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UNINTENDED CONSEQUENCES:

Impacts of Pesticide Bans on Industry, Workers, The Public, and The Environment

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University of Massachusetts Lowell

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Impacts of Pesticide Bans on Industry, Workers, The Public, and The Environment.

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The 1994 - 1995 Toxics Use Reduction Research Fellows Program

The Toxics Use Reduction Institute
University of Massachusetts Lowell

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The Toxics Use Reduction Institute is a multi-disciplinary research, education, and policy center established by the Massachusetts Toxics Use Reduction Act of 1989. The Institute sponsors and conducts research, organizes education and training programs, and provides technical support to promote the reduction in the use of toxic chemicals or the generation of toxic chemical byproducts in industry and commerce. Further information can be obtained by writing the Toxics Use Reduction Institute, University of Massachusetts Lowell, One University Avenue, Lowell, Massachusetts 01854.

Toxics Use Reduction Institute
Research Fellows Program

In 1991, the Toxics Use Reduction Institute established the Research Fellows Program at the University of Massachusetts Lowell (UML). The Research Fellows Program funds toxics use reduction projects performed by a graduate student and his/her advisor. The goals of the Research Fellows Program are:

-to develop technologies, materials, processes, and methods for implementing toxics use reduction techniques
-to develop an understanding of toxics use reduction among UML graduate students and faculty
-to facilitate the integration of the concept of toxics use reduction into UML research projects
-to provide UML faculty with "incubator" funding for toxics use reduction related research, and
-to act as a liason between Massachusetts industries and UML faculty.

Notice

Unintended Consequences
Impacts of Pesticide Bans on Industry, Workers, the Public and the Environment

Beth Rosenberg

ABSTRACT

Chemical bans are one way to regulate hazardous chemicals. Removing a chemical from the web of use and production has numerous ripple effects. The effects on workers from any kind of process change are frequently ignored, partly because of power relations and partly because there is no systematic method to study them. Pesticide bans are an extreme example of process changes. The case study method is used to examine the effects of the banning two pesticides, Alar and DBCP, on industry, chemical workers, farmers, farmworkers and the public. The unintended consequences of these bans are used to develop the equivalent of an environmental impact assessment for the workplace.

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I. Introduction

The environmental movement and, to a lesser extent, the fields of occupational and public health, have raised public awareness of the many problems associated with the use and production of toxic chemicals. Banning chemicals has been one policy response to this heightened awareness. Although it has a common sense appeal, the efficacy of this approach to the actual reduction of hazardous exposures, particularly its impact on workers, remains unstudied. Currently, there is no systematic way of looking at the changes resulting from the control of a chemical, whether that control is a minor process change or the elimination of the use and production of a toxic chemical, a "ban". Any changes in production techniques will have ripple effects, some of which may be substantial impacts on industry, labor, communities and the environment. Industrial effects are described in terms of profits, plant closings, lay-offs, and product shifts. Environmental impact analysis techniques, though far from perfect, are reasonably well developed, because the act that founded the EPA in 1970, the National Environmental Protection Act, requires them.[1] There is no such analogue for the work environment.

The primary objectives of this study are twofold: 1) to analyze the impact of pesticide bans on workers, including efficacy in protecting worker health, and unintended employment impact and 2) to develop the equivalent of an environmental impact assessment for the work environment. Other objectives are to analyze the impact of pesticide bans on the industry public health and the environment. These objectives will be accomplished by using the case study method to examine the ripple effects of two pesticide bans, Alar and DBCP.

OSHA brushes the topic of impact on the work environment in the context of the promulgation of standards. As a result of the "Benzene Decision", or American Petroleum Institute et al. v. OSHA,[2] OSHA must quantify the benefits

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[1] 42 USC 4321-4544

[2] 581 F.2d 493 (5th Cir. 1980)

that a new standard will bring, as well as the costs of implementation, to show that the benefits expected from a new standard bear a reasonable relationship to the costs that it imposes.[3] Costs here are the costs to the industry of implementing the control technology and the benefits are estimates of the decrease in illness and injury. These benefits, while extremely important, represent a mere subset of possible impacts on a workplace.

A more thorough approach is rendered by an analytic tool that is used by the EPA to analyze the environmental impact of a specific product. Life Cycle Analysis follows a product from "cradle to grave", from its mining or synthesis of the raw materials, through the production process and on to its disposal. Environmental effects include resource depletion, energy consumption, waste generation and adverse human and ecosystem effects. As Keoleian notes, "The labor inputs for the process, distribution and management components have been neglected in life cycle analysis. The exclusion of labor and other system components can distort the resource and environmental profile of the product system."[4]

This study elucidates the kinds of impacts that result from chemical bans, with a focus on the work environment. Bans were selected because they represent major process changes, and, as will be explained below, are increasingly coming to the fore as a way to control toxic chemicals. The area of study is pesticides. Under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the EPA may withdraw the registration for the use of a pesticide, which effectively discontinues its use, although not its manufacture.

A. Background

In the workplace, the notion of removing a hazardous material and substituting it with a less harmful one has longtime been a component of the industrial hygiene hierarchy of hazard control.[5] Along with an awareness that bans are

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[3]Ashford, Nicholas A. and Caldart, Charles C., *Technology, Law and the Working Environment*, Van Nostrand Reinhold, 1991 p. 124

[4]Keoleian, Gregory A, *The Application of Life Cycle Analysis to Design*, seminar presented at conference on "Environmental Life Cycle Assessment and its Application", Amsterdam June 9-11, 1993

[5]Plog, Barbara, ed. *Fundamentals of Industrial Hygiene*, Third ed. National Safety Council 1988 p. 24

increasingly advocated as a policy choice for controlling hazards is a concern that removing a known hazard may have unintended ripple effects. The ramifications of bans for workers are particularly apt to be overlooked, not only because of power relations but also because there is no systematic way to assess the impact of process changes on the work environment.

1. Bans as part of Toxics Use Reduction Strategy

Removing a hazardous substance from use--through chemical substitution, process modification, or product reformulation--is a part of Toxics Use Reduction and Pollution Prevention approaches to environmental protection. Toxics Use Reduction seeks to reduce the use or waste of toxic substances in industrial processes. Pollution Prevention is more broadly defined as the reduction of the amount of any hazardous substance, pollutant, or contaminant entering the waste stream or released into the environment prior to recycling, treatment or disposal. "Pollution prevention means identifying the source of a pollutant in a production process; eliminating it from that process and substituting a more environmentally benign method of production."[6] This approach began in the mid 1970s, spearheaded by Barry Commoner, Ken Geiser and others, who were concerned both with the tremendous amount of hazardous waste our industrial society generated and by the inadequacy of pollution control technology to minimize it. Although not explicitly stated in the definition of strategies of TUR, chemical bans can achieve the objectives of a TUR approach.

Many improvements in worker health and safety in recent years have been linked to policies, such as TUR, that have been linked to the environmental movement. In the domain of chemical restrictions, there are many examples of environmental/public health initiatives that were advantageous for workers, although occupational health was not a major factor in the in policy decision. The removal of lead from gasoline had widespread positive effects. It not only reduced the public's exposure to lead but also the lead exposure of all of those who added the lead in petrochemical plants, who deliver gas to gas stations, who pump gas and repair cars, and particularly those who were breathing lead fumes while working in tunnels and on bridges. When lead was removed from

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[6]Commoner, Barry, "After 20 years: The Crisis of Environmental Regulation" *New Solutions*, Vol. 1, No. 1 Spring 1990 pp. 22-29

housepaint for public health reasons, housepainters benefited. In 1979, in Massachusetts, concern for consumers' exposure to formaldehyde prompted the banning of an insulation product called Urea Formaldehyde Foam Insulation (UFFI) The ban benefited the mixers and installers of the insulation because their exposure to formaldehyde from this source was eliminated. Minimal unemployment resulted because many installers became removers.[7] While many removals and substitutions have been successful, we will see that this is not uniformly the case. Many bans and substitutions discussed above are successful for removing the substance in question, but there may be unintended consequences that have not been elucidated.

2. Bans as part of Industrial Hygiene Hazard Control

The process and production changes described above are consistent with the continuum of hazard control recommended by industrial hygienists. The first choice in controlling a hazard is to remove it. The second choice is using engineering to control it (e.g. ventilation or, in the case of an unsafe machine, engineering a guard such that the machine cannot be operated without the guard). The third preference is administrative controls, which, through rules governing work practices, do nothing to alter the hazard, but do reduce risk e.g. a limit on the number of hours a worker can be exposed to a substance or requiring that a machine guard be used or the fan be turned on. The least preferable option is personal protective equipment, because, like administrative controls, the hazard is not reduced and further, goggles, respirators and the like are uncomfortable and unreliable.

3. US Experience

In the United States, at the federal level, the production or use of a chemical can be restricted in a few ways. Banning provisions exist under the Food Drugs and Cosmetics Act, in the form of the Delaney Clause and under the Consumer Product Safety Commission. More central to our discussion of industrial chemicals is the authority under two acts administered by the Environmental Protection Agency, the Toxic Substances Control Act (TSCA) and the Federal

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[7]Rosenberg, Beth "The Banning of Urea Formaldehyde Foam Insulation (UFFI)" in*Toxic Chemical Management in Massachusetts: An Analysis of Further Chemical Restriction Policies* Rossi, Mark and Geiser, Ken, The Toxics Use Reduction Institute, University of Massachusetts Lowell, 1992

Insecticide Fungicide Rodenticide Act (FIFRA). In TSCA's sixteen years of existence, four substances have been severely restricted. Under FIFRA (1972), 16 pesticide's registrations have been canceled and another 25 have been voluntarily withdrawn.[8] Yet, there has not been study of the efficacy of banning as a policy response to regulating toxics. The impact of chemical bans; what they do and do not accomplish, particularly with respect to occupational health, is undetermined.

5. Significant International Experience

There are numerous banning initiatives in other countries. The bilateral Canada - US. International Joint Commission is currently spearheading a movement to phase out the use and production of chlorine. This effort is motivated by the detrimental effects of organochlorines on the health of people and wildlife in the Great Lakes. Sunsetting is a term meaning a planned phase-out over time culminating in a ban. The Canadian federal environmental agency is developing the ARET (Accelerated Reduction and Elimination of Toxics) program. Sweden's National Chemicals Inspectorate (KemI) and the Swedish Environmental Protection Agency are charged with the task of sunsetting harmful chemicals.[9]

6. Unintended Consequences

Plucking a chemical from the web of production has consequences beyond simply the removal of that chemical. It is known that the banning of DDT resulted in the deaths of hundreds of workers due to the high acute toxicity of the substitutes. The use of CFCs will be banned under the Montreal Protocol. The move towards water-based cleaners instead of CFCs may have introduced a new carcinogen, terpenes, into the workplace. As a result of the well-intentioned Clean Water Act, in the fiberglass industry, there is more recycling of the waste water used to cool the hot glass. Unfortunately, the warm water is fertile breeding ground for microbes, and workers are getting more respiratory

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[8]Rossi, Mark and Geiser, Ken, *Toxic Chemical Management in Massachusetts: An Analysis of Further Chemical Restriction Policies.* The Massachusetts Toxics Use Reduction Institute, University of Massachusetts at Lowell, 1993 p.133

[9]Rossi, Mark and Geiser, Ken, *Toxic Chemical Management in Massachusetts: An Analysis of Further Chemical Restriction Policies.* The Massachusetts Toxics Use Reduction Institute, University of Massachusetts at Lowell, 1993

disorders.[10] The point here is that to avoid at least some of the unintended consequences of any changes in production, one must acknowledge the web and that pressure on any part of it will result in quivers elsewhere. Labor is often a neglected part of the schema, partly because of power relations but also because there is no methodology to systematically study the impact of process changes on workers. Hence this study.

The scope of this work is limited to pesticide bans. Pesticides are interesting from the vantage of TUR because changing the production process may do little to reduce toxics since the very product is required to be toxic. From a regulatory point of view, unlike most industrial chemicals, there is a legal mechanism for banning under Section 6 of FIFRA. It is for this reason that the impacts of two pesticide bans were chosen for study. Each was banned for a different reason. DBCP was shown to have carcinogenic and reproductive effects in animals soon after production began. It later was found to have sterilized workers and was ultimately banned because of groundwater contamination. Alar was banned on a wave of consumer protest about children's intake of this carcinogen.

B. Research Methodology

The case study method was used to investigate the impact of the banning of DBCP and Alar. This qualitative research method was chosen both because of the richness of information it provides and because no other method is suitable. Traditional research methods strive to set up controlled situations. On the contrary, a case study "is an empirical inquiry that: investigates a contemporary phenomenon within its real-life context; when boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used."[11]

For the case study of each ban, the research included reviews of the scientific and medical literature to investigate health and environmental effects. Public health, occupational health and trade journals, as well as union newspapers and mainstream media, were included in the search. Industrial effects were

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[10]personal communication, David Kriebel, Professor of Epidemiology, Department of Work Environment , University of Massachusetts at Lowell, Sept. 8, 1993

[11]Yin, Robert K. *Case Study Research, Designs and Methods* revised edition Sage Publications, Inc. 1989, 1984

examined by using standard industry manuals (Moody's and Standard and Poors) trade journals and interviews with corporate employees. The legislative history of the ban provided names of key government and public health officials, scientists, industry and labor representatives, and non-governmental officials who were interviewed. Most important were interviews with workers themselves, who revealed how the bans affected their lives, their work, and their health.

For each of the pesticide cases, the following information was sought:

1. what prompted the ban

2. the scope (state, federal or global) and legal authority under which the ban was carried out

3. the nature of the ban, whether it's a ban on production or a restriction on applications

4. effects on industry - economic, structural, plant closings, lay-offs, labor costs, shift in products, effects on suppliers, distributors and users.

5. effects on labor - loss or gain in jobs, occupational hazards, changes in the quality of job, work structure, changes in skill requirements

6. effects on the environment - air, water, and soil pollution, and energy use

7. effects on the public.

The study combines extensive primary source research and literature reviews with interviews to address the abovementioned factors for each of the banned pesticides.

There are limitations of the case study approach. Generalizability is one limitation. Because the cases were chosen rather than randomly selected, they may not be representative. Yet, regardless of generalizability, they are instructive. It must be noted that this is hypothesis-generating work; it is not designed to "prove" any theories. The work is intended to inform policy makers

of the unintended consequences of past decisions in the realm of chemical regulation in order to avoid future mistakes due to narrowness of vision.

