Sixty-five percent of food sold at retail was partly or fully processed by 1940, rising to more than 80 percent by 1960, making food processing one of the nation's largest industries.[9] One measure of the expansion was the spread of frozen foods. Frozen foods were limited in the 1930s, in part because of a lack of freezers in stores and homes. By 1944, over 70 percent of households had refrigerators and freezers, and "frozen foods were widely accepted."[10]

Just as the market for farm products was shifting as food processors became the primary buyers of farm output, the labor shortages resulting from the war led to "a virtual explosion in production per acre and per worker."[11] Labor productivity in agriculture grew almost three times as fast as labor productivity in manufacturing from 1950 to 1970;[12] total factor productivity growth after 1935 rose at six times the rate from 1900 to 1930.[13] This growth resulted in part from the post-war recovery's luring of labor out of agriculture, which spurred further efforts to substitute capital for labor.[14] In the 30 years after World War II, only communications, electrical machinery, and chemicals surpassed agriculture's productivity growth.[15]

The revolution in agricultural productivity was driven by the spread of mechanical equipment, vastly increased fertilizer use, improved crops, and the new insecticides, herbicides, and fungicides widely available after World War II.[16] These were not accidental innovations. Beginning in World War I, a "formidable dual system" promoted innovation in agriculture, with public institutions funding research[17] and training agricultural engineers and private manufacturers turning these inputs into improved technology.[18] Major companies such as Hercules invested heavily in

developing synthetic pesticides in the 1930s.[19] Mechanization freed the 72 million acres used for work animal feed crops in 1910 for other crops.[20] Increases in fertilizer production during and after the war meant that, "for the first time in human history, the average farmer could grow crops on the same fields year after year."[21] By the end of World War II, there had been a widespread "chemical revolution" in agriculture.[22] This revolution helped agriculture expand on the intensive production demanded by war needs.[23]

The chemical revolution was a critical part of broader changes in agriculture. In the 1920s, both public research institutions and private manufacturers "assumed greater authority in determining biological and chemical resources (seed, chemical fertilizers, pesticides) and for new machinery (tractors, combines, and mechanical corn pickers). In part, this was spurred by discoveries during World War I of the pest-killing properties of substances manufactured as explosives and for gas warfare."[24] As a result, from 1920 to 1940, farmers began to shift their focus: "they dwelled less on questions of innovation and more on problems of adoption."[25] Thus, just as farmers' markets were changing to meet the rising demand from food processors, the source of agricultural productivity increases was shifting from farm to laboratory.

The new technologies from the labs transformed how crops were produced. For example, post–World War II herbicides allowed dramatic reductions in labor by eliminating the need to cultivate row crops for weed control. "For corn, herbicides raised production more than had hybridization. Farmers could now reduce the width of corn rows from three feet or more to as little as twenty inches, in some cases almost doubling production."[26] Aerial crop dusting—a technology pioneered about 1921—made widespread use of pesticides possible in many more crops than hand sprayers had allowed.[27] By 1926, aerial spraying of several thousand acres of potatoes threatened by pests accomplished with just two pilots, a mechanic, and a single plane what would have taken 2,000 ground workers.[28] By the early 1950s, more than 5,000 airplanes were involved in aerial spraying.[29]

This revolution in agricultural technology meant that the 1950s were a time of significant change in American agriculture. Farms grew larger, used less labor, and sold to large commercial buyers rather than consumers or local stores. Growing a crop involved new

seeds, new fertilizers, new herbicides, and new insecticides. Not only was agriculture more mechanized than before the war, production was becoming a sequence of complex, interrelated decisions about appropriate application rates of fertilizers and pesticides. Livestock operations were undergoing similar changes, as large commercial feedlots displaced smaller farm-based operations.[30] Similarly, farmers' relationships with the market and the government were also changing. Such shifts create uncertainties, in which policy entrepreneurs have openings.

Regulating Agriculture

Prior to the New Deal, the federal role in agriculture was largely limited to support for research intended to boost productivity.[31] But farmers were unhappy with this limited role and had been lobbying to change that focus for more than a decade. While *farms* in 1930 were not much different from farms 50 years earlier, *farmers* in 1930 were better organized politically than farmers had been in 1880. In particular, falling agricultural prices after World War I prompted agricultural interests to organize politically in search of "parity" in prices, that is, a price level for their crops relative to other goods (especially those they bought) that was the same as during the "golden era" of 1910–1914.[32] The formation of a powerful, bi-partisan "Farm Bloc" in Congress after World War I was one of the more visible results of increased focus on politics by agricultural interests.[33] In a short period, the Farm Bloc passed "the Packers and Stockyards Act, the Futures Trading Act, the Agricultural Credits Act of 1921, amendments to the Federal Farm Loan Act, the Capper-Volstead Cooperative Marketing Act of 1922, and the Agricultural Credits Act of 1923," before splitting during bitter battles over the McNary-Haugen bill[34] that sought to bring prices back to pre–World War I "parity."[35]

While the split temporarily reduced farm interests' clout in Congress, the Farm Bloc's successes gave powerful evidence of farmers' political clout when they did agree. Further, many of the new agricultural programs themselves prompted additional organizing efforts. For example, the Farm Board created by President Herbert Hoover in 1930 had a director representing each major crop and a staff distributed around the country whose job was to organize farmers into cooperatives and cartels to boost farm income.[36] Government efforts at promoting political organization by

farmers predated even the Farm Bloc. USDA had begun efforts to organize farmers in 1914, attempting to create an analogue to a chamber of commerce for agriculture. In 1917, it called a meeting of all farm organizations that led to the creation of the National Board of Farm Organizations and an early attempt to create a "national rural policy."[37] Such efforts further encouraged political organization by helping farm interests coalesce into organized groups.

