

An aerial photograph of a vast green agricultural field. A tractor with a long spray boom is moving across the field, releasing a fine mist of pesticides. The rows of crops are clearly visible, and the overall scene is dominated by the vibrant green color of the vegetation.

The Pesticide Report

Inaction Speaks Louder Than Words:
The Minnesota Department of Agriculture's Failure to
Protect Minnesota From Pesticide Contamination

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Minnesota Center for Environmental Advocacy

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Inaction Speaks Louder Than Words is also available electronically at www.mncenter.org.

The Minnesota Center for Environmental Advocacy (MCEA) is a nonprofit organization using law, science and research to protect Minnesota's natural resources, wildlife and health of its people.

Since our founding in 1974, we have advocated sound environmental policies providing positive, long-term solutions to the most critical environmental issues facing Minnesota.

At the heart of our mission is a reverence for nature and a fundamental commitment to sustain and enhance environmental quality for the benefit of future generations.

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EXECUTIVE SUMMARY

KEY FINDINGS AND RECOMMENDATIONS

Introduction

This report is the culmination of more than two years of investigation by the Minnesota Center for Environmental Advocacy (MCEA) to assess the environmental and health impacts of pesticide use in Minnesota and the efficacy of state programs to reduce and limit those impacts.

Two primary findings emerged:

- A growing body of scientific research is investigating the health risks of exposure to low levels of pesticides, which are ubiquitous in Minnesota. While there is no scientific consensus on this issue, the size of the population exposed and the seriousness of many of the potential health effects are cause for concern.
- The Minnesota Department of Agriculture (MDA) has failed to effectively carry out its statutory duties to collect pesticide use information, to monitor the extent of pesticide contamination of Minnesota's water resources, and to take action to reduce contamination when it is detected. MDA has further failed to effectively provide leadership in developing the state's programs fostering non-chemical pest management methods.

MCEA hopes that this report serves as a catalyst for change. We will use it to educate the public and to alert the Legislature to the need for increased funding and oversight to insure that the goals of the Minnesota Groundwater Protection Act and other laws passed more than a decade ago are realized. We hope that the report will spur the MDA to take the leadership role envisioned in that legislation and become a good steward of Minnesota's environment and a staunch protector of the health of its citizens.

Pesticide Contamination In Minnesota

Pesticides Are Widespread

Pesticides are in our air, our water, on our foods, and in our bodies. Sixty-one percent of samples of fresh and frozen fruits and vegetables tested by the federal government in 1998 contained pesticide residues, including 94 percent of pears, 62 percent of tomatoes, 85 percent of canned spinach, and 63 percent of apple juice. A recent study by the Minnesota Department of Health found residues of the insecticide chlorpyrifos in the urine of almost all the Minnesota children tested, and residues of the herbicide 2,4-D in more than half. About a dozen pesticides, many of them corn herbicides, are detected routinely in Minnesota's groundwater and surface waters in all parts of the state, including urban areas.

One of the most important facts MCEA uncovered in its research is the high degree of uncertainty among scientists regarding the health effects of exposure to low levels of pesticides, such as the levels routinely found in Minnesota rivers and groundwater and as residues on more than half the foods sampled by the U.S. Department of Agriculture. This issue is important because MCEA's analysis found that millions of pounds of pesticides sold in Minnesota have been identified by government agencies as known or probable carcinogens, reproductive toxins, or known or suspected endocrine disruptors. Many of these pesticides are also toxic to fish and other wildlife.

Of the 33 million pounds of pesticide active ingredients sold to Minnesota's agricultural sector in 1998, more than seven million pounds have been identified by the federal Environmental Protection Agency (EPA) as known or probable carcinogens. Some 3.4 million pounds have been identified as causing reproductive problems, such as birth defects and infertility; nearly 12 million pounds have been identified as

potential endocrine disruptors, chemicals which can irreversibly harm the developing fetus's brain, nervous, immune, and reproductive systems at extremely low levels of concentration.