C. Work Environment Impact Assessment

In the past, not all stakeholders have been included in decision-making about process changes or bans. Manufacturing workers, farmworkers and small farmers have traditionally been excluded from political consideration, with, as we will see, dire consequences. This work is an attempt to underline that the repercussions of decisions can be profound, and actions that will benefit the most people can be accomplished only by consulting *all* stakeholders.

One way to address this problem is with a methodology to assess the ripple effects of process changes, with a focus on the work environment. The factors addressed in a Work Environment Impact Assessment flow directly from the findings of the cases. An outline for a Work Environment Impact Assessment is contained on page 59 of this report.

The Work Environment Impact Assessment is designed to acheive for the worker what Environmental Impact Assessment does for the environment. Environmental impact assessments were mandated in the National Environmental Policy Act of 1969, which requires all Federal Agencies to ". . . utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making which may have an impact on man's environment."[12] Since then, the environmental impact assessment, or EIA, has gone from simple checklists of potential impacts to complex matrices and decision trees. They have been criticized as too long, too costly and not useful for decision-making.[13] The objectivity of the appraisal is questioned: there is a

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[12]National Environmental Policy Act of 1969, P.L. 91-190, 83 Stat. 852, Section 102 (A) (1)

[13]Winder, John Jr., and Ruth H. Aken *The Environmental Impact Assessment Project: A Critical Appraisal* Institute of Ecology, Washington DC Oct. 1975 p.43, Wathern, Peter *Environmental Impact Assessment: Theory and Practice* Unwin Hyman, London 1988 and Environmental Impact Assessment: Principles and Procedures SCOPE workshop on Impact Studies on the Environment Co-sponsored by the United Nations Environment Program, Environment Canada and UNESCO Scope Report 5 Toronto Canada 1975

concern that it is a political, rather than a scientific, objective, procedure.[14] Proponents point to the enormous amount of useful information that they generate and how vital they are to sound decision-making.[15] The purely objective, apolitical decision in the public arena is non-existent, so the "not objective" criticism is merely stating the obvious. "At one extreme, EIA may only be a perfunctory exercise endorsing public and private actions. At the other extreme, it may signify a full internalization of environmental values into planning and decision-making processes and may precipitate a substantial transformation in institutional structure."[16]

The goal of the Work Environment Impact Assessment is to bring to the decision-making table the concerns of labor and thus open the process to all those affected. In addition to democratization of the process, which is a goal in itself, the use of a Work Environment Impact Assessment would yield information not heretofore used in planning. Not only could this result in better policy, that is, policy that benefits the most people and does the least harm, but it might possibly result in a further internalization of humane values into planning and decision-making processes.

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[14]Ibid.

[15]James Goldstein, Environmental Scientist, Tellus Institute, Boston MA Telephone interview Mar. 1, 1995

[16]Lim, Gill-Chin "Theory and Practice of EIA Implementation: A Comparative Study of Three Developing Countries" *Environmental Impact Assessment Review* 1985; 5 p. 134

II. ALAR CASE STUDY

This is the first of two case studies of the multi-dimensional, intended and unintended, impacts of a pesticide ban. The Alar study vividly demonstrates that chemicals are versatile. They perform functions, both positive and negative, other than those that are advertised, so the impact of their removal can be profound. It is also a story about information, specifically how important information was excluded from the political process with detrimental effects. What follows is the history of Alar, the ban and the effect of the ban on two industries, the chemical industry and the Massachusetts apple industry; workers in these industries, and the public health.

A. HISTORY

Daminozide is the commonly accepted name for butanedoic acid mono (2,2-dimethyl hydrazide.) It is a growth hormone but was registered for use as a pesticide under FIFRA in 1963 by Uniroyal Chemical Company under the trade name Alar.[17] Uniroyal was the principal manufacturer; Aceto Chemical Company made it for a short time. Alar is 85% daminozide and 15% inert ingredients. It was first registered as a plant growth regulator on apples in 1968 and was later registered for use on other food crops. For food uses, daminozide affects vegetative and reproductive growth, such as flower bud initiation, fruit set and maturity, pre-harvest fruit drop and storage life. It was used on orchard crops such as apples, cherries, nectarines, peaches and pears, as well as on tomatoes, grapes and peanuts. On apples, Alar was used in two different ways. In the spring, daminozide was sometimes used on bearing trees to reduce vegetative growth and promote flower bud development. Flower buds grow into apples, so when early frosts destroyed some or all of the buds, Alar helped replace them.[18] The more common use of Alar was during "mid-season" (21 days after petal fall to 70 days before harvest) or in "summer" (60 to 70 days before

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[17]Daminozide; Termination of Special Review of Food Uses, Federal Register Vol. 54, No. 216 Tuesday, November 14, 1989 p. 47482

[18]Daminozide Special Review Technical Support Document - Preliminary Determination to Cancel the Food Uses of Daminozide, May 1989, Office of Pesticide Programs, Office of Pesticides and Toxic Substances, United States Environmental Protection Agency D-10806 p. III-3

harvest.)[19] This treatment served to decrease fruit cracking and splitting, delay watercore development (an internal core rot), increase fruit firmness and storage life, prevent pre-harvest fruit drop, and enhance color. For non-food uses, daminozide is registered for use on cut chrysanthemums and bedding plants: hydrangeas, marigolds, petunias, zinnias, asters, azaleas, poinsettias and gardenias.[20] The formulation for non-food uses, B-Nine, is identical to Alar. Table 1 summarizes the history of Alar.

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[19]Ibid.

[20]Daminozide; Termination of Special Review of Food Uses, Federal Register Vol. 54, No. 216 Tuesday, November 14, 1989 p. 47482

TABLE 1

CHRONOLOGY OF ALAR

1963	Registered as a pesticide under FIFRA by Uniroyal
1969	Registered for use on apples
1969	Mass. Extension Service touts Alar's promise "to alleviate harvest labor problem" and extend harvest
1973	Toth, NCI study of carcinogenicity of Alar's breakdown and contaminant, UDMH. Increased incidences of blood vessel, lung and kidney tumors found in mice.
1977	Toth study on Alar. Increased incidence of blood vessel and lung tumors in mice, kidney tumors in male mice.
1980	Uniroyal submits study to EPA indicating that boiling treated apples converts daminozide to UDMH.
1981-83	Six meetings between Uniroyal and EPA to discuss potential special review process of daminozide
1983	EPA issues a data call-in notice to the registrants, Aceto and Uniroyal
1984	Aceto did not comply with the call-in notice and its registration was suspended. Uniroyal withdrew its registration for use of daminozide on plums/prunes, brussel sprouts, peppers and cantaloupe.
July '84	EPA issues notice in the Federal Register announcing a Special Review of daminozide on the basis of its oncogenicity in rats and mice, and UDMH's oncogenicity in mice and hamsters.
Dec. '84	National Grape cooperative, producers of Welch's grapes, notifies members that grapes treated with daminozide would not be accepted for processing.
Aug. '85	National Public Radio story "Does an apple a day cause cancer?"
Sept. '85	EPA announces proposal to cancel all food uses of daminozide.
11,12/85	Numerous meetings between EPA and Uniroyal and International Apple Institute to discuss reduction in use for grapes and apples, cancellation possibilities on peanuts, grapes and cherries
Jan. '86	EPA announced its decision to permit continued use of daminozide pending submission of new toxicity and residue data. In the interim, reduced tolerances will be established for apples, a use advisory that daminozide not be sold for processed foods, including grapes used for raisins.
Apr. '86	EPA issues proposed rule to reduce daminozide tolerances for apples from 30 ppm to 20 ppm.
May '86	Massachusetts establishes action levels to reduce and eventually eliminate daminozide in heat processed apple products and all infant and baby foods.

May '86	Maine issues proposed rule: no detectable residues in baby foods or heat processed foods after Oct. 1, 1986.
Feb. '89	Segment on Alar appears on television newsmagazine "Sixty Minutes" on the 26th. The next day, Natural Resources Defense Council releases its study, "Intolerable Risks: Pesticides in our Children's Food."
May '89	EPA issued preliminary determination to cancel all food uses of daminozide.
Nov. '89	Uniroyal voluntarily withdrew Alar's registration.

The evidence of the carcinogenicity of daminozide accumulated in the 1970's. Daminozide contains unsymetrical dimethyl-hydrazine (UDMH) both as a breakdown product and as a contaminant. It is a more potent carcinogen than Alar and is formed when daminozide is hydrolyzed, that is, when fruit treated with Alar is cooked. Daminozide's carcinogenicity flagged EPA's attention in the early 1980's. Concern about pesticides in food and specifically children's intake of cooked apple products like apple juice and apple sauce prompted the Natural Resources Defense Council, to initiate a campaign which called for the banning of Alar. In the 1980's, there were multiple meetings between EPA, Uniroyal, environmental and food safety groups, farmers who were dependent on Alar, and fruit industry associations to decide what to do about the carcinogen and the increasingly negative publicity surrounding fruit.

New Hampshire apple growers and other New England farmers had a number of concerns about the political process. The camps were, in their view, the registrant (Uniroyal) and growers who needed the product versus the food safety advocates, with whom organic growers aligned.[21] These New England growers did not want to align themselves with either group but saw themselves as unable to get information about the risks and the process, or introduce information to the process, unless they joined a camp.

The information they wanted to convey to EPA and NRDC was about Alar's Integrated Pest Management application. Integrated Pest Management, or IPM, is Toxics Use Reduction in agriculture. Reductions in pesticide use come from more precisely targeted pesticide applications, applications timed so as to be more effective and nonchemical controls including development of plants that are genetically resistant to pests, crop diversification, rotations, etc.[22] Apple grower Wood wrote:

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[21]Op. Cit. p. 5

[22]Lehman, Hugh "New Directions for Pesticide Use" in in Pimentel and Lehman, ed., *The Pesticide Question: Environment, Economics and Ethics* Chapman and Hall 1993 p. 4

By restricting succulent shoot growth, early-season treatments of Alar had been shown to reduce aphid populations to levels that ensures natural predators could control them without chemical assistance. By preventing premature fruit drop, Alar enabled growers to allow a much higher level of foliar damage (which tends to cause fruit to drop early) from various insects and mites that would otherwise be possible, thus preventing late-season applications of environmentally harsh insecticides and miticides. Also, by keeping the crop on the tree, Alar ensured that a larger proportion of the fruit would be harvested and removed from the orchard, thus removing hosts (apples) for the following season's pests. These benefits of Alar were well known to us, but we had never heard about them in the regulatory benefits debate.. . . we had information that we thought was critical to the regulatory decision, but we couldn't find the door in.[23]

By 1986, Massachusetts and Maine established plans to eliminate daminozide in heat processed fruit products. A segment on Alar appeared on the television newsmagazine "Sixty Minutes" in February of 1989. It was based on a report by the Natural Resources Defense Council, "Intolerable Risks: Pesticides in Our Children's Food", which was released the next day. Apple sales plumetted. Six months later, Uniroyal voluntarily withdrew the registration for Alar. Daminozide continues to be registered for non-food uses.

B. After The Ban

1. Effects on the Producers

Uniroyal voluntarily withdrew its registration for Alar in November of 1989. The remaining stocks of Alar were recalled and relabelled B-Nine and B-Nine SP for use on non-food uses.

Daminozide was a very small percentage of Uniroyal's sales, and Alar was about half of these sales in 1985.[24] In 1984 article, the *Chemical Marketing Reporter* announced that a Uniroyal pesticide will be reviewed by EPA. "Uniroyal's

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[23]Memo from Stephen Wood, President of New England Fruit Growers' Council on the Environment, Poverty Lane, West Lebanon New Hampshire, to Members of the Risk Assessment/Risk Management Work Group, Keystone National Policy Dialogue on Food Safety Oct. 26, 1990

[24]Daminozide Special Review Technical Support Document - Preliminary Determination to Cancel the Food Uses of Daminozide, May 1989, Office of Pesticide Programs, Office of Pesticides and Toxic Substances, United States Environmental Protection Agency D-10806

spokesman said that 'daminozide represents less than 1% of the company's total sales, which amounted to $2.04 billion in 1983.'"[25]

The most revealing source about daminozide production is a newspaper article in the Baton Rouge Morning Advocate, that ran on March 15, 1989. It states that Uniroyal's Geismar plant is the source of Alar. The manager of the plant, Hovey Simon, said that Alar brings

"a good profit," but its loss shouldn't damage the future of the plant. "It's going to hurt if (the chemical is banned), but it's not a life or death matter" to the Geismar operation, he said. "It's not going to have a big negative impact on people working at the plant."

Alar represents only about 3 or 4 percent of the production at the Geismar facility, Simon said. The material is made once a year, in response to market needs, and the process equipment is then cleaned and used in the production of other chemicals. . . .Uniroyal's Geismar plant mainly makes rubber and chemicals for use in the rubber industry.[26]

2. Effects on labor - manufacturers

Mr. Ames, manager of plant growth regulators at Uniroyal Chemical, said there were no employment effects of the ban, neither plant closings, nor lay-offs. This is not surprising given that daminozide is manufactured, part-time, in just one plant in the United States; it is still used on ornamentals in the form of B-Nine and it is exported, according to a Uniroyal vice president "to 71 export markets."[27] Mr. Ames said that daminozide has no health effects and that epidemiologists have been following workers for years and have found nothing. However, the study that shows no ill effects is not available to the public.