By the time Franklin Roosevelt was preparing to take office, agricultural interests were powerful enough that he directed that whatever program his underlings designed for agriculture, it be one that was acceptable to farm interests.[38] One measure of agriculture's clout was that the task of writing production codes for agriculture was given to USDA rather than the National Recovery Administration.[39] The regulatory program that emerged still shapes agricultural policy today in two important ways.[40]

First, New Deal agricultural policy furthered organization among farm interests, requiring farmers to join local groups to participate in programs under the Agricultural Adjustment Act of 1933 and putting AAA offices in "every farming county in America."[41] Moreover, because the "confusing array" of agricultural programs adopted during the New Deal had no guiding principle,[42] interest group politics could be given free rein. There were thus good reasons for farmers to pay close attention to politics: "by the 1930s, the USDA was one of the largest governmental agencies in the world and was the most powerful one for a single occupational interest. In 1931, it had 25,000 employees . . ."[43] As historian Paul Conkin summarized,

> In no period of American history has the federal government undertaken so many initiatives or inaugurated so many programs to aid one economic sector. Farmers received payments for cutting production and subsidies to carry out necessary conservation practices; they received price supports for five basic commodities and crop insurance as a form of disaster relief. In fact, the sheer number of new programs still confuses most historians, just as they confused the legislators who approved them and the farmers who benefited from them.[44]

Second, the New Deal married farm incomes to government policy. By giving the federal government a major role in determining commodity prices, it created a powerful alliance between USDA

and farm constituencies. This alliance's efforts at promoting higher prices through programs that gave farmers incentives to produce more intensively expanded the use of pesticides dramatically. The one constant in the farm policies inaugurated by the New Deal was the tying of participation to production levels. As a result,

> [p]roduction controls made it more difficult for small farmers to compete with larger ones, and larger and more efficient farmers gained the greatest benefits from farm policies. In the long run, the most enduring benefits of price-raising subsidies were an increase in the value of farmland and an even greater importance for base acres. One long-term effect of this product-based system was a tendency for small, less competitive farmers to leave agriculture, often selling their land to more commercially successful neighbors. At the same time, the large and expanding Department of Agriculture, despite internal battles, continued to cater to its prime constituency—the most affluent and capable farmers.[45]

The labor shortages produced by World War II furthered this movement and reduced federal investment in efforts to keep people on the land[46] as well as generating ever more opportunities for lobbying.[47] As farms got larger, technology improved the ability to increase yields. This was reinforced by the many farm policies that encouraged intensive production such as the 1950s Soil Bank, which limited the land farmers could use, encouraging more intensive cultivation of their remaining acreage.[48]

As a result, by the 1950s the federal government's relationship to agriculture was different than it had been in 1930. The USDA now played a major role in determining farm income through its many programs, federal agencies were significant sources of farm credit, and federal policies reinforced trends toward larger farms focused on commodity production.[49] Further, both public- and private-sector research provided agriculture with a steady stream of technological improvements that continued to raise productivity. Finally, consumers' preferences for high standards of appearance in produce also pushed farmers toward greater chemical use.[50] In response to these changes (and partially a cause of them), agricultural interests were well organized politically and paid close attention to the federal policies that played such an important role in determining their income. The early 1950s were marked by constant struggles over the level of

price support the federal government would provide.[51] Moreover, constant increases in production as a result of subsidies during the fifties drove farmers toward more intensive techniques in efforts to maximize yield.[52] This kept farmers in a "cost-price squeeze" and heightened the importance of federal assistance, focused on those USDA thought most likely to succeed.[53]

The creation of a powerful federal agency dealing with agriculture and the transformation of agriculture into an area of the economy dependent on federal policy did more than create incentives to speed the transformation of a nation of small farms using animal power to produce a broad range of products into a nation of large farms relying on mechanical power, fertilizers, and pesticides to produce single crops. It transformed many agricultural decisions into political questions, to be settled (at least in part) through bureaucracies and legislatures rather than in the marketplace. As USDA's size and budget grew, and rural populations continued to shrink, farm interests developed a growing interest in making alliances with nonfarm interests to protect the farm programs that had become a key source of farm income.[54] Pesticide issues became a part of this politicized and rapidly changing landscape.

The Growth of Pesticide Use

DDT played its first major role in World War II, sparing servicemen and civilians from scourges of pests, such as mosquitoes and lice, and the diseases they carry, such as malaria and typhus. As Donald Roberts and Richard Tren explain in this volume, immediately after the war, DDT was used for mosquito control both at home and abroad. Its use quickly expanded into agricultural pest control, where its combination of safety for humans, toxicity for insects, and low cost made it popular.[55]

DDT was not the first agricultural pesticide, of course. Insect pests had been problematic during the last half of the 19th century; many of these pests were non-native species that had been brought to North America by cargo and immigrants.[56] The most common solutions to pest problems were inorganic poisons, substances such as "Paris Green" (copper acetoarsenite) and lead arsenate.[57] By the 20th century, problems included the peddling of ineffective products by scam artists to unsuspecting farmers[58] and free-riding by some farmers, whose failure to spray their crops with effective

insecticides allowed insects to harm their neighbors' crops.[59] To address effectiveness issues, federal and state governments imposed consumer protection regulations, most often requiring labels to disclose the active ingredients.[60] Free riding was addressed by mandatory spray laws in the Pacific Northwest.[61]

Those commercial insecticides developed in the 19th century and used before World War II required high enough doses that they could cause acute medical problems for people who ate food with pesticide residues still on them.[62] Because the effective ones were based on highly toxic chemical substances such as arsenic, farmers, consumers, regulators, and food processors worried about residues. This was a particular problem in the apple market, where high loss rates were common, especially for apples shipped from the Northwest to eastern and foreign markets. People wanted fruits free of worms, but worries about residues caused some governments to restrict the sale of sprayed crops not fully washed. For example, in 1925 two shipments of apples from the United States to London were rejected because of spray residue.[63]