Pesticides pose risks to Minnesota's wildlife as well, both through direct exposure and their impact on food sources and habitat. Over 11 million pounds of pesticide active ingredients sold in Minnesota are toxic to fish, and 6.3 million pounds are toxic to aquatic invertebrates, important food sources for fish and wildfowl. Two million pounds are toxic to mammals, 1 million pounds to birds, and 700,000 pounds to bees.

The question is: At what level of exposure are adverse effects produced?

While Health Effects Of Exposure At Low Concentrations Are Uncertain, There Is Cause For Concern

There is no question that exposure to high concentrations of pesticides harms human health, as we know from the thousands of pesticide poisonings reported annually. Similarly, animal testing conducted by the EPA provides evidence that high concentration exposures can lead to cancer, reproductive system abnormalities, and other serious health impacts. The information regarding impacts at low concentrations is less certain, partly because they have not been adequately studied.

In Animals, Endocrine Disruptors Can Harm The Embryo Or Fetus At Very Low Concentrations

While there is much less certainty as to low concentrations, disturbing evidence from wildlife studies indicates that endocrine disruptors, including many pesticides, can produce serious effects **at very low concentrations**, well below levels at which federal pesticide standards are set. Those at greatest risk from exposure to these substances are the most vulnerable: embryos and fetuses whose developing bodies are more susceptible to harm from toxic chemicals because they are less able to detoxify them. Scientists agree that animals exposed to these chemicals at certain critical points during gestation can suffer permanent alteration of the structure and operation of the brain, and the nervous, reproductive, and immune systems.

"There is evidence that pesticides have indirect, sublethal, and very subtle impacts that impair the ability of wildlife to eat, survive and reproduce. And what the population implications are, no one really knows." – *Dr. Mary G. Henry, Deputy Chief, Division of Environmental Quality, U.S. Fish and Wildlife Service*

The Effects Of Low Concentrations On Humans Is Uncertain

Although the human endocrine system is very similar to that of animals, there is as yet no consensus as to whether similar mechanisms are at work in humans. We know that many of the kinds of effects such chemicals may produce – such as testicular cancer and other reproductive abnormalities, and learning and behavioral disabilities – are growing. Chemical tests to screen substances to determine if they have endocrine disrupting properties are still being developed. In short, there is currently no scientific consensus on this issue, and it is doubtful that one will be reached through further study soon.

Some epidemiological studies have found statistically significant links between pesticide exposure and stillbirths and spontaneous abortions; birth defects; various childhood and adult cancers; Parkinson's disease; and impaired neural development among children. Other studies have not found correlations and all studies suffer from methodological problems, such as the difficulty of measuring past exposures. The difficulties have prevented the existing epidemiological studies of human populations from reaching widely-accepted conclusions.

"Pesticides are designed to be toxic to living things. Because humans share many of the same basic building blocks of life with animals and insects, pesticides can injure people as well. Children are quite vulnerable to injury from pesticide and other chemical exposures very early in life. This is especially true in the womb and just after birth when the brain, reproductive and other organ systems are still developing. Recent animal studies indicate that even low exposures to certain pesticides very early in life can impact learning, behavior and other critical brain functions.

Many pesticides disrupt the work of hormones. In animals, these pesticides have been found to affect the development of nipples, testicles and penises in males, decrease semen quality, change the timing of sexual maturity, and lead to abnormal behavior. Similarly, atrazine, the most widely used pesticide in the U.S., indirectly interferes with estrogen. As a medical doctor, I am concerned that our current pesticide practices make our children unwitting guinea pigs in a large-scale chemical experiment."