4. Effects in the Apple Orchard

To fully explore the effects of the Alar ban on labor, I now move from Alar's manufacturing to the site of one of its uses, the apple orchard. As previously

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[25]"Uniroyal pesticide to be reviewed by EPA: Regulatory Action Prompted by its Toxicity" *Chemical Marketing Reporter*, July 23, 1984 226; 3

[26]Anderson, Bob "La. plant makes chemical that has apple industry in uproar" *The Baton Rouge Morning Advocate*, 3/15/89 , p. 3-A

[27]James A. Wylie quoted in "Uniroyal pulls apple pesticide from market, citing controversy," *Chemical Marketing Reporter*, June 5, 1989

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To fully explore the effects of the Alar ban on labor, I now move from Alar's manufacturing to the site of one of its uses, the apple orchard. As previously

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[25]"Uniroyal pesticide to be reviewed by EPA: Regulatory Action Prompted by its Toxicity" *Chemical Marketing Reporter*, July 23, 1984 226; 3

[26]Anderson, Bob "La. plant makes chemical that has apple industry in uproar" *The Baton Rouge Morning Advocate*, 3/15/89 , p. 3-A

[27]James A. Wylie quoted in "Uniroyal pulls apple pesticide from market, citing controversy," *Chemical Marketing Reporter*, June 5, 1989

stated, Alar was used on a number of orchard crops, such as pears, cherries and plums, as well as a variety of other food crops - peanuts, tomatoes, Brussels sprouts, cantaloupes and others. Apples were chosen as the focus for this part of the study because most of the food use of Alar was on apples. In addition, it is an industry that is based in Massachusetts.

a. Economics of the Massachusetts Apple Industry

The most recent available statistics are for 1992, when 2,002,400 bushels were harvested in the state.[28] The crop was valued at $13 million or $6.86 per bushel. Although it was a near perfect growing season, there were problems with storage, storage diseases, that reduced the value of the crop. In 1989, there were fewer apples harvested, 1,008,570 bushels but the value was higher: over $16 million at $9.16 a bushel. The 1993 crop is expected to be more valuable than the 1992 crop, with an increase of about $4.00 per bushel over the '92 price, but the harvest size down an estimated 18%. Alar was never used on all apples, but in 1985, when Alar was still being used on some of the crop, 1,977,000 bushels were harvested at a value of $14.5 million at $7.75 a bushel.

[28]This, and all subsequent information in this paragraph is from George Porter, at the Massachusetts State Department of Food and Agriculture. The statistics are from the New England Agricultural Statistics Service, USDA, Concord, NH 1992

TABLE 2

APPLES IN MASSACHUSETTS, PRODUCTION AND VALUE[29]

year	production (1,000 bushels)	$ price per bushel	value of crop ($1,000)
1983	2,310	7.10	16,403
1984	2,238	7.46	16,704
1985	1,976	7.74	14,558
1986	2,024	8.23	16,068
1987	2,048	8.66	17,322
1988	2,095	9.48	19,196
1989	1,857	9.16	16,133
1990	1,476	10.02	19,322
1991	1,417	10.66	13,962
1992	2,024	6.86	12,905
1993 (est.)	1,600	10.86	17,376

From these figures, it is not obvious how the Alar controversy affected the industry. Recall that Uniroyal withdrew Alar in November, 1989, but there were rumblings of the withdrawal for a few years before. There is a decrease in the value of production and a slight decrease in the price per bushel in 1989, but it is within normal market fluctuations. There is a drop in production for 1989 through 1991, with a concomitant rise in price per bushel, which may be due to Alar.

Yet, acording to growers and employees of the USDA extension service, the loss of Alar has had a marked effect. They claim that more apples, especially Macintoshes, are now being lost to "drop." One grower estimated that he lost a full third of his Mac harvest because Alar is unavailable.[30] Most growers, including Joe Syncook, who, at the Horticultural Research Center, serves as an information service, estimate that yields are down 5-20%.[31]

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[29]New England Agricultural Statistics, 1992 USDA publication, p. 34
[30]Dana Clark, interview, Oct. 13, 1993
[31]Joe Syncook, telephone interview, Nov. 16, 1993

With Alar, the apples stayed on the tree longer, which meant they got bigger and redder. These two attributes are necessary for premium prices at market, and they are harder to attain without Alar. This is especially true for Macintosh, because they are by nature mostly green, but consumers like red apples. Apparently, to get "good color" naturally, sunny days and cool nights are required. These climactic conditions are met easily in high elevations, but in the valley, redness is guaranteed by additional growing time supplied by Alar. The issue of consumer preference i.e. why redder is better is not discussed here. The point is that growers in the Valley claim they are getting lower prices for their Macs because they're not as red and as big as they were when Alar was used. However, the USDA statistics on apple production and yield conflict with growers' reports. It is possible that growers have found other ways to compensate for their losses which are not reflected in the numbers.

b. Effects on Labor

About a dozen orchard owners/growers in Massachusetts were interviewed. Farm visits were made to three. Two use Jamaican pickers, and the third uses domestic pickers. Two domestic pickers were interviewed as well as two packers. Jamaican pickers are inaccessible; they fear deportation and are reluctant to speak.

Effects on Pickers

A taciturn 83 year old picker, and mentor of one of the growers, said of Alar, "Best chemical ever invented." On the withdrawal of Alar, "bad for growers." Another picker added, "Yeah, good for consumers, bad for growers." It's bad for growers because Alar kept the apples on the trees, it prevented "drop." When apples drop, they are virtually worthless; they're bruised and are only good for cider. Because there is a world wide apple glut, the price of cider is low and it's hardly worthwhile to gather the fallen apples for cider. Both pickers and growers mentioned that now there are fewer apples to pick, although USDA statistics do not reflect this. Fewer apples to pick means less money for both growers and pickers.

Picking apples is more difficult without Alar because apples are knocked off more easily and bruise more easily. A picker said, "you set your ladder up more

times and go up without hardly breathing."[32] More ladder moving is required because when Alar was used, a picker could pull a branch close to himself, pick the apples and then release the branch. Now, since apples fall off easily, grabbing branches this way causes "drops." The heavy wooden ladders, with stakes to prevent slippage, must be uprooted and replanted three to four times more frequently now that Alar is not used. Pickers also must go up and down the ladders, with their bushel bags swung over their shoulders, just as frequently. Grower and picker Rick Smith said that the rungs hurt your arches, you get a stiff neck from the bag and your hands freeze because the apples are cold.

Picking must be done more gingerly because apples bruise more easily without Alar. Since pickers are paid by the bushel, rather than by the hour, there is incentive to move quickly to pick as much as possible. In this case, haste really makes waste because haste causes bruising. One grower, whose pickers are Jamaican, complained of the difficulties of trying to get them to slow down, and sometimes resorts to putting them on an hourly rate for a day or two.[33] I was unable to talk to Jamaican pickers, (their fear of deportation makes them inaccessible) but I was told by the grower that an hourly wage is about half the piece rate wage.

Rick Smith, who was clearly on very good terms with his domestic pickers, said, "The pickers are bumming out as much as the growers. They watched the fruit grow all year, and it's on the trees one day and the next day it's not. It's a bummer." The pickers nodded concurringly, but the growers are probably experiencing more adverse effects than the pickers.

Effects on Growers

Dana Clark, a fourth generation grower, said that "losing Alar had a big impact on the bottom line. It's one more nail in the coffin of the family farm." Alar had two important benefits for growers; 1) it prevented "drop" i.e. kept apples on the trees and 2) it produced firmer fruit. Each of these benefits had a number of sequelae. Alar allowed a longer picking season than nature does. Because treated apples did not fall off the tree when ripe, they could be harvested at a "leisurely"

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[32]Unidentified picker on Rick Smith's orchard, Ashfield MA Oct. 13, 1993
[33]Dana Clark, grower, Ashfield, MA, interview,Oct. 13, 1993

pace. Grower Fred Chick said, "Alar took a lot of the pressure off. You had more than three weeks to get your Macs picked."[34] Now, growers complain of the stress of the shortened harvesting season.

The farm superintendent at the University of Massachusetts Horticultural Research Center in Belchertown, described the changes in harvesting which were echoed by all the other growers. He said that with Alar, you picked 2000 bushels the first week, 2000 bushels the second week and 2000 bushels the third week.[35] Without Alar, he (and all the other growers) concentrate labor in the first week: he hires more pickers to pick more bushels. Because "drop" can no longer be controlled, the anxiety is to be able to pick the reddest apples before they fall. The level of anxiety caused by the loss of control over the harvest is expressed by a Massachusetts apple broker who told the Boston Globe, "There were times you would be lying in bed, miles away from an orchard, and you'd think you could hear them dropping."[36]

The increased pace of the harvest is felt by everyone in the orchard. Grower "Dick Bargeron notes that the time pressure often results in pickers working much longer hours at a frantic pace, in an attempt to harvest the crop before too much is lost to drop..."[37] The goal is to harvest the crop quickly and get it into storage quickly. The shorter picking window, according to one grower, requires a 40% increase in the equipment needed to move the apples into storage.[38] According to Bargeron, since smaller orchards can ill afford to buy new equipment, overused and possibly dangerous equipment is now being used.[39] Although there are no data available, it seems likely that the increased pace of work, longer work hours, with overused equipment would result in higher injury rates.

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[34]Fred Chick, grower, Worthington, MA , interview, Oct. 14, 1993
[35]Joe Syncook, telephone interview, Nov. 16, 1993
[36]Britton, Sharon "The post-Alar era dawns chilly for apple growers" *Boston Globe* Oct. 25, 1989 p. 34, quoting Jack Manning, sales agent for J. P. Sullivan and Co., of Ayer, MA, an apple commission house
[37]Warren, Nick, unpublished paper *Unanticipated Consequences of Banning A Chemical: the Case of Alar,* Work Environment Dept., UMass Lowell Dec. 17, 1992 p.14
[38]Ibid.
[39]Ibid.

The hectic pace is carried over into the storage facilities, where the increased load of apples needs to be packed quickly for cooling.[40] That the fruit bruises more easily without Alar has consequences for everyone handling the fruit. The pickers and the packers must be more careful, but ultimately it the grower who cares the most about the condition of his harvest, so it is the grower who keeps an anxious vigil on his employees. "I have to watch them closer," said Dana Clark.

Psychological Effects on Growers

In addition to the stresses brought on by the shorter harvesting season and financial losses of smaller, less than premium apples, the Alar incident had other effects on growers. Dana Clark said, "I feel like I'm the bad guy." After I thanked him for speaking with me, he replied, "Thank you. This was good therapy. So different than all those people calling me up screaming about Alar."[41] A grower in the state of Washington was quoted in the New York Times saying, "We farmers are taking a hard look at the chemicals we're using, and that's a legitimate concern, but you never really get over the bitterness that was created, that we were somehow trying to poison children."[42]

c. Effect on Industry practice

One of the growers, Rick Smith, mentioned that Alar allowed orchards to get bigger, because the harvesting time could be spread out. Other growers agreed. Now, large orchards are more difficult to manage, so some growers are not harvesting part of their orchards or are selling off part of their land.

Other changes because of the Alar ban include; 1) increased use of summer pruning 2) Cutting down old, 45 ft trees because of uneven ripening and switching to dwarf or semi-dwarf varieties. 3) Diversifying with more varieties (less Macs).

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[40]Ibid. p. 7

[41]Dana Clark, interview, Oct. 13, 1993

[42]Timothy Egan, "Apple Growers Bruised and Bitter After Alar Scare" New York Times Tuesday July 9, 1991

In order to allow more sunlight to reach the apples, which enhances reddening, more summer pruning is being done. Previously, pruning was mainly done in the winter, to avoid any possible damage to the fruit. Summer pruning removes shoots and stems so that the leaf canopy will obstruct the light as little as possible. According to Joe Syncook, the farm superintendent at the Horticultural Research Center, summer pruning costs about $4-5 per tree.[43] However, the economics of summer pruning, that is, whether increased summer pruning and concomitant decrease in winter pruning represents more work or less, is unclear.[44] There is evidence that although summer pruning slightly decreases the yield, the value of the crop, due to the questionable import that consumers place on redness, is actually increased.[45] The increase in summer pruning means that more Jamaicans, or off-shore labor, are doing the work. Growers who use this kind of labor for harvesting simply hire them a month before harvest season, in August.[46]

All the growers report a trend that was hastened by the Alar ban, which is cutting down the old 45 foot high trees and replacing them with dwarf or semi-dwarf varieties. A Boston Globe article, written soon after the ban begins, "Older Macintosh trees, the gnarled but graceful standard of the state's rural landscape, could all but disappear over the next decade as apple growers, adjusting to life without the chemical Alar, begin cutting their losses with chain saws."[47] The old trees ripen unevenly, whereas the smaller trees have less leaf canopy and

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[43]Joe Syncook, telephone interview, Nov. 16, 1993

[44]Nick Warren, in his unpublished paper *Unanticipated Consequences of Banning A Chemical: the Case of Alar,* Work Environment Dept., UMass Lowell Dec. 17, 1992 states, "One estimate (Greene and Autio, 1987) puts the labor of summer pruning at 30 hours/acre, with an accompanying 40% drop in dormant pruning time. Since dormant season pruning used to take about 35 hours/acre, this translates into 21 hours of dormant pruning for a year-round total of around 51 hours/acre. Autio's more recent estimate (1992) is 23 hours/acre in the summer, with an additional 10-12 hours in the winter, resulting in a total figure of 30-32 hour/acre. If this more recent estimate proves to be correct, summer pruning may actually have reduced year-round pruning from the older winter figure of 35 hours/acre. . . But most growers seem to feel that the move to summer pruning does represent some increase in labor needs." p.13

[45]Autio 1992, phone conversation cited in Warren, Nick unpublished paper *Unanticipated Consequences of Banning A Chemical: the Case of Alar,* Work Environment Dept., UMass Lowell Dec. 17, 1992

[46]Ibid.

[47] Britton, Sharon,"The post-Alar era dawns chilly for apple growers" *Boston Globe* Oct. 25, 1989 p. 29

they are much easier to prune and harvest. Less leaf canopy means more redness earlier, so that less ripe, harder, fruit can be harvested and put into storage. So even though the yield of dwarves is less than the big, old trees, less fruit is lost to storage throwaway and drop.

Macintosh apples were the most Alar-dependent variety. The EPA claims that in 1985, 17% of Macintosh were treated with Alar, but in New England, this figure was probably higher. Macintosh may have once represented as much as 70% of New England apple production but by the 1980s this figure was about 60% and falling.[48] Now, growers are diversifying their trees not only to get away from Macs, but also to stagger their harvest, because different varieties ripen at different times. About the failing New England Macintosh industry, grower Stephen Wood remarked that "there is a lot of tacit blaming on the loss of Alar, but it was in distress before . . . that just shows how fragile the industry is, if it can't survive the loss of one tool. You wouldn't expect American agriculture to go under if we lost John Deere tractors. We became too dependent on Alar, from a business point of view. It (Alar) made it possible to rely on a single variety, and we probably asked more from a single variety than we ever should have."[49]

d. Chemical Use

Probably the most striking unintended consequence of the withdrawal of Alar is the increased use of insecticides. Stephen Wood, a New Hampshire farmer and president of the New England Fruit Growers' Council on the Environment described Alar's role in Integrated Pest Management program for apples previously.