Hence, farmers and food processors were aware of the potential problems posed by agricultural chemicals well before DDT appeared on the scene. James Whorton quotes an 1891 contributor to *Garden and Forest* who worried about the long-term impact of the use of "a most virulent mineral poison,"[64] a concern similar to Carson's worries over the aggregate impact of DDT. During the 1920s and 1930s, the medical profession took increasing notice of the dangers of the arsenical pesticides.[65] And in *100,000,000 Guinea Pigs*—discussed by Desrochers and Shimizu in Chapter 3—Arthur Kallet and Frederick Schlink devoted a chapter to the dangers of arsenic and lead residues and blamed the FDA for failing to be more aggressive. Similarly, *The American Chamber of Horrors,* authored by the FDA's information officer, included a chapter on "How Much Poison Is Poisonous?" which cast the FDA as heroically attempting to save children from foods with pesticide residues.[66]

Indeed, the new pesticides coming into use during World War II represented a step toward solving these problems, since they were not acutely toxic to humans and were applied at lower doses than earlier pesticides. DDT and other organochlorines[67] rapidly grew in use, as they appeared to be safe for both farmers and consumers as well as effective.[68] By the end of the war, DDT and the other

members of its chemical family had almost completely replaced most other insecticides in agricultural use.[69] Moreover, tax incentives for DDT production and federal money to build plants created a ready infrastructure for DDT when peace came.[70]

Not surprising, farmers loved the new generation of pesticides. As the USDA was fond of noting in its congressional testimony in the postwar years, damage to agricultural output from pests cost $4 billion a year, almost 1 percent of GDP at the time.[71] The new pesticides offered significant savings. For example, using DDT to control the horn fly increased milk and beef output by $45 million in the states that kept statistics on the matter.[72] Where DDT was used, the USDA estimated that cattle gained an average of 50 pounds more.[73]

While agricultural interests and the USDA focused on the benefits of increased productivity from the new pesticides, other agencies were less enthusiastic. Beginning in the late 1940s, both the Fish and Wildlife Service and the FDA began to raise questions about DDT and other new pesticides. Early FWS involvement is important to the *Silent Spring* story because Carson worked at FWS for many years, where she headed publications and developed a reputation as a science writer for the public. As Desrochers and Shimizu note, Carson edited some FWS publications that were critical of DDT. Although her own work about DDT appeared many years later, she was aware of negative views about DDT at a time when most people were still celebrating its benefits in agricultural use and the relief it provided to millions of people suffering from many diseases.

What Carson Saw

DDT received good publicity during the war. For example, *The Saturday Evening Post* titled one article "How Magic Is DDT?"[74] Prof. Edmund Russell of the University of Virginia concludes that hundreds of such articles "cemented DDT's reputation as a miracle worker."[75] But not everyone shared the popular press's enthusiasm. The day after Nagasaki was bombed, the FWS warned that "DDT is toxic to both human beings and animals."[76] The degree of the problem was not well understood, and tests were begun. A week after the surrender of Japan, Secretary of the Interior Harold Ickes and FWS Director of Wildlife Research Clarence Cottam both warned of damage to wildlife, beneficial insects, and crops from DDT use.[77] They asserted that even a single application could do significant harm to

nature. While its benefits during the war may have warranted ignoring the side effects, that was no longer the case in peacetime. Cottam unsuccessfully sought to prevent DDT's release for civilian use until the FWS could assess its impact.[78]

In 1945, Carson wrote to *Reader's Digest*, proposing an article on FWS research about what DDT "will do to insects that are beneficial or even essential; how it may affect waterfowl, or birds that depend on insect food; whether it may upset the whole delicate balance of nature if unwisely used."[79] That same year, the Audubon Society (of which Carson was an active member) held a conference on DDT at which C. H. Curran of the American Museum of Natural History warned that the pesticide could "kill almost [all], if not all, cold-blooded animals."[80] In 1946, the FWS issued a "warning" that "care must be taken in applying DDT to field and forest areas if wildlife is not to be endangered."[81] Marine life—an area of particular concern to Carson, as Kaufman describes in this volume—was thought to be most at risk as high kill rates were observed among fish in ponds sprayed with DDT at multiple test sites. Carson wrote a series of articles for the *Baltimore Sun* "whose theme was often the same—marine ecologies in some state of crisis" while she worked at FWS.[82]

The agency's annual report for 1948 noted that its studies of DDT began in 1945 and that "it is unsafe to apply by airplane more than two pounds of DDT per acre if harm to birds, mammals, and amphibians is to be avoided."[83] For many years to come, the agency continued tests and lobbied for increased funding for tests of DDT and other pesticides.[84] By 1965, the agency was reporting that "amazingly small amounts of pesticides can kill shrimps, crabs, and other aquatic life," such as "one part of DDT in one billion parts of water."[85]

Meanwhile, the Public Health Service was singing in praise of the glories of DDT. The experience in World War II at controlling malaria, yellow fever, dengue, and other diseases was a wonder.[86] While not advocating willy-nilly use of DDT, the PHS saw huge potential benefits in extending its use. The PHS and U.S. Army issued a "Joint Statement of Policy" for the "Use of DDT for Mosquito Control in the United States," advocating spraying DDT on houses to kill adult mosquitoes, using it as a larvicide where it would not harm fish and wildlife, and applying it by aircraft in large areas when needed.[87]

A test spraying of 513 rural houses in the South noted the cost was only 74 cents per house, and the mosquito population remained reduced for months.[88] The PHS soon reported that "the highly effective insecticide, DDT powder, obtained through the Public Health Service, is being used to spray the workers [seasonal migrant workers who were often infected with lice] before they board the train in Mexico City [to come work in the United States]."[89] A year later, in 1946, a report from the new Communicable Disease Center (which replaced the Office of Malaria Control) noted that "the advent of DDT wrote a new chapter in the history of insect control, yet the surface of this important subject is barely scratched."[90] The next year the British reported success in ridding a prison of bed bugs by application of DDT: "It is . . . no mean achievement to obliterate bugs from an infested prison. . . ."[91]

Not unmindful of the criticism of injury to wildlife, the PHS did its own investigation of the impact on wildlife from spraying a swamp with DDT. The mosquitoes died but, presaging Rachel Carson, it reported in 1947 that bird "singing continued into July and August" after months of spraying.[92] In 1948, the PHS was reporting on the beneficial effects of aerial spraying with DDT in urban areas to reduce the population of flies.[93] In the 1950s, the PHS was still reporting health benefits from DDT spraying, such as in outhouses and in areas subject to flooding,[94] but more impressive in those years were many reports from around the world of the huge impact on disease control, especially malaria, from the spraying of DDT.[95] The effects were a near miracle from the viewpoint of public health experts.