– David Wallinga, MD, Director, Antibiotics Resistance Project, Institute for Agriculture and Trade Policy

The presumed safety of the low concentrations of pesticides to which Minnesotans are routinely exposed is questionable because the animal testing of pesticides required by the federal EPA does not measure all relevant health risks before approving pesticides for use. The EPA does not require animal tests that would reveal more subtle effects, such as tests of the nervous and immune systems, or of the developing brain. Neither does it require that tests be conducted specifically on developing animals. Testing for neurodevelopmental and immune system effects is not required; tests for endocrine effects have not yet been developed; some 2,300 so-called inert ingredients undergo few safety tests, though some have been shown to pose serious risks; no testing is done of combinations of pesticides, even though mixtures may greatly enhance the toxicity of these chemicals. In the absence of such testing, the safety of exposure to low concentrations of pesticides is uncertain. Standards based on incomplete testing do not necessarily protect us from all risk because many potential risks go unmeasured.

Amid all these uncertainties, two things are clear: No one can say for sure that exposure to low concentra-

tions of pesticides does or does not cause harm and there is no assurance that additional studies in the near future will produce a consensus one way or the other.

Based Upon The Knowledge We Do Possess And The Remaining Uncertainty Regarding Adverse Effects Of Pesticides, The State Of Minnesota Should Take Action To Minimize Potential Risk

Given what we do know about the health effects of pesticides and the magnitude of the risks attached to questions to which we don't yet know the answers – the severity of the effects that may be associated with pesticide exposure; the large population exposed; the risk that additional decades of study may not reach a consensus; the history of discovering toxic health effects at ever-lower exposure levels; and the availability of cost-effective non-chemical alternatives – MCEA believes it is prudent policy for the state of Minnesota, where economically feasible, to reduce the amount and toxicity of pesticides present in the environment, and thereby lower the likelihood of exposures and potential for harm. Stated simply, what we don't know might hurt us and it is therefore wise to act cautiously.

The MDA Has Failed Both In Its Statutory Duties And In Its Leadership Capacity To Protect Minnesota's Environment And Citizens From The Potential Adverse Effects Of Pesticide Use And Exposure

Monitoring chemical use and contamination, acting to reduce contamination, and promoting non-chemical alternatives are basic elements of any program to protect the environment and public health from toxic exposures due to the annual distribution of tens of millions of pounds of what are, by definition, chemical poisons. Monitoring chemical use and contamination and acting to reduce contamination when it is found are and have been statutorily required responsibilities of the MDA for a dozen years. Furthermore, MDA has had the authority and discretion to promote non-chemical alternatives and the use of less toxic chemicals for a long time. MDA has ignored these duties, or has complied with them only marginally and has not actively used its authority in a fully-protective way.

MDA Has Failed To Fully Monitor For Pesticides In Minnesota And Its Testing Regime Underestimates The Extent Of The Contamination

MCEA believes that MDA's failure to monitor groundwater in all agricultural areas of the state and to test for breakdown products of some common pesticides amounts to a violation of the law.

About a dozen pesticides, many of them corn herbicides, are detected routinely in Minnesota's groundwater and surface waters in all parts of the state, including urban areas, where airborne pesticides fall to the ground during rainstorms. Despite the widespread nature of pesticide contamination, areas of groundwater and surface water in some agricultural regions of the state are not being monitored by the MDA or other agencies. The MDA also fails to test waters for breakdown products of some common pesticides. Breakdown products are chemicals formed when pesticides degrade in the environment. These breakdown products are themselves contaminants and the failure to test for them greatly underestimates the extent of contamination.

Recommendation: Groundwater and surface water monitoring should provide accurate measures of pesticide contamination in all agricultural areas of the state, so that we can spot trends and quickly address problem areas. The MDA should establish groundwater monitoring in the southwestern part of the state, and add surface water monitoring stations in the southwest, west central, and northwest. Additional grab sampling in the southeastern karst area is also needed.

Recommendation: In order to accurately measure the extent of groundwater and surface water contamination by pesticides, the MDA should test for breakdown products from the pesticides alachlor, acetochlor, and metolachlor to avoid underestimating the extent of contamination.