As grower Fred Chick explained, "Spider mites suck nutrients from the leaves, and if you don't control them, they cause early drop. With Alar, even with a heavy mite infestation, you could get by."[50] Now, he applies miticide freely. (He uses Omite, which is severely irritating) Dana Clark reports that he's using "more chemicals. The trees can't tolerate insect injury as well as they used to

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[48]Warren, Nick, op. cit. p. 7
[49]Stephen Wood, telephone interview, Feb. 28, 1995
[50]Fred Chick, interview, Oct. 14, 1993

with Alar."[51] He's using Vydate for leaf miner and a miticide. The increased use of miticides has posed problems for growers and workers.

The greatest insecticide exposures, other than to manufacturers, are to applicators and orchard workers. In Massachusetts, applicators tend to be either the growers themselves or someone "generally at the top of the employer scale," because applying chemicals is complicated - "you need to calibrate and navigate."[52] For many compounds, licensing is required. According to Joe Syncook, the manager of the Department of Agriculture Extension Service in Belchertown, MA, Vydate is "a particularly hot material" and he has had reports of people "getting numb lips."[53] Vydate, or oxamyl, is a cholinesterase inhibitor. The Material Safety Data Sheet, from Du Pont, states that "oxamyl poisoning produces effects associated with anticholinesterase activity which may include weakness, blurred vision, headache, nausea, abdominal cramps, discomfort in the chest, constriction of pupils, sweating, slow pulse, muscle tremors." [54] The scientific literature reports systemic poisonings of field workers and applicators in California from 1982-1989 characterized by headaches, weakness and nausea.[55] When I asked Mr. Syncook if he had heard of any severe poisonings, he replied, "Growers who have applicators who are poisoned are really suppressed. I wouldn't hear about that."[56] Omite, or propargite, is less hazardous systemically, but can cause severe dermatitis and eye irritation.[57] According to entomologist Clive Edwards, fruit-tree red spider mites were never a problem in orchard crops until DDT killed off their natural enemies, which are mostly predatory mites.[58]

When Alar was used, growers, pickers and consumers were exposed to both fewer and, it appears, lower quantities of pesticides than they are with the ban.

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[51]Dana Clark, interview, Oct. 13, 1993
[52]Joe Syncook, telephone interview, Dec. 16, 1993
[53]Ibid.
[54] Du Pont MSDS No. M0000057 p. 2
[55]Berberian, IG, *Journal of Occupational Medicine*, Vol. 29 1987, p. 409
[56]Joe Syncook, telephone interview Dec. 16, 1993
[57]Saunders et al. 1987 "Outbreak of Omite-CR-Induced Dermatitis Among Orange Pickers in Tulare County, CA," JOM, Vol. 29, No. 5 pp. 409-413
[58]Edwards, Clive A. "The Impact of Pesticides on the Environment," in Pimentel and Lehman, ed., *The Pesticide Question Environment, Economics and Ethics* Chapman and Hall 1993 p. 29

Alar was applied in early spring and then two weeks before harvest, to a portion of the crop. Insecticides, depending on the severity of the infestation, can be applied 4-6 times to the same crop. Comparing the relative toxicities of numerous insecticide applications with one dose of Alar is well beyond the scope of the paper, although relevant toxicological information is presented below in Table 3.

In the table, the first chemical name is the brand, or common name of the product. The second name is the main ingredient. In the case of Vydate, it is formulated in a 24% liquid solution, so some toxicological information is for the pure compound, and other information is for the 24% solution.

TABLE 3

TOXICITY DATA FOR ALAR AND TWO INSECTICIDES

	Alar Daminozide[59]	**Vydate** Oxamyl[60]	**Omite** Propargite[61]
Oral LD50 (rat) in mg/kg[62]	8450	5.4 (pure) 37 (24%)	4029
Acute dermal LD50 (rabbit)	>1600	2960 (pure)	2940 "severely irritating"
Acute inhalation LC50 (rat)	>147 mg/l	0.14 mg/l (24%)	0.05 mg/l
Toxicity Class	III[63]	III[64], I[65]	I[66]
Other information	Uniroyal MSDS: "no evidence of carcinogenicity"[67]	contains >2% methylene chloride, a carcinogen, and 35-45% methyl alcohol[68]	

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[59]All information about Daminozide is from *Farm Chemicals Handbook 1985* Meister Publishing Co., Willoughby, Ohio 1985 p. C 10.

[60]Information about oxamyl is from the *Farm Chemicals Handbook 1985* Meister Publishing Co., Willoughby, Ohio 1985 p. C 175 and Du Pont Material Safety Data Sheet #M0000057 for "Vydate" L Insecticide/Nematicide 5/90

[61]*Farm Chemicals Handbook 1993* Meister Publishing Co., Willoughby, Ohio 1993 p. C 282

[62]LD50 and LC50 stand for Lethal dose and Lethal Concentration, repsectively. They represent the dose at which 50% of the test animals die.

[63]National Institutes of Occupational Safety and Health Classification of Pesticides p.360

[64]Du Pont Material Safety Data Sheet #M0000057 for "Vydate" L Insecticide/Nematicide 5/90

[65]National Institutes of Occupational Safety and Health Classification of Pesticides p. 349

[66]Ibid. p.350

[67]Uniroyal Chemical MSDS No. A313002 for B-Nine (same formulation as Alar) 12/19/90

[68]Neither OSHA nor ACGIH (American Conference of Industrial Hygienists) has established an Exposure Limit for Vydate, although Du Pont's is 0.5mg/m3 for an 8 hour Time Weighted Average, according to Du Pont MSDS # M0000057

From the information in the table above, it appears that Alar is more benign than two of the chemicals that are now used more often now that Alar is banned. Rats can ingest more of it and breathe more of it than either Vydate or Omite. Its toxicity class (III) indicates that by toxicological standards, it is considered less toxic than Omite or Vydate. However, the information that is available is limited. The LD50 and LC50 (Lethal Dose and Lethal Concentration) represent the dose of the test substance at which 50% of animals die. The lower the LD50, the more acutely toxic the substance. It cannot indicate chronic effects, or any effects that may harm the animals but not kill them, such as arthritis, cognitive disorders, etc. Toxicological information is restricted to just a few kinds of tests: it cannot possibly reveal all one would like to know to insure the harmlessness of a substance. Further, not only is the science limited, but the access to information is limited. It is curious that the Uniroyal MSDS for B-Nine of 1990 states that there is no evidence of carcinogenicity. This means that if manufacturers and applicators of this compound (whose formulation is identical to Alar) rely on the Material Safety Data Sheet for information, they are being misinformed.

The stability of substances over time affects their hazardousness. Vydate, while it is acutely toxic, disintegrates quickly. Therefore, consumers are not affected by its toxicity, only workers are exposed. Omite leaves residue.

There is some disagreement about the increased use of insecticides. Although the overwhelming majority of growers maintain that their use of insecticides has increased due to the Alar ban, there is one exception. Grower Stephen Wood said, "Cause and effect are not clean, there are no straight lines in this field, no correlations. Alar was nothing more than a very promising line of research. There's been more research in the last 10 years. Those guys (other growers) are still pissed off, and they feel insulted, because all of a sudden they're baby killers. And they're right to go apoplectic when Alar is mentioned, but it's not useful. They may tell themselves and you that they're using more miticides because they're pissed about Alar, but it's just not true."[69] He attributed any increase in

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[69]Stephen Wood, telephone interview, March, 29, 1995

miticide use to the loss of another miticide whose registration was withdrawn two years before Alar's.

Indeed, a call to Uniroyal revealed that Omite sales started increasing when Cyhextin was banned in 1987.[70] Uniroyal's Richard Moore did not think that the loss of Alar influenced Omite sales.[71] However, entomologist Ron Prokopy explained that growers are "definitely using more Vydate and Lannate for leaf miners" and Omite for mites.[72] He said that, while it is uncertain whether or not mites induce fruit drop, it is what growers believe, and the belief prompts them to spray more. Lannate (methomyl) is a class I pesticide, with a very low LD50 of 17 mg/kg for male rats and a half life of only three to 3-5 days.[73] It appears to be acutely toxic, but not stable, and therefore, would adversely affect workers and not consumers.

Aside from the increased use of insecticides, there are two important changes in the way growers think about chemicals since the Alar ban. It made them more wary of their dependency on chemicals because one never knows when the government would take one away or consumers would suddenly decide not to buy fruit treated with one. So, there is renewed interest in reducing the use of chemicals through Integrated Pest Management Techniques (IPM). The ban also altered at least some growers' relationships to their orchards, because IPM techniques require close monitoring of insects. Grower Fred Chick mentioned that before the ban, he didn't spend any time in the orchard, he simply sprayed a variety of chemicals on his crop according to the USDA Extension Service's schedule.[74] Now, he's "out there" much more. He expressed satisfaction with his increased involvement and feels like he really knows what's going on with his trees. It is possible that not every grower is pleased with the increased attention and discretion that IPM requires, but the decrease in routine spraying, and therefore a lessening of some degree of alienation, is valuable to at least one grower.

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[70]Richard Moore, Uniroyal Agrochemical Division, telephone interview, March 30, 1995
[71]Ibid.
[72]Ron Prokopy, telephone interview, March 31, 1995 He also explained that Stephen Wood is more "up on the literature" than most growers.
[73]*Farm Chemicals Handbook* Meister Publishing Co., Willoughby, Ohio 1994
[74]Fred Chick, telephone interview, Oct. 14, 1993

III. DBCP CASE STUDY

The previous case study revealed that the banning of Alar had unintended, negative consequences for orchard workers and consumers. The banning of DBCP teaches different lessons. It is a story of corporate misconduct, government inefficiency and the international repercussions of domestic policy decisions. Although it took place decades ago, it is valuable because there is nothing to prevent something similar from happening again. This case study explores the history of DBCP, and the effects of the ban both domestically, on the Peach industry in Georgia, and abroad.

A. History

Dibromochloropropane (DBCP) was synthesized by Oppenheim in 1833.[75] In the early 1950's both Dow and Shell chemical companies found the compound to be an effective nematocide. Nematodes are worms that live in soil and plague a multitude of crops. They feed on the roots of plants and are a particular problem in warm climates because they cannot survive in frozen soil. Table 4 is a summary of the history of DBCP.

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[75]International Agency for Research on Cancer. "1,2-Dibromo 3 - Chloropropane," *IARC monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans* World Health Organization, Vol. 20, 1979 p. 84 cited in Gips, Terry *Breaking the Pesticide Habit* International Organization of Consumers Unions, Penang, Malaysia 1990 p. 128

TABLE 4

CHRONOLOGY OF DBCP

1950s	Dow and Shell discover DBCP is an effective nematocide
1954-55	studies done by Dow and Shell reveal DBCP's high toxicity
1955	DBCP registered as nematocide
1956	Shell begins production of Nemagon
	Georgia Exp. Station runs trials, finds, "Plants grown in fumagated soil grow faster, attain larger size, and, in the case of fruit trees, produce larger yields." Growers told to get details on use from manufacturers.
1957	Dow begins production of Fumazone
1960	Shell hires Dr. Charles Hine to prepare product report. He was instructed to minimize effects and precautions. "This is not a treatise on safe use."
1961	Torkelson's article in *Toxicology and Applied Pharmacology* reveals testicular atrophy and other health effects.
1961	USDA official in charge of product labeling for safety purposes is called "overcautious" by Shell because he is concerned about testicular atrophy in experimental animals. He is reassured when workers at Shell's Denver plant are given a clean bill of health - by a doctor not told to look for testicular effects.
1960s	Standard Fruit/Dole begins DBCP trials in Central America on bananas.
1971	Study by Rakhmuatullayev indicating adverse effects on rat testes. Kidney, liver, reflex, blood functions and fertility disturbed.
1972-74	Olsen et al. at NCI report stomach and mammary cancer
1973	Dow submits registration application for another DBCP product to EPA. EPA does not comment on the Torkelson study. No oncogenicity studies were submitted by the registrant.
1976	DBCP identified by EPA as a candidate for review for possible cancellation due to NCI studies.
1977	NCI finds DBCP "produced high levels of squamous cell carcinoma in rats and mice." EPA requests data from Dow and Shell.
July '77	Chemical workers at Occidental Petroleum plant in CA found to be sterile. Similar findings at other plants.
	OCAW makes a public request for a NIOSH HHE and demands an Emergency Temporary Standard from OSHA.
	Standard Fruit/Dole receives information about sterility from Dow.

Aug. '77	California bans DBCP. Production in US is halted, supplies recalled. Occidental Petroleum's supplies sold to Philippines. Standard Fruit worries about loss in DBCP supply, pressures Dow.
Sept. '77	OSHA issues standard that effectively eliminates domestic production of DBCP.
	OCAW initiates a Right-to -Know campaign featuring the DBCP story as an example of unfairness to workers.
Oct. '77	Standard acquires DBCP from Israel, Mexico
Nov. '77	EPA administrator revokes registrations for use on 19 crops. It continued to be used on cotton, soybeans, peaches, citrus, pineapple, nuts, lawns, golf courses and ornamental plants.
Feb. '78	Dow signs indemnity agreement with Standard
July '79	DBCP found in California wells. EPA bans use in US except for pineapples.
Feb. '79	Use banned in Costa Rica Standard sends stocks to Honduras
Dec. '80	OSHA proposes Hazard Communication Standard to provide workers with the Right-to-Know
1980-81	Shell sells Nemagon in Africa
1984	OSHA's final Hazard Communication Standard is promulgated
1986	Standard using DBCP in Philippines

DBCP was registered by Shell and Dow in 1955 as a nematocide. In compliance with federal requirements for product registration, both companies began toxicological studies in 1954-55.[76] Dr. Ted Torkelson was the toxicologist for Dow; Dr. Charles Hine directed the studies for Shell. Results from both labs indicated DBCP's high toxicity. Significant changes to organs, at relatively low doses were called "surprising." At doses of 5 ppm, rats had retarded growth, organ damage and undersized testes.[77] At 10 ppm, all but one of the rats had testes half the normal size and at 20 ppm, the surviving rats were completely sterile.[78] The labs then began to collaborate in the testing in order to confirm the results.