Scrap among Agencies

FWS was casting doubt on DDT because of its impact on wildlife. Soon, and more important to the long-run debate, it gained a potent ally. The FDA claimed that the new pesticides had serious human health consequences, as described below. The FDA had begun as the Bureau of Chemistry within USDA, then changed its name to the Food and Drug Administration in 1930, and finally separated from USDA in 1940.[96] Solving a botulism outbreak in 1919–1920 (ultimately traced to a California packing plant) and ending sales of a new antibiotic that turned out to be fatal for some users in 1937 were high-profile successes for the agency.[97]

Even before DDT appeared on the scene, the FDA was heavily involved in pesticide residues, spending over a third of its budget on residue enforcement in 1933.[98] Food regulators generally had focused on residue issues—which became their "single most serious concern"—at least since a 1919 conference on the topic.[99] The 1925–1926 publicity in Britain over arsenic residue on American apples also prompted concern among exporters, who saw the potential for disaster.[100] That incident prompted the bureau to consider establishing a publicly acknowledged tolerance for residues; previously, the agency's tolerance levels had not been released to the public.[101] In 1927, the bureau convened a conference in Salt Lake City to discuss tolerances, which it hoped would settle the issue.[102] It did not.[103]

The residue issue gained additional traction when Assistant Agriculture Secretary Rexford Tugwell, a key member of Franklin Roosevelt's "brain trust," pushed the issue to the forefront after receiving a citizen complaint about the use of lead arsenate on food crops.[104] Moreover, there were other constituencies outside the shrinking population that earned its living in agriculture worried about chemicals in food. Organic farming entrepreneur J. I. Rodale launched the magazine *Organic Gardening and Farming* in 1942,[105] and his 1948 book *Pay Dirt* attacked DDT.[106] Indeed, Russell argues that investigations into charges of war profiteering during World War I transformed chemical companies generally into "iconographic 'merchants of death'" for much of the public by the 1930s.[107] Consumers might not have wanted to grow their own organic tomatoes, and welcomed the convenience offered by the new processed foods, but the postwar years were also the time when protoenvironmentalist books such as Fairfield Osborn's *Our Plundered Planet* (1948) and William Vogt's *Road to Survival* (1948) were best sellers (whose impact is discussed by Desrochers and Shimuzi in this volume), evidencing some broader disquiet among the general population.[108]

These concerns prompted the federal government to revisit its pesticide regulatory strategy after the war. One of the first battles was over the proper approach to investigating the scientific issues, and the National Academy of Sciences prevailed over USDA in the organization of the academy's Insect Control Committee. Particularly irksome to USDA was that the committee "was dominated by medical doctors and chemists who had specialized in chemical weapons" while entomologists were deliberately excluded

as committee members.[109] USDA did not lose every battle, as it succeeded in shaping the 1947 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to its liking. The 1947 Act gave USDA primary control of pesticide regulation and focused on notification and informational labeling.[110] Crucially, the new statute did not mandate testing of substances before marketing, as the FDA had urged. Most importantly, Congress rejected the FDA's bid for control of the entire pesticide regulatory process. But FIFRA's passage did not end the struggle for regulatory turf. USDA had regulatory authority that the FDA wanted. DDT and other chemicals would serve as a vehicle in that fight. And from the start of that struggle, while the FDA assailed many pesticides as dubious, it gave DDT special attention, as we discuss below.

The 1947 version of FIFRA required that product labels include the product name, name of maker or distributor, list of ingredients, net contents, warning about use, and directions for use.[111] USDA was given, but rarely exercised, authority to require testing to demonstrate safety when used as directed. In a minor victory for the FDA, the statute required USDA to consult with the FDA to determine if residuals on food were acceptable, as the presence of residuals could put a chemical, or at least certain uses of it, under the authority of the Federal Food, Drug and Cosmetic Act of 1938 (FFDCA). In practice, however, USDA rarely interacted with the FDA on pesticide issues.

The FDA did not abandon its quest for regulatory authority after its defeat by USDA in 1947. As early as 1949, FDA Commissioner Paul Dunbar argued that DDT's war use had been a "reasonably calculated military risk" but that the civilian calculus would be different.[112] The agency began a campaign to discredit USDA's administration of FIFRA. Bit by bit, FDA was successful, as the 1958 amendments to the Food, Drug and Cosmetics Act gave the FDA power to establish residual clearances for pesticides [113] so that, from that point forward, USDA had to coordinate registrations with the tolerances set by the FDA for food and animal feed crops.[114] The key with respect to DDT was not the final outcome but the dynamics of the struggle for regulatory authority, to which we now turn. Moreover, the FDA needed an issue on which it could win public support, because it had made powerful enemies in Rep. Clarence Cannon, a Mississippi Democrat, and Rep. John Taber, a New York Republican, both of whom sat on the House Appropriations Committee. In the mid-1930s,

Cannon—who raised apples—barred the FDA from spending money on investigating harmful effects of pesticide residues on humans.[115] In the 1950s, annoyed at the FDA's unwillingness to compromise on a label for canned beets to allow a company from his district to sell cut-up regular beets as "baby beets," Taber cut the agency's budget by 15 percent from 1951 to 1954.[116]

The House Select Committee Hearings

The House of Representatives passed a resolution in 1950 calling for an investigation into chemicals in food products and named Rep. James J. Delaney of New York as chair of the House Select Committee to Investigate the Use of Chemicals in Food Products.[117] Delaney chose Vincent A. Kleinfeld, the FDA's general counsel, to be the committee's chief counsel. Kleinfeld played an important role in pesticide law from this point forward. Not only did he co-found a law firm in 1953 that specialized in FDA-related law, he served as plaintiffs' counsel in the landmark (and unsuccessful) suit against DDT spraying on Long Island to control gypsy moths in 1957.[118] (Carson relied on materials collected by the plaintiffs in that suit in her research for *Silent Spring*.[119]) Kleinfeld's firm notes in its history that Kleinfeld served as counsel to the "Delaney Committee" and helped craft concepts incorporated into the FFDCA relating to pesticides, chemicals, and food additives.[120]

Kleinfeld masterfully ran hearings for the select committee, which received major coverage in the media as hearings moved around the country.[121] Agricultural interests were represented on the committee and, as we noted, powerful in Congress, and those members were fearful of costly regulatory controls that could limit farmers' access to useful chemicals or raise their costs, or could reduce USDA's authority. Kleinfeld was therefore constrained in his ability to directly challenge those interests. A frontal assault on USDA's authority would have been futile. Instead, Kleinfeld used USDA and agricultural witnesses' testimony to paint USDA as a biased agency beholden to agricultural interests and ignorant of the harms that were being inflicted on, or might be inflicted on, the public by the use of toxic chemicals that tainted food. The hearings effectively built a case that the FDA needed greater authority to protect the public from toxic risks by enhanced testing of chemicals present in the food production process.[122]

At the hearings, the assistant secretary of agriculture discussed the importance of chemicals in agriculture but noted USDA's concern that sprays should be safe.[123] The director of USDA's Plant, Soil, and Nutrition Laboratory discussed soil conditions around the country and agreed with Kleinfeld that organic farming could be productive and healthy.[124] Physicians from CDC and NIH discussed their concerns about DDT, attacking the USDA standard of five parts per million in foodstuffs as too generous given the lack of knowledge of safety for human consumption.[125] Witnesses noted that the *Journal of the American Medical Association* had discussed whether "Virus X," a health scare sparked by a New York physician's articles, could be caused by DDT poisoning.[126] A professor of medicine from the University of Cincinnati who focused on environmental health hazards testified that not enough was known about DDT, but that "it is probably responsible for such conditions as suicidal tendencies, aplastic anemia, pneumonia, leukemia, "Virus X", arteriosclerosis, and even cancer."[127]

Kleinfeld carefully built a case that agricultural chemicals should not be sold until proven safe and that DDT was the tip of the chemical iceberg.[128] His proposed remedy was for an "impartial board" of scientists to determine what should be allowed on the market[129] and to subject products to extensive premarketing testing, beginning with animal tests and then, for products that passed the first hurdle, human testing to search for safe exposure levels.[130] In short, Kleinfeld sought an FDA standard for agricultural chemicals that mimicked the FDA standards for drug approval. Without such standards, he argued, public health was threatened and, thereby, agriculture was threatened because of the possible backlash against chemically tainted foods.[131]

Agricultural representatives fought back. Dr. George Decker, the head of economic entomology at the Agriculture Experiment Station, University of Illinois (a major land grant university), testified that while about 200 farmers were killed every year, and 300 debilitated, by farm machinery in Illinois alone, none had ever died from chemicals used on farms and FIFRA regulations were adequate safeguards.[132] He noted that most food shipment seizures ordered by the FDA were due to insect infestations, not excessive levels of spray residue.[133] Kleinfeld responded that just because there was no evidence of current deaths from DDT and other pesticides, that did

not mean pesticides did not cause "chronic illnesses" that had not yet been discovered.[134] Foreshadowing one of Rachel Carson's main themes (see Meiners, in Chapter 6, reviewing cancer evidence), a committee member noted that the incidence of cancer was rising in the United States over time and speculated that there "might be a connection between some of these insecticides and chemicals being used."[135] Kleinfeld cited a British scientist who stated that DDT and other insecticides upset the balance of nature (another key theme in *Silent Spring;* as discussed by Gregory in Chapter 7),[136] and asked the witness if there should not be extensive testing of all chemicals before use.

Dr. Decker addressed several key issues. Americans had come to expect quality produce. Not only did that expectation dominate the market, it was part of the law. The public "will no longer accept the old scabby apple or the wormy apple. When you and I were young the worm had to look out for himself when we ate an apple. Today, the Department of Agriculture would not let that apple move in interstate commerce. As a matter of fact . . . the Food and Drug Administration could take action on an apple moving in interstate commerce because it had a worm in it."[137] As to Kleinfeld's assertion that new chemicals should be tested for perhaps 15 years before being certified for use, Decker replied that the notion was good in theory but not in practice. "Such would be desirable, but such is utterly prohibitive and impossible. If every new and potential chemical that may be valuable as a pesticide . . . had to have fifteen years of study we would never have a new chemical introduced."[138] In fact, chemicals were field tested by scientists, just not under such prohibitive conditions. As to the claim that insecticides upset the balance of nature, Decker stated that the result, even if a chemical was worse than anticipated, was not catastrophic. There was no evidence that such a problem had happened. "But if I wiped out every insect in an entire county in my state this year, every insect beneficial and bad . . . next year or the year after, the population would be approaching normal, and within five years the balance would be right back where it started."[139] Nature is tougher than city folks might think.

Arguments at the hearings went back and forth. Agriculture experts from various colleges generally defended the then-current practices and cited evidence that DDT and other sprays were not harmful to humans as currently used. A Utah State professor

testified that evidence from rat studies showed that DDT at high levels is harmless. A member of the committee blasted the notion, saying that rat studies did not mean that DDT was not harmful to humans.[140]

The attack on DDT was weakened by evidence from agriculture researchers which showed that DDT was not present in food products consumed by humans. Kleinfeld countered this point with testimony from a junior researcher from a new organization, the Texas Research Foundation (TRF). Although numerous senior researchers from universities and USDA had testified that DDT residue in plant and animal foods was consistently within the 5 ppm level believed to be safe, a TRF representative with a recent master's degree from Oklahoma A&M University (now Oklahoma State) reported DDT levels up to 14 ppm in milk and up to 69 ppm in beef.[141] Furthermore, he testified that DDT was absorbed into cereal crops such as corn, making its way into many other foodstuffs. This testimony reframed the issue as how to resolve contradictory scientific evidence. Crucially, this testimony—cited for years to come—was buttressed by testimony from food processors, who expressed concern about toxins making their way into the products they sold. Beech-Nut worried that baby food could be tainted.[142] A lawyer representing numerous food processors noted a lack of effective regulation.[143] Not only was more publicly funded research needed, but standards like those employed by the FDA for drugs before approval should be employed.