The companies were not daunted by these preliminary results. Shell began production of Nemagon™ in 1956 and Dow started producing Fumazone™ the following year. They told the manufacturing plant managers that DBCP was "moderately toxic" if inhaled or eaten and "slightly toxic" if absorbed by skin.[79]

Both labs continued testing and found damage at the lowest levels tested - 12 ppm at Dow and 5 ppm at Shell.[80] Most importantly, neither lab tested to the "no-effect" level, which meant the highest dose that would not harm the animals was never found. On this basis, scientists suggested that the workers safety level be 1 ppm. Later in 1958, the Dow group prepared and circulated a report to management personnel inside the company, that included the abovementioned findings, as well as Hine's findings from Shell, which showed that "exposure tests on rats, rabbits, guinea pigs, and monkeys showed that inhalation of 12 ppm DBCP over a course of 50-60 seven hour days killed nearly

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[76]Thrupp, Lori Ann "Sterilization of workers from Pesticide Exposure: the Causes and Consequences of DBCP-Induced Damage in Costa Rica and Beyond" *International Journal of Health Services* Vol. 21, No. 4, pp. 731-757, 1991, citing Dow, Confidential Report, UC278, 1958

[77]Ibid. p. 740

[78]Ibid.

[79]Ibid., citing Shell, toxicology lab. Unpublished research report, 1956

[80]Thrupp, Lori Ann "Sterilization of workers from Pesticide Exposure: the Causes and Consequences of DBCP-Induced Damage in Costa Rica and Beyond" *International Journal of Health Services* Vol. 21, No. 4, pp. 731-757, 1991 citing Dow, Confidential Report, UC278, 1958

half the animals, reduced number of sperm cells and testicle size, and created liver and kidney damage."[81]

Dow scientist Torkelson was appointed to summarize the findings of both companies. The 1961 article in *Toxicology and Applied Pharmacology* revealed that this compound caused testicular atrophy as well as the other health effects.[82] It recommended that the workplace concentration be kept at 1 ppm and that "Formulator workers should wear full-face gas masks equipped with vapor canisters, and protective clothing impermeable to the material."[83]

The problem was that although the article was available, to readers of *Toxicology and Applied Pharmacology*, it was unlikely that the actual users of the chemical, the customers of Dow and Shell, ever saw the article. It was not used in the product data summary. Dr. Hine was hired by Shell to prepare the public summary in 1960.

His draft report contained some of the same facts included in the journal article, but it reduced the details on the adverse effects. Dr. Lykken, Shell's technical services director, reviewed the draft report and advised changes to understate the hazards and to exclude some of the toxic effects and safety precautions. For example, remarking on Hine's observation that repeated exposure could have an effect on the human reproductive system, Lykken wrote, "Do not extrapolate. Leave out speculations about possible harmful conditions to man. This is not a treatise on safe use."[84] He also advised Hine to delete references to the need for further DBCP testing. His suggested changes were made in the public product summary, therefore minimizing the actual effects and precautions. This summary was then given to customers and public officials. It noted risks of skin and eye irritation, but did not mention organ damage such as testicular dysfunction. The only mention of safety precautions was a suggestion for formulator workers in closed areas to wear respirators.[85]

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[81]Ibid. citing Trost, C. *Elements of Risk: The Chemical Industry and Its Threat to America.* Times Books, New York, 1985

[82]Torkelson, TR., et al. "Toxicologic investigations of 1,2, dibromo,-3-chloropropane." *Toxicology and Applied Pharmacology* 3 pp. 545-59 1961

[83]Torkelson, TR., et al. "Toxicologic investigations of 1,2, dibromo,-3-chloropropane." *Toxicology and Applied Pharmacology* 3 pp. 545-59 1961

[84]Hine, C. Unpublished report on DBCP. Dow Chemical Company, 1959 cited in Thrupp, op. cit.

[85]Thrupp, Lori Ann "Sterilization of workers from Pesticide Exposure: the Causes and Consequences of DBCP-Induced Damage in Costa Rica and Beyond" *International Journal of Health Services*

USDA was in charge of product labeling for safety purposes. At this time, a USDA registration official wrote to Shell saying that in view of the testicular atrophy in experimental animals, the USDA requested the health records of manufacturers and formulators of DBCP. Memos from Shell indicate its opinion that the USDA was being "overcautious" and that the USDA's proposed precautionary statements "could have an adverse effect on the sale of this product."[86] Finally, the USDA was willing to relax its labeling requirements if Shell could show a history of safe experience in the field and in the factory. Shell began a survey of workers at the Denver plant but did not tell the examining doctor to look for testicular effects. The manufacturers reported that the product could be used without "undue hazard" and the government registered the products with the words "Do not breathe the vapors" and "Use only in well-ventilated area." Dow's label read, "Avoid prolonged breathing."[87]

In the late 1960's, DBCP trials began on the Standard Fruit Company's Central American banana plantations. William Liebhardt, then a young scientist with Standard Fruit in Honduras recalled, "In the DBCP trials, toxicological analyses were not undertaken on the potential effects of those chemicals on the users' health or the environment . . . We did not consider such factors at all at that time . . . While working, all of us never used any kind of safety equipment in those days."[88]

In the early 1970's, evidence of DBCP's carcinogenicity appeared. A National Cancer Institute study reported a high incidence of mammary cancer in female rats.[89] A year later, pathologists for the same study declared DBCP "very carcinogenic."[90] The 1977 draft report of the NCI study, found that DBCP "produced high levels of squamous cell carcinoma in rats and mice of both sexes

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[86]The Legacy, A booklet compiled by Misko, Howie and Sweeney, Dallas, Texas, 1993 p. 13

[87]Ibid. p.14

[88]Ibid. p. 16

[89]Olsen, WA. et al. Brief Communication; induction of stomach cancer in rats and mice by halogenated aliphatic fumigants. *Journal of the National Cancer Institute* vol. 51, No. 6, pp. 1993-1995 1973

[90]Ward, JAM and RT Haberman, 1974 Pathology of stomach cancer in rats and mice induced with the agricultural chemicals ethylene dibromide and Dibromochloropropane. *Bull. Soc. Pharmacol. Env. Pathol.* Vol. 74, series 2, issue 2:10-11

at both exposure levels tested."[91] A second study at the same laboratory was funded by Dow and terminated in June of 1977.[92] Incidences of possible neoplasms in the liver, kidneys and stomach were reported.

In 1977, the human evidence came in. On August 1, 1977 EPA was notified of the human health effects in some chemical workers in Lathrop, California by their employer, Occidental Chemical Co.[93] The Occidental Chemical plant in Lathrop formulated DBCP that had been made in Dow's plant in Magnolia, Arkansas. Of the 23 non-vasectomized men working in the production area, 13 either had no or low sperm production. The estimations of the exposure levels of men in the plant varied from 0.4 - 0.6 ppm[94] to 0.9 ppm.[95] Men at seven other locations in the United States were tested, with similar results.[96] Twelve out of 14 men in Dow's Magnolia plant had reduced sperm counts.[97] *Mother Jones* reported 62 out of 86 employees of the Magnolia plant were either sterile or had very low counts.[98]

1. Oil Chemical and Atomic Workers and OSHA

In 1976, workers in the Occidental Petroleum Plant in Lathrop, California noted that many seemingly healthy men in their 20s and 30s were trying to have children, and were unable to do so. They suspected that a workplace exposure was the problem. Rafael Moure, OCAW's industrial hygienist, instructed the head of the union local to ask the company for a list of chemicals, their intermediates and their toxicities. The company had no legal obligation to provide any information since there was no Right-to-Know law at this time, so Occidental Petroleum revealed nothing. The company was also asked to pay for sperm analyses for seven workers in the Agricultural Chemical division.

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[91]Federal Register, Vol. 42, No. 212 Thursday, Nov. 3, 1977 p. 57546
[92]Federal Register, vol. 42, no. 184 Thursday, September 22, 1977 p. 48030
[93]Ibid.
[94]Whorton D, Krauss RM., Marshall S et al. Infertility in male pesticide workers *Lancet* 2 p.1259-1261 1977
[95]Ibid.
[96]Dow had three plants that had manufactured, or were manufacturing DBCP in 1977. They were in Magnolia Arkansas, Pittsburgh, PA and Midland, Michigan. Shell's plants were in Denver CO and Mobile, Alabama. Chevron and Velsicol had a few formulation plants.
[97]Federal Register, Vol. 42, No. 184, Thursday, September 22, 1977
[98]Daniel Ben-Horn, "The Sterility Scandal" *Mother Jones*, May 1979 p.61

Occidental flatly refused to conduct any medical evaluation "because they saw no reason for it."[99]

In the spring of 1977, filmmakers Hanig, Davis and Mooser, who were making a documentary about occupational health, became interested in the story and paid for the seven sperm analyses. The results of the sperm counts were sent to Dr. Donald Whorton, the union physician. Five of the seven had grossly abnormal sperm counts. Whorton requested that they repeat the test because he was incredulous, but the results were confirmed. OCAW Health and Safety personnel Rafael Moure and Sylvia Krekel sent an open telegram to the director of Health Hazard Evaluations at OSHA's research institute, NIOSH, who initiated a Health Hazard Evaluation. NIOSH's intervention was widely publicized in the media. It was aimed to alert other potentially exposed chemical workers and to pressure Occidental to provide the union with health and safety information. Occidental Petroleum invited Whorton to be their medical advisor and NIOSH called him to do the Health Hazard Evaluation. After low sperm counts were confirmed, Whorton requested testicular biopsies from affected workers in order to get a more complete diagnosis. In the Dow plant in Magnolia, permission was granted. In the Lathrop plant, the prevailing feeling was, as Moure states, "First they poison us and then they want to cut our testicles?"[100] The biopsies revealed destruction of the Sertoli cells, which are the cells that make spermatozoa. When the story of the sterilized workers hit the press, the company finally gave the union the chemical information they had requested months before, improved the ventilation system in the Ag-chem division, and suspended production. Affected workers filed third party law suits against Shell and Dow for failure to warn them about reproductive hazards.

2. Domestic production ceases

Dow halted production and sales on Aug. 11, 1977. The next day, the California Department of Food and Agriculture suspended the use and sale of DBCP and urged a recall. Later in the month, Dow and Shell announced a recall of all DBCP from users and distributors.

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[99]Letter to *Mother Jones* from Rafael-Moure, Industrial Hygienist, Oil, Chemical and Atomic Workers International Union June 26, 1979

[100]Rafael Moure, Professor of Industrial Hygeine, Department of Work Environment, University of Massachusetts Lowell, personal communication, Sept. 16, 1994

After a petition for an Emergency Temporary Standard form OCAW, OSHA acted quickly. Within three months of the discovery of the sterility problems, on September 9, 1977, the Agency issued the Emergency Temporary Standard at 10 ppb 8 hour Time Weighted Average for a full shift. The standard effectively eliminated the domestic production of DBCP because of the alledged cost of compliance with the new standard claimed by the manufacturers. In March of 1978, the standard of 1 ppb became permanent.

3. EPA Response

Meanwhile, EPA was deciding how it was going to protect the public from DBCP residues on crops, protect workers in the field i.e. mixers, loaders, applicators, farmers and farmworkers, and not harm agricultural interests. This was quite a tall order given the extremely hazardous nature of DBCP, both as a potent animal carcinogen and reproductive hazard. In fact , it is noted in the EPA's Final Position Document that "the CAG (Carcinogen Assessment Group) has determined that exposure to a single drop of DBCP could result in an increased risk of cancer on the magnitude of 6.5×10^{-4}. Accordingly, it is necessary to eliminate all possibility of human contact with DBCP."[101] The surest way to "eliminate all possibility of human contact" with this hazardous substance that is both highly volatile, i.e. easily inhaled, and readily absorbed through skin would be to withdraw the registration for all uses immediately. This did not happen.

EPA did a cost benefit analysis, weighing the effects on applicators against the costs to the farming industry. The deficiencies of this analysis are many, but a few are mentioned here. The impacts of the continued use of DBCP on the environment is never mentioned. While it is possible that the effects of the nematocide were unknown by the EPA, it is strange that an agency mandated to protect the environment neglected to research this information before approving the continued use of a known carcinogen and reproductive hazard. Further, this product, a fumigant, was designed to spread through soil. A stable poison with

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[101]Dibromochloropropane (DBCP) Final Position Document US. EPA 6 September 1978 PB80-213853 p. 56

exceptional leaching abilities should raise concerns about groundwater contamination, but apparently it did not.

The only people considered in the risk assessment are applicators. The risks to farmworkers, mixers, loaders, and people who clean up spills are calculated, but are never mentioned in any of the impact analyses. Cancer estimates for the public were done on a crop by crop basis, so there is no adequate measure of DBCP exposure for an average person who consumes an average diet i.e. someone who eats plums and grapes and broccoli and maybe even some almonds.[102] Reproductive effects to the public are ignored. Reproductive effects to applicators are mentioned, but not calculated.

In response to the sterility scandal of the chemical workers and the final document, the EPA administrator revoked the registrations for use on 19 crops in late 1977. California banned its use in the state soon after the scandal, but it continued to be used elsewhere in the country on cotton, soybeans, peaches, citrus, pineapple, nuts, lawns, golf courses, and ornamental plants.[103] Therefore, farmers, applicators, farmworkers and nursery workers working in all these industries continued to be exposed to DBCP. It wasn't until DBCP was detected in wells in the San Joaquin Valley in California that EPA took the major action of canceling almost all uses of DBCP. However, the use of the chemical in Hawaiian pineapple groves was permitted "because the pesticide does not leave a residue on them."[104] Apparently groundwater contamination and worker exposure were not issues in Hawaii. It stopped being used on pineapples in 1985; its substitute on pineapples, EDB, was later banned as well.

4. Extent of Use and Who was Affected

DBCP was applied to almost every plant one could imagine - fruits, vegetables, ornamentals, flowers, trees, home lawns, commercial turf, soybeans and cotton. In 1977, 831,000 pounds of DBCP were used in California alone.[105] Nationwide,

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[102]Ibid. p. 41

[103]Charles Petit, "US Follows State in Banning DBCP" *San Francisco Chronicle* July 20, 1979 p. 2

[104]"EPA Bans Almost All Uses of DBCP" *San Francisco Chronicle* Oct. 30, 1979 p. 6

[105]*Fourth Annual Report on Carcinogens* Dept. of Health and Human Services, National Toxiology program (NTP)85-002 1985 p. 77

in 1972, a staggering 12 million pounds were consumed in the US.[106] In 1974, 9.8 million pounds were applied to crops.[107]

Although more DBCP was applied to soybeans than any other crop, which amounted to 12,378,000 pounds per year covering over a million acres, only 2.1% of the crop was treated.[108] This contrasts sharply with peaches and nectarines, where just under 2 million pounds treated 44% of the crop.[109] DBCP was widely used on almonds, where over half the crop (54%) was treated. Forty-six percent of the pineapple crop was treated with an average of 302,000 pounds per year. Fruit crops were treated every 2 or 3 years, while soybeans, cotton, strawberries and peanuts got an annual dose.[110]

Numerous kinds of workers handled DBCP. They include: manufacturers, formulators, distributors, sales people who did demonstrations, farmers, applicators, farmworkers, and USDA extension workers who tested the product's efficacy and showed farmers how to use it. There is little information on these people.