A final theme in the testimony came from a representative of the organic farming community. An organic farmer testified that organic agriculture was an alternative that avoided the problem of toxic residues in food: "The use of poisons in the growing and processing of our foods has steadily increased until today millions of pounds of these poisons are used, of which a considerable amount is consumed by our people."[144] Tying organic agriculture to the commercial food processing industry, he reported that some food processors demanded organically grown crops so they would know there would not be chemical residue. Furthermore, he asserted that organic farming was better for the environment and sprays were unnecessary because nature was "in balance" on organic farms. Such techniques were viable, based on the example of French farmers, who he claimed had never used sprays.[145] Finally, the organic farmer

repeated the concern that DDT caused "Virus X"[146] and accused agriculture colleges of pushing chemical use.[147]

The testimony cast the credibility of agricultural experts in doubt. For example, when a USDA poultry expert explained that chemicals used in and around egg-laying facilities did not get inside the shells and any residues were generally washed away in cleaning, the committee expressed skepticism about his certainty.[148] The next witness, a doctor from the American Cancer Society, testified that while rising U.S. levels of cancer were due partly to longer life spans, the increase might also have been caused by the millions of pounds of chemicals being used on crops.[149] Indeed, he even suggested that the chemicals used in growing tobacco might result in it causing cancer.[150] He concluded that, given the myriad risks, more research and regulation, especially by the FDA, was needed. This conclusion was echoed by a researcher from the National Cancer Institute.[151]

As the 19 days of hearings moved around the country, similarly conflicting testimony was presented. Agriculture representatives, while never opposed to more research, pointed to the lack of evidence of harm from current spray levels and the great increase in output allowed by the use of sprays—not only increasing agricultural productivity but saving forests as well. They also noted that the new generation of sprays was clearly less harmful than the lead arsenates and other sprays used in previous years.[152]

Critics of agriculture widened the assault, raising the issue of hormone use in animal production. A scientist from Swarthmore called for a complete ban.[153] UCLA dermatologists agreed, saying that hormones were unsafe and extensive testing was needed because latency issues might exist that could not be known for years.[154] A medical professor from the University of Southern California testified that estrogen in animals could cause a sex change in people consuming such food products.[155] A California doctor reported that while he did not think estrogen caused cancer, it caused cancer to spread.[156] A scientist from the drug industry, testifying about the hormone issue, recommended expanded FDA powers to ensure public safety.[157] Other testimony on the issue was in conflict; there seemed to be no scientific consensus about the matter, but if the critics were right, the risks were substantial.

Witnesses raised multiple food safety issues. People were reminded of a mass poisoning at an Oregon state hospital in 1942

that killed 47 people.[158] Regular themes included the dangers of mislabeled products,[159] the need for the burden of proof of safety to be on manufacturers, the inadequacies of FIFRA, and the need for stronger FDA oversight.[160] Kleinfeld found an instance of a commercial chemical in use in agriculture that was not registered under FIFRA; this was evidence of sloppy USDA practice and, he noted, people die from improper use of chemicals.[161] Kleinfeld was not the only one concerned. Industry representatives from the National Canners Association and the Grocery Manufacturers Association testified about their concerns over chemical toxicity.[162] As the director of the National Canners Association Research Laboratories noted, "Industries are concerned primarily with the unavoidable presence of pesticide residues on certain crops."[163]

As the hearings drew to a conclusion in California, conflicts persisted. A University of California professor of agriculture testified that existing controls were sufficient; the FDA process would be too long and costly and, besides, FDA proceedings had all the fairness of a kangaroo court.[164] Kleinfeld attacked him, and others, who questioned the wisdom of expanded FDA control. He used witnesses from the cosmetics industry, who, his questioning implied, knew little about the scientific testing of the chemicals they were selling. The chemicals could be toxic, Kleinfeld regularly implied, citing, for example, the case of a woman who died during a hair permanent procedure in Georgia in 1941.[165] The hearings ended with a California allergist testifying that DDT and other sprays made people sick. He claimed people suffered from a strange lethargy after exposure and that DDT was particularly bad, present in the milk supply, and steps were needed to "protect our infants."[166] Committee chair Delaney went so far as to publish an article in *American Magazine* entitled "Peril on Your Food Shelf."[167] Ultimately, the hearings helped the FDA secure passage of a 1954 amendment to the Food, Drug, and Cosmetic Act, requiring inclusion of toxicity and residue studies in petitions to the secretary of Health Education and Welfare for permission to market a new pesticide.[168]

This review of the 1951 hearings illustrates three important parts of the saga of the regulation of DDT. First, it illustrates how prominent the criticisms of modern pesticides generally, and DDT in particular, had become soon after widespread use of these products began and long before *Silent Spring* crystallized these concerns.

The themes voiced in these criticisms continued into the 1960s and 1970s: the need for caution in adopting new technologies that affected the food supply, the promotion of organic farming as an alternative, and a reliance on scientific uncertainty created by an unwillingness to make judgments between any points of view that could marshal someone in a lab coat to defend it. Stories about "Virus X" or a strange lethargy, put forward by witnesses with weak credentials seemingly counted equally with the views of the agricultural establishment and thereby served as a basis for caution. The testimony suggested science was in conflict. At a minimum, there should be more money for research, and extensive federal oversight might be warranted.[169] The committee gave a junior researcher at an unknown Texas foundation the same credibility it gave many experienced scientists with more impressive credentials. The committee treated impracticable ideas, such as reliance on lower-productivity organic farming techniques, as worthy of consideration. *Silent Spring* was the most noteworthy attack on DDT and pesticides through 1962, but virtually all of the criticisms it made were well developed and being articulated more than a decade earlier.