As Glass et al. point out, the largest group of people exposed to DBCP were not the manufacturers, but the workers who mixed, loaded and applied the chemical in the field. In 1976, in California alone, several thousand independent farmers and professional pesticide applicators applied more than one million pounds (>450,000 kg) of DBCP to more than 50,000 acres (>20,000 hectares) of fields.[111] Sandifer et al. report decreasing sperm counts in order of the following

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[106]Federal Register vol. 43, No. 53 Fri. Mar. 17, 1978 p. 11514

[107]Op. Cit p. 77

[108]Dibromochloropropane (DBCP) Final Position Document US. EPA 6 September 1978 PB80-213853 p. 56

[109]Ibid.

[110]Ibid.

[111]Glass RI, Lyness RN, Mengele DC, Powell KE and Kahn E. "Sperm Count Depression in Pesticide Applicators Exposed to Dibromochloropropane" *American Journal of Epidemiology* 109;346-351, 1979

occupations: researchers and salesmen, farmers, formulators and custom applicators.[112] Decreasing sperm counts correlate with dose.

A study sponsored by the Dow Chemical Company, surveyed chemical workers in Michigan who were potentially exposed to DBCP in two plants during the years it was produced from 1957 through 1975. The abstract begins, "The agriculturally important nematocide. . ." and concludes that the study's "findings are consistent with a testicular effect of DBCP and a reversibility of that effect over time."[113]

A follow-up study done in 1986 by Eaton et al. partially contradicts Dow's study. It indicates that most men who were sterile in 1977 due to exposure to DBCP had permanent destruction of germinal epithelium and therefore continued to be sterile.[114] In his follow-up review, "DBCP: Eleven Years Later," Whorton reports a correlation between sperm count and duration of exposure.[115] Those men who were initially diagnosed as oligospermic (having few sperm) eventually recovered function. Men who were made azoospermic (spermless) by DBCP, did not recover the ability to produce sperm. DBCP permanently destroyed the germinal epithelium, the layer of cells that makes sperm.

B. Effect of the Ban on Production

DBCP was produced by Shell and Dow, and formulated in a few plants in the US. Dow plants were in Magnolia, AK, Midland, MI and Pittsburgh, CA. Shell's were in Denver, CO and Mobile, AL. Chevron, Velsicol and Occidental Chemical were formulators. The strict OSHA standard of 1 ppb was reported by *Chemical Week* to have played a large role in Dow's decision to "bow out of DBCP."[116] The article explained that there would be no incentive to resume production

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[112]Sandifer et al. "Spermatogenesis in agricultural workers exposed to dibromochloropropane (DBCP)" *Bulletin of Environmental Contamination Toxicolgy* 23 (4-5): 703-710, 1979

[113]Egnatz et al. *DBCP and Testicular Effects in Chemical Workers: An Epidemiological Survey in Midland, Michigan* Journal of Occupational Medicine, Vol. 22 No. 11 November 1980

[114]Eaton et al. "Seven-Year Follow-up of Workers Exposed to 1,2, Dibromo-3-chloropropane" *Journal of Occupational Medicine,* Vol. 28 No. 11 November 1986

[115]Whorton, Donald and Foliart, Donna "DBCP: Eleven Years Later" *Reproductive Toxicology,* Vol. 2 1988 pp. 155-161

[116]*Chemical Week* April 5, 1978 p. 18

because the expenditures required to comply with the OSHA standards would mean that "nobody could compete with foreign production."[117] Shell's inventory of 300,000 gallons of DBCP was reported and although they could legally sell the product, and the company notes it had, "received a great deal of pressure from the agricultural community" to do so but had "refrained because of concern about the health aspects."[118] Shell noted that the OSHA standard did not apply to farmers and other applicators and was concerned that those users would not protect themselves adequately. Shell said that it was considering either selling the product to professional pesticide applicators or destroying it. The company added, "It gets to be a moral question. If we err, we're going to err on the side of safety."[119]

The article continued, "Meanwhile, although manufacturers in some other countries also suspended DBCP operations, two Mexican companies have stepped up their production. Quimica Organica de Mexico (subsidiary of CYSDA, Mexico's second largest private chemical firm) and Quimica Agrosano are operating close to their 1,000-metric-tons/year capacities in Mexicali."[120] Qiumica Agrosano's general manager, Mario Cota, said that his firm was selling some of its technical grade DBCP to the US distributor, Amvac Chemical Co. in Los Angeles. "Amvac President Glenn Wintemute confirmed that his company is selling DBCP in the US and elsewhere but declined to say where its material comes from or how much the firm distributes."[121] Cota said that his firm was contemplating expanding its DBCP capacity four-fold, since Mexico was having trouble meeting the demand for the product in the US and Central America.[122] The article mentioned that OSHA officials, at the request of the Mexican government, planned to visit the plants to offer advice on health issues.[123]

The 1981 Farm Chemicals Handbook states that Devidayal Sales Private Ltd. in Bombay, India was selling DBCP, so we know that four years after the scandal,

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[117]Ibid.
[118]Ibid.
[119]Ibid.
[120]Ibid.
[121]Ibid.
[122]Ibid.
[123]Ibid.

DBCP was made in India. The Dead Sea Bromide Company in Beersheva, Israel discontinued production shortly after the health effects were publicized in the US. Occidental Petroleum's left over DBCP was sent to the Philippines.[124]

C. Effects Of The Ban On Shell and Dow

Dr. Charles Ross, from Shell's corporate office in Houston, said that DBCP was not, "a major source of profitability." It was, "to fill out the product line." At the Mobile plant, other products were made. According to Dr. Ross, it was made once every 3 months. When asked about unemployment caused by the ban, he said that there was no job loss. There were "a few contract employees to do the more manual tasks but we even were able to keep them on."[125]

Echoing Dr. Ross' thoughts on unemployment, Mike Wright, Director of Health and Safety of the union covering the Dow plants, knew of no lay-offs due to DBCP's discontinuance. He said that chemical plants are "modular and pretty flexible. They switch products all the time."[126] Multiple telephone calls to Dow were not returned, but the 1980 Dow Chemical Company 10-K report (an annual financial report to stockholders) states: "More than 1500 products and services are offered by Dow and no single one accounted for as much as 6% of the consolidated sales in 1980."[127] The report assuages worried stockholders about the potential financial effects of the DBCP affair, by stating, "DBCP is not linked to any major product group."[128] In 1979, net income was $784 million, the next year it was $805 million.[129] Unless other products were unusually lucrative, discontinuing DBCP does not seem to have had an injurious effect.

D. International Effects of the Domestic Ban

As previously stated, DBCP production continued in other countries after it ceased in the US. According to the previously mentioned article in *Chemical Week*, it quadrupled in Mexico.[130] Occidental Petroleum sold its remaining

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[124]Ben-Horn, Daniel,"The Sterility Scandal" *Mother Jones*, May 1979 p. 61
[125]Dr. Charles Ross, Shell Corporation, Houston TX, telephone interview, Aug. 8, 1994
[126]Mike Wright, UnitedSteel Workers of America, Pittsburgh, PA, telephone interview, Oct. 1994
[127]Dow Chemical Company 10-K report, 1980 p. 5
[128]Ibid. p. 6
[129]Ibid. p. 10
[130]*Chemical Week* April 5, 1978 p. 18

stock to the Philippines. The 1981 Farm Chemicals Handbook states that Devidayal Sales Private Ltd. in Bombay, India was selling the compound.

DBCP was especially valuable to banana growers. According to an official at Castle and Cooke, a giant food conglomerate and owner of the Central American banana growing operation, Standard Fruit/Dole, DBCP increased banana yields, almost instantly, by 30%.[131] To its credit, after the sterility scandal in the US in 1977, Dow wanted to destroy its remaining stock, but Castle and Cooke pressured Dow into selling its inventory, warning that refusal to sell amounted to a "breach of contract."[132] After Standard agreed to indemnify Dow against claims for injuries resulting from DBCP use, Dow resumed sales.[133] In Costa Rica, Standard Fruit continued to use DBCP for over a year after the scandal in the United States.[134] The following excerpt from *Mother Jones* reveals much about corporate decision-making.

In an internal memo dated August 16, 1977, Jack Dement, [Castle and Cooke] worried that a ban on DBCP would drastically reduce banana yields, pointed out that alternative chemicals were only 65% as effective, and emphasized that "there is no evidence that people who apply the chemical, as opposed to those who manufacture it, have been rendered sterile or have been harmed in other ways." Dement's memo concluded that Castle and Cooke would continue using DBCP until it was banned in the company's areas of operation. . . The decision to continue using DBCP in Costa Rica for 15 months after the sterility link made news in the United States came from the "highest level of the company" admits retired executive vice president Leonard Marks, Jr.. . . ."You see, DBCP was so important to us. It wasn't a cover-up, believe me, but hope springs eternal. When the DBCP disclosures began, it was like we were on a freeway, going 65 miles per hour and suddenly there was a sign, 'Detour now.' Well we didn't do that. We thought, what's going on? What shall we do?" . . . Other corporate executives involved in the DBCP saga continue to dispute evidence that it causes sterility. Clyde McBeth, one of those who helped develop DBCP for Shell, says he handled it without safety equipment and suffered no health problems.

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[131]Weir, David and Matthiessen, Constance "Will the Circle be Unbroken?" *Mother Jones* June 1989 p. 24

[132]Ibid.

[133]The Legacy, A booklet compiled by Misko, Howie and Sweeney, Dallas, Texas, 1993 p. 17

[134]Weir, David and Matthiessen, Constance, "Will the Circle be Unbroken?" *Mother Jones* June 1989

"Anyway," says McBeth, who has never been to Costa Rica or met any of *los afectados,* "from what I hear, they could use a little birth control down there."[135]

Dow made a tactical as well as moral error. Over 16,000 plaintiffs from Latin America, the Caribbean, Africa, and the Philippines are now suing Dow, Shell, Standard Fruit/Dole and Occidental Petroleum Companies.[136] DBCP was finally banned in Costa Rica in 1979, at which time Standard Fruit shipped its stocks to Honduras.[137] In 1981, Shell sold Nemagon in Africa.[138] As late as 1986, Standard was using DBCP in the Philippines.[139]

E. Effects Of The Ban On Peach Industry in Georgia

The peach crop was chosen for a closer examination of the domestic effect of the ban. Because such a large percentage of this crop (44%) was treated, it was assumed that the effects of a ban would be striking. Six members of the Peach Growers Association in Georgia were interviewed to determine the effects of the ban. They represent the largest peach farms in the Georgia: all live in Peach County. It is possible that the California peach growers had a completely different experience from their Southeastern counterparts. The information presented below was gleaned from interviews with growers, entomologists, plant pathologists, extension service employees and agricultural literature.

Many changes in farming have occurred since 1979 and it is difficult to establish causal links between any particular change or trend and a specific event, such as the loss of a pesticide. The context of this case is one in which farmland was already being consolidated for decades. Farms are fewer and larger. According to one grower, in the 1950s, there were about 30 large growers in Peach County, Georgia. Now, about the same acreage forms six farms.[140] The consensus among all the farmers is that farming is getting more difficult, more expensive and

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[135]Ibid.

[136]The Legacy, Op. Cit. p. 5 Plaintiffs are from Costa Rica (8,069), Equador (57), Guatemala (497), Honduras (2,604), Nicaragua (195), Panama (78), Domenica (91), St. Lucia (264), St. Vincent (17), Burkina Faso (94), Ivory Coast (664), and Philippines (3,768).

[137]The Legacy, op. cit.

[138]Ibid. p. 24

[139]Ibid. p. 23

[140]Bill McGhee of Big Six Farm, Fort Valley, Georgia, interview, Nov. 13, 1994

riskier and that the loss of DBCP represents the loss of one more item in their arsenal.

To understand why DBCP was valuable, one must learn about Peach Tree Short Life or PTSL. PTSL is a disease that kills peach trees suddenly. It is a problem in the Southeastern United States, where an average of 3% of trees die annually. In 1985, this represented 300,000 trees in Southeastern United States and $20 million in lifetime loss each year.[141] Lifetime loss is value of the lost yield due to a tree's premature death, much like a person's loss in expected earnings in case of untimely death. Severe losses occurred in 1962 (300,000 trees in Georgia alone), 1973 (500,000 trees in the Southeast)[142], and 1984 (100,000 trees in Georgia,[143] 500,000 trees in the Southeast).[144] Several factors, particularly when they occur together, predispose trees to PTSL. Extreme fluctuations in winter temperatures, pH of the soil, site (for unknown reasons, PTSL is more common in sites that have had previous plantings of peaches) and nematodes are a few of these factors. "Recent work has shown that the ring nematode is a key factor in PTSL."[145] Nematode infestations weaken the trees and make them vulnerable to the ultimate cause of death, bacterial canker. The action of nematodes sucking on peach tree roots was likened to hogs lined up at a trough.[146]

One of the ways growers decrease their risk of PTSL is to fumigate the soil before trees are planted to kill all the nematodes. DBCP was valuable because, at the time of the ban, it was the only fumigant that could be used after the trees were planted. All the other fumigants, if used postplant, killed the trees. DBCP could be used both preplant and postplant. It was used every two years and it was cheap. Andy Nyczepir, a nematologist with the extension service in Byron,

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[141]Okie, WR, Reilly, CC, Nyczepir, AP USDA-ARS SE. Fruit and Tree Nut Research Laboratory, Byron, Georgia "Peach Tree Short Life - Effects of Pathogens and Cultural Practices on Tree Physiology" in the proceedings of the International Conference on Peach Growing, Verona, Italy July 9-13, 1984 pp. 503-506 and Acta Horticulturae 173,1985

[142]Ibid. p. 503

[143]Ibid. p. 509

[144]Ibid. p. 503

[145]Ibid. p. 504

[146] Professor R. W. Miller, Extension Plant Pathologist, Clemson University, S. Carolina, telephone interview, Sept. 1994 He ran demonstration trials of DBCP with growers in the 1960s and 70s.