Second, powerful interests within the government saw pesticides as an important issue long before *Silent Spring*. Considerable attention has been paid to USDA's promotion of pesticide use in the 1950s, including its subsidizing of public spraying programs aimed at eradicating pests like the fire ant and gypsy moth,[170] while FDA's role has not received as much. As the records of the 1950 and 1951 hearings demonstrate, Delaney and Kleinfeld were masters of congressional and regulatory techniques. They made a case for expanded FDA authority, which enhanced Delaney's power in Congress and Kleinfeld's authority as general counsel of FDA, which he would soon leverage in private practice. Indeed, Kleinfeld's questioning of the witnesses at the hearings foreshadowed his questioning of government witnesses in the 1957 Long Island case involving the spraying of gypsy moths.[171] This does not require imputing bad motives to them; we have no reason to doubt they believed in what they were doing. Rather, the point is that their beliefs were aligned with their career interests. The result was that Delaney and Kleinfeld laid important groundwork for *Silent Spring* by stoking the public's fears of the new technologies.

Third, food processing companies were crucial players in the debates over pesticides. Organic farmers, a few researchers, and individuals who feared "Virus X" would not be a sufficient constituency to attract much congressional attention, and the millions who had bought *Our Plundered Planet* or *Road to Survival* were not yet organized into an effective political constituency, as they would be by the end of the 1960s. Beech-Nut and other food processors were rightly concerned about the issue. If, in fact, toxins were present in foodstuffs, food processors would be the main defendants as easily identifiable parties with deep pockets. Not only was food processors' liability for contaminated products well-established in American tort law,[172] but the issue was receiving attention in the legal press.[173] Moreover, getting chemicals out of the food supply was costly. At the hearings, Beech-Nut reported that it spent $668,000 over six years (more than $5.5 million in today's dollars) removing pesticide residue from baby foods and peanut butter.[174] The director of toxicology for Swift & Co., a major brand name meat packer, supported more controls: "It is my opinion that any food processor proposing to incorporate a new nonfood material into a food product that is to be made for commercial use should be required to pretest such a material to assure adequate evidence of innocuousness in the human dietary."[175] And the new FDA commissioner appointed in 1954 focused on cultivating the industries regulated by the agency, in an effort to build support for the agency. As his deputy put it, "in order to administer a regulatory law, the regulator has to have a constituency; he has to have someone who will back him before Congress."[176] The 1959 controversy over cranberries contaminated with aminotriazole—a controversy that Carson biographer Mark Lytle says Carson followed "[d]ay by day . . . especially the fortitude shown by HEW Secretary Arthur S. Flemming in the face of hostile industry reaction to the ban"[177]—drove the issue home to the food processors.

Although tighter controls on pesticides could mean higher agricultural prices paid by food processors, they appeared to prefer to reduce the likelihood of tort litigation and the possible damage to their brands that litigation could cause. For example, Beech-Nut was a major food processor. Even one story that babies were poisoned by pesticide residues in their baby food, let alone a successful suit, could cause sales to collapse.[178] All industry,

and consumers, would pay higher prices if input costs rose, but as long as everyone in the industry shared the cost, the impact on profits would be minimal. Moreover, the larger firms were the ones with the most at stake, and they were the firms that testified at the hearings.[179] Regulations can be costly, but in almost all regulatory experiences, large firms have an easier time bearing the costs than smaller competitors.

Why Was DDT the Primary Target?

DDT was the first, and most widely used, of the new class of insecticides discovered around the time of World War II. That alone made it a logical target. Moreover, unlike many other chemicals used only in agriculture, DDT's nontoxicity for humans meant that it was widely used in insect control programs outside rural areas—as Carson highlighted in *Silent Spring*—making it highly visible to those not directly involved in agriculture and so lacking a direct economic benefit from its use. Farmers, on the other hand, who were profiting from the new pesticides, and whose regular contact with them provided personal experience that contradicted claims like those about "Virus X" and other ills would prove to be a much more difficult audience for pesticide critics throughout the battles over pesticides.

While DDT use was extensive, its use in the United States peaked in 1959, well before *Silent Spring*;[180] DDT production peaked in 1962, the year the book appeared. Production dropped 40 percent by 1966, and domestic use fell by half between 1958 and 1966.[181] By 1966, DDT, toxaphene, and aldrin, members of the same chemical family, constituted just half of the pesticide market. One reason was that pesticide producers preferred alternatives because newer products had intellectual property protection that increased profits. In contrast, the World War II bargain between the military and pesticide producers to secure sufficient production of DDT to meet military needs included grants to multiple companies of the right to produce it,[182] reducing those companies' incentive to invest heavily in DDT's defense. The five major DDT producers[183] would suffer lost sales of DDT from restrictions on DDT, but as makers of substitutes, they would gain sales of their more profitable proprietary products. The

substitutes were more costly than DDT, which was one reason farmers had not previously switched to such alternatives.

These tradeoffs were recognized during the later fight over banning DDT. For example, USDA reported in 1970 that the ban meant winners and losers in the industry.[184] A few years later, reviewing the ban on DDT, the Environmental Protection Agency concluded that the largest impact was on cotton.[185] The 1975 EPA review concluded that DDT was still in use on 17 percent of cotton farms in 1971 and that those farmers doubled their pesticide cost by 1973 as a result of the ban.[186] So certain farmers suffered greater economic injury than others, but the impact was not draconian, as pesticide cost was estimated to be just 5 percent of the production cost of cotton.[187]

There are costs and benefits to any change. The new generation of more costly pesticides that replaced DDT and its chemical siblings were short lasting, so the problem of residual effect was lessened, but were more potent at the time of application. USDA reported that the new pesticides were more dangerous to the users and would cause increased injury to wildlife and to beneficial insects at the time of application.[188] The new insecticides were more costly, in part because of the more stringent permission process. As early as 1970, only 1 in 1,800 new compounds tested made it to market after years of research.[189] "The requirements for registering new pesticides are likely to increase. This would tend to reduce the competition in the pesticide industry. On the other hand, the markets for new products created by banning organocholorines would be attractive to manufacturers."[190]