Georgia remarked that, "after growers lost the chemical, they were frantic."[147] In an article in *Fruit South*: "Effective Postplant Nematicide for Peach Trees 'Nonexistent'," strategic options for growers were outlined.[148] The author points out that all the available preplant nematicides - ethylene dibromide (EDB), 1,3 dichloropropenes (D-D, Telone) oxamyl (Vydate), phenamiphos (Nemacur), methyl bromide, Zinophos, isothiocyantes and chloropicrin - will not control PTSL, peach decline, bacterial canker nor maintain productivity of peach trees. He then reviews the current research and stresses the need for short-term chemical control and long-term biological and cultural control strategies.

It is important to note here that DBCP affected tree health, not fruit health. Therefore, in contrast to Alar, fruit management did not change. Fruit harvesting and storage were unaffected by the ban.

In response to the ban, growers concentrate on the other factors to control PTSL. They lime the soil to prevent it from becoming too acidic. Site selection has become extremely important, and good sites have a number of requirements. "Freedom from frost is the primary consideration for site selection," according to plant pathologist Miller.[149] The higher up one goes, the more vulnerable the trees are to frost. On the other hand, they must have some elevation so that cold air "has someplace to drain."[150] Elevation is important for water drainage, too, so the trees don't get "wet feet."[151] In addition to proper elevation, growers look for sites that haven't had peaches on them, because of the penchant that nematodes have for land that's been "peached." As grower Billy Davidson points out, "Once, the supply of virgin land was plentiful, and now it's not."[152] Butch Feree, of the USDA extension service in Byron, Georgia, says that "the strategy has gone from killing the nematode to finding land that's not infected" and this

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[147] Andy Nyczepir, telephone interview, September, 1994

[148] Miller, RW "Effective Postplant Nematicide for Peach Trees 'Nonexistent'" *Fruit South* Jan. 1981 Vol. 5, No. 2, pp. 12-15

[149] Professor R. W. Miller, Extension Plant Pathologist, Clemson University, S. Carolina. telephone interview, Sept. 1994 He ran demonstration trials of DBCP with growers in the 1960s and 70s.

[150] Bill McGhee of Big Six Farm, Fort Valley, Georgia, interview, Nov. 13, 1994

[151] Mark Collier, USDA Extension Service, Fort Valley, Georgia, telephone interview, Aug. 8, 1994

[152] Billy Davidson, Miami Valley Farm, Fort Valley, Georgia, interview, Nov. 13, 1994

quest for "clean dirt" has "changed the way of doing business. You have friends competing for the same land."[153]

Peach growers have responded to the removal of the postplant nematicide in a number of ways. Some rent land that's "clean" to grow peaches and lease some of their land to farmers who grow other crops (e.g. soybeans, peanuts or cotton). Others grow pecans, which are not bothered by nematodes, but pecan trees take a few years to mature, and therefore are not income producing for some time. Some farmers grow row crops, like sorghum or stacey wheat, for a year or two to clean the land so that an orchard can then be planted. Coastal bermuda and bahia grasses also clean up the land. Peanuts are a desirable row crop, but in Georgia, not everyone can grow this crop: one must pay for a peanut allotment, and growers don't want another expense.

All this swapping of land and quest for clean land has spread out each farm. Instead of the farm being together in one location, some acreage is close and some may be five or ten or twenty miles down the road. Management is difficult. "The bigger you get, the less control you have over things. Waste is great."[154] Spreading out is also expensive. As Bill McGhee explained, costs are incurred when you have four sites instead of one because you need more managers, you need to dig more wells, you have four storehouses of chemicals instead of one, you have multiple loading stations, and you have hauling costs. Maintenance of equipment costs more because you have to travel farther to get to the site. Peaches are "jealous," meaning they require attention and visual inspection at many stages - thinning, pruning and picking. McGhee said that "that look is not easy to learn," so those with skilled eyes must travel to the different sites.

According to growers, the only advantage that spreading out has it that has decreased a crop's vulnerability to "single site acts of God."[155] As Bill McGhee explained, hail storms are not uncommon in June. They come from tightly knit clouds, which tend to be 1/4 of a mile or less across, so to have one's orchards

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[153] Butch Feree, USDA Extension Service, Byron Georgia, telephone interview, Aug. 10, 1994

[154] Chop Evans, owner of Evans Farm, Fort Valley, Georgia, interview, Nov. 13, 1994

[155] Bill McGhee, co-owner of Big Six Farm, Fort Valley,Georgia, interview, Nov. 13, 1994

spread over a distance is advantageous. Ecologically, it's better to have small areas of different crops rather than huge stretches of a monoculture because crops are less vulnerable to pests and the land is at least punctuated by unfarmed areas.

1. Effect Of The Ban On Yields

USDA statistics of peach yields for the state of Georgia are difficult to interpret. (see appendix) A simple T-test of average annual crop yields a decade before and a decade after the ban indicates that the difference pre- and post-1977 is not statistically significant. However, the post-ban average is lower (145.2 vs. 118 mil. lbs.). Counts of the numbers of bearing trees began in 1978, so it may be that more trees have died of PTSL. Yet, according to Chop Evans, individual trees are bearing more peaches than ever, so numbers of trees don't directly reflect yields.[156] From 1940-1977, yields fluctuate widely, while after 1977, they are much more consistent. Chop Evens suggested that in the 1970's all the "hobby farmers" got out of the business and only the serious ones remained, hence more consistency.

2. Nematode control after the Ban

Telone II (dichloropropene), a chemical relative of DBCP, has been the most popular substitute preplant nematocide, mainly because it costs $275 per acre, which is considered inexpensive.[157] It's toxicity class is II, and it has a relatively low LD50 for rats of 224 mg/kg.[158] It is an irritant and now under consideration for banning. For a while, a post plant nematocide called Nemacur (Fenamiphos) was used, but it was expensive ($400 per acre in spring *and* fall for the life of the orchard) and there was not consensus about its success. It is very toxic acutely, with a toxicity class of I and an LD50 of only 3 mg/kg.[159] Ethylene Dibromide, which was banned, was used preplant.

The failure and/or economic impracticality of chemical controls, as well as the uncertainty about their continued availability, spurred the Extension Service and

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[156]Chop Evans, owner of Evans Farm, Fort Valley Georgia, telephone interview, Feb. 22, 1995

[157]Andy Nyczepir, Extension Service nematologist, Byron, Georgia, telephone interview, Oct. 26, 1994

[158]*The Farm Chemicals Handbook*, Meister Publishing Co. Willoughby, Ohio, 1994

[159]Ibid.

Experiment Stations to research non chemical ways to control nematodes - biological controls and nematode resistant rootstocks. Andy Nyczepir says that a wheat sorghum rotation is as good as preplant Methyl Bromide and is much cheaper than the $1400 per acre that the chemical costs. The Nemaguard rootstock, a nematode resistant peach rootstock, has been used for the past few years with mixed results. Although it is resistant to the rootknot nematode, the main pest culprit in PTSL, it is more susceptible to ring nematode, a secondary threat, and to cold injury.[160] A number of extension service employees mentioned a new rootstock, currently named BY-520-9 as "the big light on the horizon."[161]

For six years, Chop Evans has successfully controlled nematodes by planting stacey wheat between his peach trees.[162] This practice was suggested by Andy Nyczepir from the USDA extension service. When asked about the loss of DBCP, Chop Evans said, "Most of the growers cry that they can't live without it, that it's going to kill them, but I say no big deal, we'll find something else, some other way."[163]

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[160]Dean Everett, Assoc. Prof. Fruit Trees, Tifton Georgia, telephone interview, Oct. 25, 1994

[161]Eldon Zehr, Extension Service Fruit Tree specialist, Clemson University, S. Carolina, telephone interview, Oct. 25, 1994

[162]Chop Evans, owner of Evans Farm, Fort Valley, Georgia, interview, Nov. 13, 1994

[163]Chop Evans, telephone interview, Nov. 2, 1994

IV. ANALYSIS

This study was initiated to investigate the unintended consequences of bans, particularly for workers. One of the objectives was to examine the ripple effects of removing a chemical from the web of production and use. The effects on labor are likely to be ignored not only because of power relations but because at present, there is no accepted systematic way to assess effects in a workplace. The other objective was to develop the equivalent of an environmental impact analysis for the work environment in order to begin to assess the effects of consequences of a process change, of which bans are an extreme example, or any other kind of change in a workplace. Other objectives were to analyze the impact of pesticide bans on the industry, the public health and the environment.

Before delving into the lessons to be gleaned from the case studies, a comment about the methodology is necessary. The case study method is very time-consuming and yields rich information. The main limitation is the difficulty of access to information. "Confidential" corporate information is the first obstacle. Obtaining production and sales information from companies was nearly impossible, although some information is available through newspapers, trade journals and industry publications. Consistency of information from interviews and published sources was the most important factor in determining quality data. Any inconsistencies were followed for possible explanations; none were discarded and all were reported.

The key findings of the Alar and DBCP case studies are presented in the table below. Note that some of the conclusions are general but they are drawn from the cases of Alar in the New England apple industry and DBCP in the Georgia peach industry.

TABLE 4

SUMMARY OF CASE STUDY FINDINGS

	ALAR	DBCP
What prompted ban	food safety concern	well water contamination
Pre-market testing	unclear, not public	yes, results not public* until six years later
Purpose	facilitate harvest	kill nematodes. Save peach trees from disease (PTSL)
Intended consequences of ban	remove from food supply	OSHA's standard removed haz. from chem. workers. then EPA ban was for public safety
Unintended consequences of ban	more insecticides, more hectic harvest, fewer MacIntosh apples	production shifted abroad, use continued until EPA ban, so farmworkers' exposure continued, then workers abroad exposed. Nonchemical nematode controls (rootstock, grasses) in peach industry
Effectiveness of ban	not used in food, but still produced and used on ornamentals	use continued until EPA ban so farmworkers not protec'd. Ban spurred prod. abroad, foreign workers exposed, as use continued
When were users informed of toxicity?	data accumulated in '70s, '80s, users informed by media in mid '80s	25 yrs. after toxicity known to companies
Availability of "drop-in" substitutes	no	no post-plant fumigants available
Ban's effect on chem. manufacturers	minimal	minimal
Ban's effect on chem. workers	none	no longer exposed in US, much international exposure
Ban's effect on farmers	more hectic harvest, more lost to "drop", diversification of apple varieties	spread out orchards, using nonchem. nematode controls
Ban's effect on farmworkers	increased exposure to insecticides, more hectic harvest	no longer exposed in US, much international exposure
Ban's effect on public health	increased exposure to insecticides on apples	decreased exposure to nematocides on peaches

*"public" here means "in the public domain" and not "publicized"

B. Alar

Each of the case studies had important lessons to teach. Banning, or rather, the withdrawal of the registration for Alar, had several unintended consequences. From the Toxics Use Reduction perspective, the ban's success is questionable. Although Alar is no longer used on food crops in the United States, daminozide production has not decreased since 1989. Consumers are no longer ingesting daminozide, farmers and pesticide applicators in orchards no longer use it; but manufacturers and greenhouse workers continue to be exposed. Consumers and all orchard workers are being exposed to more insecticides.

It is important to recognize that one of the driving forces for farm practice is the desire for red apples. If consumers didn't require red apples, that is, if growers didn't get more money for redder apples, things would be different. Alar would not have been so valuable and now, there wouldn't be the incentive to leave the apples on the trees until the last, reddest, pre-drop moment. With no premium on redness, apples could be picked slightly earlier. Pickers would not have to worry so much about knocking apples off the trees, growers would not be as concerned about loss to drop, and apples would bruise less and store better.

Alar served two functions other than just as an apple reddener. First, it allowed growers and apple orchard workers a less hurried harvest; the intensity of work in the orchard has increased without Alar because of both the more frantic harvests and the raised anxiety levels about bruising the fruit and "drop." Although it has not been documented, it is not unreasonable to speculate that haste and stress and increased trips up and down ladders cause injuries. Second, Alar was a component of a program to minimize pesticide use on apples. This piece of the story was never made public and did not influence the regulatory process. Because of the loss of this Integrated Pest Management tool, growers are using more insecticides and consumers may be eating more insecticides without Alar.

However useful Alar was, the lack of knowledge about the human health effects of Alar is conspicuous. That companies are allowed to manufacture substances without proving their harmlessness certainly violates the public health

precautionary principle. That EPA and OSHA don't require this information even when a chemical comes under scrutiny is worrisome.

The Alar case study points to the hazards of our chemically dependent system of agriculture. It illustrates the need for Toxics Use Reduction in agriculture, because replacing a carcinogen in the food supply with neurotoxins is not progress.

This case study is also a critique of regulatory process in which not all voices can be heard. Agriculture is complicated and pointing a finger at one chemical falsely simplifies things. An apple grower particularly concerned about environmental issues, Stephen Wood said, "We should be thinking about what sorts of incentives produce what kinds of behavior. If you're asking if this apple was grown with captan, then you're asking the wrong question. If you're asking if this apple was grown organically then you're asking the wrong question because organic pesticides are made in smoky factories and transported on barges just like everything else. The real question is 'how do you grow food gently?' And that's complicated."[164]

C. DBCP

The DBCP case study is a cautionary tale about relying on industry for information about its products. The default practice of depending on the regulated industries to supply data is unwise and dangerous. Further, just because information is in the literature (recall the 1961 Torkelson article in *Toxicology and Applied Pharmacology*) does not mean it reaches anyone who needs to see it: the manufacturers, the regulators, the extension service or users. One wonders what other chemicals are in production, that either have not been thoroughly tested, or whose toxicological profiles are neither publicized nor even in the public domain. This case points to the need for effective pre-market testing of chemicals, by an independent agency, that would allow the general public access to the results. The DBCP scandal prompted California's OSHA and the state health department to create a program called the Health Evaluation System

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[164]Stephen Wood, telephone interview, New Hampshire Apple Grower, President of New England Fruit Growers' Council on the Environment Jan. 29, 1995

and Information Service (HESIS).[165] Its purpose is to serve as an early warning system by scanning the scientific literature about chemical hazards, translating the information into the vernacular, and informing workers, employers and other people who need to know. Other states have followed suit. New Jersey's Hazard Information materials are excellent, but many states still rely on manufacturer's Material Safety Data Sheets.