DDT's most important use was in mosquito control in anti-malaria programs, as described in detail by Roberts and Tren in Chapter 8. Carson barely mentioned its public health use in *Silent Spring*. This may have been partly because the primary public health uses by that time were in Africa, Asia, and Latin America, out of sight of Carson and her readers. Indeed, by the time of the ban, most of the DDT produced in the United States was exported. At no point in the debate over DDT begun by *Silent Spring* was there more than passing discussion of DDT's huge impact in reducing malaria and other scourges. One reason was that foreigners suffering from malaria do not vote in U.S. elections. Even taking this into account, there was less sympathy for the foreign ill and dying than might be expected, given the commitments the United States made during the same

period to development aid, the Marshall Plan, Food for Peace, the Peace Corps, and other programs that were at least nominally aimed at improving the lives of nonvoters. The ugly truth is that the writers who were articulating nascent environmentalism in the late 1940s and early 1950s saw overpopulation as an overriding threat and so were harshly critical of the use of DDT precisely *because* it would save lives.[191]

Finally, again and again, while organochlorides were condemned as a group, DDT was held up for special attention by Kleinfeld and others. While other sprays of the same chemical group, such as aldrin, were used in agriculture as much as DDT and seemed to have the same environmental characteristics, there may have been an element of marketing involved in singling out DDT. "DDT" is simple. "Organochlorides" does not have much of a ring to it. And while "chlorides" may sound suspicious, "organo" sounds, at least to ears today, like "organic," which is "good," like organic farming.

Putting the Battle over DDT in Context

Silent Spring may have been the spark that ignited the modern environmental movement, but it was one of many sparks thrown off by the post–New Deal realignment of American agriculture. The industry had moved from multicrop, relatively small, non-capital-intensive operations using traditional agricultural methods and selling in local markets into monocrop, relatively large, capital-intensive operations using modern techniques, selling to commercial food processors, and dependent on federal programs for portions of farm income. The combination of this transformation and the parallel transformation of the American diet created conditions under which interest groups both inside and outside the federal government sought advantages.

Inside the government, USDA and its farm-state allies engaged in high stakes battles for resources and control over agricultural policy. As part of that conflict, they had to contend with the FDA and its allies' efforts to expand their authority. DDT, in particular, and pesticides, in general, provided the FDA coalition with a useful tool with which to assert a claim to authority, playing off popular concerns over chemicals and the uncertainties created by the transformation of agriculture. Those battles—illustrated by the hearings we described—both reacted to and expanded public concern

about food safety and the role of pesticides in agriculture, laying important groundwork for *Silent Spring* as well as likely introducing Carson to the topic through her work at FWS. Outside the government, the food processing industry sought a safe harbor against the impact of possible contamination both on sales and in tort actions.

The economist Bruce Yandle coined the term "Baptists and Bootleggers"[192] to explain how interest alignments among otherwise opposing or nonaligned groups could facilitate regulation. Traditional models of regulation posited that regulations emerged because they were in the "public interest" or, in the alternative, they evolved because politicians had been "captured" by economic interests. Yandle posited that some voters support regulatory controls that have no particular economic benefit to them but do provide economic benefits to others. He developed a model of unwitting political cooperation among divergent groups in support of particular regulatory measures. The name he gave the phenomenon, for purposes of alliteration, not disparagement, came from Baptists who support restrictions on the sale of alcoholic beverages on Sunday. They support such regulation for the good of society. But such legislation has hidden supporters, the bootleggers, who earn their living by skirting the regulations that make their livelihood possible. The two groups have nothing in common and do not explicitly cooperate, but their different interests combine to strengthen the incentives for politicians to regulate. One group has a publicly acceptable interest but insufficient clout to achieve its aims; the other group has an economic interest but lacks a publicly acceptable justification for action. Both provide political support for regulations that limit certain economic activity that would otherwise occur.

The creation of a coalition that ultimately would succeed in obtaining a federal ban on DDT in 1972 had aspects of a bootleggers and Baptists coalition. Environmentalists were the "Baptists." Pesticide manufacturers, looking to move beyond generic products such as DDT, played the role of the bootleggers, accepting enhanced regulatory authority by the new EPA as the price of creating significant barriers to entry in order to protect their markets. USDA ceded environmental authority to EPA but preserved its larger agricultural policies. That is not to suggest that the battles over DDT in the late 1960s and early 1970s were not heated and intense, for

they were. But the ultimate resolution—by Richard M. Nixon, the politician to whom environmentalists ought to award the title "greatest environmental president" for his role in creating EPA, the Clean Air Act of 1970, the Clean Water Act of 1973, and the Endangered Species Act of 1973—largely disadvantaged poor malaria victims in Africa and had relatively little impact on American farmers.

At the risk of mixing metaphors, the future "Baptists" were still wandering in the wilderness in the 1950s. As we have shown here, it was the FDA and its congressional allies' efforts to expand their authority that helped bring the dispersed interests opposed to pesticide use together around DDT as an issue. There is no doubt that policy entrepreneurs in Washington saw *Silent Spring's* publication as an opportunity. For example, Interior Secretary Stewart Udall, soon to author his own environmental classic, *The Quiet Crisis*,[193] "assigned a member of his staff to track the book's reception and report ideas for future policy initiatives."[194] Continuing Yandle's metaphor, Rep. Delaney and his general counsel played the roles of Roger Williams and John Clarke, the originators of the Baptist denomination in America.[195] Their work prepared the way for Carson and *Silent Spring*, whose impact on environmentalism can be analogized to the religious Great Awakenings of the 18th and 19th centuries. And no doubt policy entrepreneurs in Washington saw *Silent Spring*'s publication as an opportunity. We thus offer an addition to Yandle's theory, illustrating how regulatory "Baptists" can come into being as a result of policy entrepreneurs' efforts.

Silent Spring is properly credited with a major role in changing Americans' attitudes toward the environment. But the context of the changing nature of American agriculture and the conflict for regulatory authority between USDA and the FDA also suggests that *Silent Spring* was as much an expression of those changes and struggles as it was an innovation.