The DBCP case galvanized union actions to demand Right-to Know regulation for the work environment. OCAW initiated a nationwide campaign for Federal Right-to-Know legislation using the DBCP story as an example of the unfairness of keeping the workers ignorant about the health effects of chemicals in the workplace.[166] The campaign included the systematic requesting from chemical companies of all data on workers' exposures and health effects of the chemicals. If the requests were denied, companies were accused of unfair labor practices under the National Labor Relations Act. After two successful test cases (3M and Colgate Palmolive), a legal and moral basis was created for the passage of the OSHA Right-to-Know law in early 1980.[167]

One also learns that regulatory decisions made in the US have ripple effects beyond our borders. OSHA's virtual prohibition of the manufacture of DBCP was not accompanied by an EPA prohibition of use for almost three years (and six years for pineapples.) Other countries, such as Mexico, were thereby spurred to increase production. Even after use stopped in the US, DBCP continued to be used for almost a decade in other parts of the world, with devastating effects. The DBCP case underlines the need for globalization of strict health and safety standards, and the need to regulate transnational corporate conduct. The enforcement of global standards is a complex problem and well beyond the scope of this work. Yet, a substantial positive impact could be made if American companies were not permitted to export banned substances.

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[165] Prof. Rafael Moure, Department of Work Environment, University of Massachusetts, Lowell, former industrial hygienist with Oil, Chemical and Atomic Workers Union during the DBCP incident, personal communication, Mar. 24, 1995
[166] Rafael Moure, personal communication, April 12, 1995
[167] Ibid.

D. The Case Studies

Both Alar and DBCP are case studies about information and power. In the case of DBCP, if the balance of power were different, and companies were required to test their products and make full disclosure to workers, users and the public about the results, then thousands of men, both here and abroad, would not have been sterilized and numerous cancers would not have been induced.

The Alar case is more complex. A small group of small farmers, as well as a few extension agents, had information about Alar's role in an Integrated Pest Management Program that they could not inject into the political process. With the help of a public relations firm and the media, Natural Resources Defense Council along with other environmental groups, were powerful enough to publicize their message, "Alar is a carcinogen, it should be banned." They are to be lauded for using the media as successfully as industry has for years, yet their notion of victory was narrowly defined, and ultimately was harmful to those they were, with good intentions, trying to protect. It seems as though Uniroyal was not very invested in Alar since it was such a minuscule percentage of its sales. It is puzzling why no one at EPA paid any attention to Alar's role in reducing pesticide use. Possibly, bans assure the public that the government is doing its job to protect it, and that this particular assurance cost EPA very little, because it cost Uniroyal so little. Nevertheless, this ban gave only an illusion of safety because banning Alar resulted in the increased use of pesticides.

Both bans follow a familiar history consistent with the pattern described in The Toxic Use Reduction Institute's Chemical Management Report.[168] A chemical is used for some years, scientific evidence surfaces of its adverse effects, there is a public outcry, then it is banned. Public outrage seems to be a prerequisite for banning. There are numerous industrial chemicals whose adverse effects are obvious, (and have been for years) and yet are still in use because there is no outrage to prompt governmental action. Alar was under EPA review for years before the NRDC goaded the system and induced Uniroyal to withdraw the registration. DBCP's use was not banned after the sterility scandal; apparently not enough public outrage was generated by a carcinogenic substance that sterilized

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[168]Rossi, Mark and Geiser, Ken, *Toxic Chemical Management in Massachusetts: An Analysis of Further Chemical Restriction Policies.* The Massachusetts Toxics Use Reduction Institute, University of Massachusetts at Lowell, 1993

chemical workers. EPA withdrew the registration only after it was found in well water and threatened the public.

This patchwork, ad hoc system of removing harmful chemicals is unsatisfactory for a number of reasons. First of all, it takes a lot of time. While scientific evidence of harmful effects is slowly accumulating in the public domain, people are being damaged. Then citizens and their organizations need to mobilize to induce governmental or consumer action. Harm continues. Also, this method of chemical regulation requires mobilization for each new chemical. There is insufficient structure to insure that the chemicals in commerce are safe. For pesticides, because they are meant to be lethal to living creatures, insuring safe manufacturing and use conditions is particularly unlikely.

E. The Role Of the USDA Extension Service

The case studies show that the bans prompted Agricultural Extension Service staff to research non-chemical solutions to the problems that the agrochemicals had previously solved. This was especially obvious in the case of DBCP, where researchers are investigating nematode-resistant peach tree rootstocks and advocating the planting of grasses that nematodes find repellent. This line of research may have been spurred by a fear of dependency on an agrochemical that may be taken away, or by a desire to reduce chemical use for ecology's sake, or perhaps by a combination of the two. What is clear is that extension research is moving towards less chemically-intensive farming methods.

In order to continue towards sustainable agriculture, it is important to understand how farmers and extension staff perceive chemicals. The majority of those interviewed view chemicals just as we view sharp cutlery - very useful tools that must be used with care. When peach grower Billy Davidson was told that 1500 Costa Rican banana workers were sterilized as a result of DBCP exposure, he asked how it was used. The implication was that if it were used correctly, it would not cause harm. None of the peach farmers knew why it was banned and one said it was banned "for no good reason." It is troubling that farmers know so little about the health and environmental effects of the chemicals they use. Most would prefer not to use chemicals because they are expensive and because they never know when the government will take one away. Their dependence is uncomfortable. However, if they were better

informed, they might be even more inclined to reduce their use of agrochemicals.

Implications For A Work Environment Impact Assessment

One of the goals of this work is to develop a methodology to assess the ripple effects of process changes, focusing on the work environment, that would be analogous to the Environmental Impact Assessment (EIA). Typical EIAs describe the proposed project, and then discuss the repercussions of the man-made choices, like damming a river or building a highway, on various pertinent environmental domains such as soil, air, water and biota. For example, in a proposal for a building a dam, the effects of sedimentation rates, transportation and traffic patterns, and noise, on air quality and river biota would analyzed. Each project presents unique potential assaults, and sometimes improvements, to the environment. Yet there is consensus that project's effect on air, water, soil, and ecology must be considered. Work environments deserve no less consideration than the environment at large.

The case studies highlight aspects of the workplace and the environment at large that need to be considered when a ban or process change is proposed. Just as the goal of the EIA is to factor in the quality of the environment in a proposed project, the goal of the WEIA is to integrate the health and well-being of the workers in decision-making. A general outline for a Work Environment Impact Assessment is presented below.

Work Environment Impact Assessment of a ban, phase-out or process change

I. The function of the chemical

- A. As advertised (the purpose)
- B. As revealed (the function)

II. Available substitutes or alternatives

- A. Chemical ("drop-in" or other)
- B. Process changes
- C. Other

III. Health Effects for Workers of Substitutes and Alternatives

- A. Chemical effects of substitutes on health - carcinogenic, mutagenic, teratogenic, reproductive, neurotoxic, respiratory, renal, cardiac, hepatic, dermal, etc.
- B. Effects of process change
  1. Physical hazards - heat, noise, vibration, etc.
  2. Ergonomic hazards - lifting, repetitive motion, awkward posture
  3. Psychosocial hazards - stress, limits on social interaction
  4. Other

IV. Other ripple effects

- A. Employment
  1. Staffing requirements
  2. Skill requirements (stimulating or "stupidifying")
- B. Community effects/public health effects
- C. International effects/export of hazards
- D. other

The function of the chemical. Anthropologists make a useful distinction between purpose and function that is often blurred in the normal course of life. For example, the purpose of a rain dance is to make rain, while the function is to gather the community, to affirm common goals, to have fun, etc. This distinction is pertinent to the Alar story because Alar's purpose was to prevent apples from dropping off the trees. It was not developed or marketed to allow trees to be more tolerant of mite infestations, although the loss of this function subsequent to the ban turns out to be consequential. Workers and consumers are now being exposed to more insecticides. Therefore, *all* the functions of a chemical must be considered in order to fully grasp the impact of a ban. Only by knowing all the functions of a chemical or process or technology can one think systematically and creatively about alternatives. As we have seen, the only way to know all the functions is to ask those people who are intimately involved with the process.

Availability of Substitutes and Alternatives. Environmental Scientist James Goldstein points out that in Environmental Impact Assessments of proposed highway or incinerator projects, alternatives are usually given short shrift, because the writers of the proposal are proponents of the project.[169] Similarly, when EPA and USDA consider the impact of a ban, the claim that there are no chemical alternatives is often used to justify the continued use of a hazardous chemical or some other form of inaction. To seek only "drop-in" substitutes is myopic. Alternative technologies need to be considered and exactly what needs to be accomplished should be examined. For example, in the case of DBCP, coastal bermuda grass is aversive to nematodes. One doesn't need to kill nematodes; one needs to keep the nematodes away from the peach trees.

Health Effects of Substitutes and Alternatives - Chemical Effects. Knowledge of health and environmental effects of chemicals is necessary in order to make wise decisions. We have seen the difficulty of access to such information and the dire consequences of that inaccessibility. Rigorous pre-market testing by an independent agency would be ideal. Short of that, dissemination of available information, in an understandable form, to users is required.

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[169]James Goldstein, Tellus Institute, Boston, MA. telephone interview, April 5, 1995

Health effects of process change - Ergonomic and Psychosocial hazards. The Alar story clearly shows how the loss of an agrochemical adversely affected the pace of work in the orchard. It also influenced the structure of work, i.e. work organization. Level of supervision, flexibility, control, and pace of work all effect stress levels. And, of course, the exact tasks required (moving heavy ladders) and concomitant physical exposures influence health.

Community and Public Health Effects. The loss of Alar had public health effects in that more insecticides are used on apples. Community level effects could be the result of other kinds of changes. For example, changes in technology that cause unemployment influence the whole community.

International effects. The DBCP case points to the limitations of US regulatory policy, because even after it was banned domestically, it continued to be used, and to cause harm, abroad.

Of course, the cases did not illustrate all the possible impacts of bans or process changes. The Work Environment Impact Assessment outline can serve as a guide to raise the work environment to the status of the external environment in policy decisions by calling possible effects into awareness.

Fortlage, in her book, *Environmental Assessment, A Practical Guide,* points out that "Environmental Assessment is a discipline which has arisen from man's lack of self-discipline. Before man possessed the power to destroy his environment it was unnecessary to protect the planet from his interference..."[170] One could say that the notion of a Work Environment Impact Assessment arose from man's lack of consideration, in both senses of the word. The DBCP story illustrates man's thoughtlessness about workers, while the Alar story shows the dangers of not considering the views and information of all stakeholders.

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[170]Fortlage, CA *Environmental Assessment; A Practical Guide* Gower Publishing Co. Hants, England 1990 p. xi

V. CONCLUSIONS

This study has revealed two important aspects of bans: their efficacy and their political nature. Regulating hazardous chemicals by banning them one at a time is of limited efficacy. First, we rarely see a complete ban, that is, a case in which both production and all uses are forbidden. Alar was banned for food uses, but daminozide production continues. Even after DBCP's reproductive and carcinogenic effects became known, its use, and therefore exposure, was permitted for years in this country.

These bans had minimal impact on chemical companies. Because the companies are so well diversified, the loss of one product has negligible financial and unemployment impact. For farmers, bans threaten to remove tools upon which they have become dependent. Their fear has spurred the extension service to focus on non-chemical solutions to farming problems, which may have a cumulative, beneficial effect in the long run.

Mainly, bans reassure the public that the government is doing its job to protect it. NRDC's Janet Hathaway referred to the banning of Alar having a "palliative effect."[171] She called the tremendous effort surrounding Alar "disappointing" because she, and many others, had hoped that people would view the problem of pesticides in food more seriously and that there would be a revolution of sorts. Instead, Alar was banned and life (except for apple growers and workers) returned to normal. The DBCP case certainly spurred Right to Know legislation and other efforts to disseminate hazard information to workers, but it did not alter corporate or public opinion about our system of production or specifically, a chemically dependent system of agriculture.

The reason that the bans had so little impact is that the problem was too narrowly defined. The definition of a problem shapes the solution and definitions occur in a socio-political context. Current chemical regulation defines the problem as a specific chemical. Since the "problem" was the specific

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[171]Janet Hathaway, Natural Resources Defense Council, telephone interview, March 28, 1995

chemical, the solution was to remove it. Our chemical regulation policy focuses on individual chemicals, one at a time, rather than on a system of production that requires toxics, and in the case of pesticides, on an industry whose product is required to be toxic. In neither of the cases was the agriculture system addressed; the web was ignored. In both cases, the chemical was "fetishized," that is, it was imbued with a value, that it did not inherently possess. Chemical companies present the subject agrochemical positively, as a "yield fetish." Environmentalists, discovering negative aspects, of a chemical, demonize it. The danger of fetishizing chemicals is that attention is paid to the individual chemical rather than to the whole system, which is only slightly perturbed when one chemical is removed. Structurally, nothing changes.

The need for systematic planning, rather than our current fragmented approach to agriculture, the environment, food safety and worker safety is clear. Pesticide regulation need not be covered by four different agencies, each myopically tending to its own domain. Many of the deficiencies in pesticide regulation can be traced to this myopia, but curing it is beyond the scope of this work. Presently, the burden of getting rid of individual harmful chemicals has been shifted from government to less powerful groups, with unsatisfactory results. An "ecologically informed" citizenry, with an awareness of the web of chemical use and production, would permit a more sophisticated critique of the chemical industry because the weakness of the fetish would be revealed.

A broader view of chemical use and regulation is necessary. One tool to expand the vision of policy makers is the Work Environment Impact Assessment. The impact on workers of any process change would not be ignored. Given that there are numerous agencies involved in pesticide regulation, this tool would provide a common language. In the pesticide domain, there would be positive ripple effects. First, domestic workers would be protected from the kind of inadequate legislation that prohibited DBCP' s manufacture while permitting its use, which was unacceptable because farmers and farmworkers were still being exposed. Second, this tool would prod the already changing orientation of the extension service towards sustainable agriculture. And lastly, a long-standing source of conflict between labor and environmentalists is labor's belief in environmentalists' indifference to its concerns. The use of WEIA could reconcile

some of these differences because labor would be reassured that there would at least be some attention paid to the employment and health effects of a given proposal. Stronger links could be formed between labor and environmentalists, which would benefit us all.