MDA's Failure To Survey For Pesticide Use Data Leaves Serious Gaps In Our Knowledge Regarding The Magnitude And Location Of Pesticide Use In Minnesota

The MDA has also failed to fulfill a statutory requirement in the pesticide control law to collect data on actual pesticide use in Minnesota. Although a mail survey was conducted in 1990, since then the MDA has collected data from only a few dozen farmers. As a result, it does not know how much of what types of pesticides are used in different areas of the state.

Recommendation: The MDA should comply with the statutory requirement to collect pesticide use data. Without such information, we cannot analyze use or risk trends, determine areas which may be at risk, correctly interpret monitoring data, or secure the public's right to know about chemicals to which it may be exposed. Statistically valid surveys of actual pesticide use must be collected on a regular basis in major agricultural regions in Minnesota. The data should be collected at the sub-agricultural district level through an in-person survey administered by the Minnesota office of the federal National Agricultural Statistics Service on the crops which account for the bulk of the state's pesticide use: corn, soybeans, wheat, sugar beets, and potatoes. The information collected should include the type and amount of pesticide used, method of application, acreage treated, crop type, target organism, number and dates of application, name of applicator, and detailed location. The MDA should publish an annual analysis of the data, and should make the data available on its website.

Despite Widespread Pesticide Contamination, MDA Has Failed Its Statutory Duty To Take Action To Correct Or Minimize It

The MDA has ignored evidence of widespread contamination of water resources by low levels of pesticides. It has not developed and promoted the use by farmers of **voluntary** "best management practices" (BMPs) – ways of using pesticides more carefully to minimize groundwater degradation and surface runoff – for specific pesticides, as the Minnesota Groundwater Protection Act (the Act) requires. BMPs have only been developed for a single pesticide, ten years ago.

The Membership Of The Common Detection Advisory Committee Is Predisposed To Pesticide Use And Has Set A Threshold For Action Inconsistent With The Law

The Act's trigger for BMP development is called "common detection," defined as "detection that is the result of normal use" of a pesticide. MDA has unofficially delegated initial advice on common detection to a committee. The committee created by the MDA to advise it regarding common detection is dominated by representatives of interest groups which have a large financial stake in maintaining the status quo relative to pesticide use. Pesticide manufacturers, pesticide manufacturers' trade associations, pesticide retailers, commodity groups and agricultural producers each have a representative on the committee. The committee has no experts in hydrology, toxicology, or public health.

The Common Detection Advisory Committee (CDAC) has established a very high threshold for action, in contravention of the Act's low threshold, and which is apparently inconsistent with a legal opinion interpreting the Act made by the MDA's own counsel. Nonetheless, the MDA has never rejected the CDAC's advice. The result is that the CDAC has recommended only one pesticide to be placed in common detection status. Prior to June 2001, the CDAC had not even met for two-and-a-half years.

Recommendation: The Minnesota Legislature should amend the Groundwater Protection Act to transfer the decision regarding designation of pesticides as common detection (and related funding) to the Minnesota Department of Health. The advisory committee should be abolished and the decision made by Minnesota Department of Health staff with technical expertise in an open public process.

Recommendation: The trigger for action on common detection should conform closely to the definition contained in the Act. Geographic-specific responses should be made quickly when warranted.

MDA, Following Common Detection Committee Advice, Has Not Developed Pesticide-Specific BMPs

Because the CDAC has established an extremely high threshold, MDA has not developed pesticide-specific BMPs for pesticide use. BMPs were developed for atrazine ten years ago, but that action was quickly superseded by action of the federal government. No other pesticide-specific BMPs have been developed. Therefore, users of pesticides are not currently subject to even voluntary practices that might protect groundwater.

Recommendation: The MDA should take action to reduce documented contamination. When contamination is detected, Minnesota must implement the remedies called for by the state's Groundwater Protection Act by developing and promoting voluntary best management practices by farmers, such as reduced application rates. MCEA harbors doubts about the efficacy of voluntary measures, but they have not been implemented widely enough to assess their success in reducing contamination.

Recommendation: Current evidence of pesticide contamination indicates that BMPs should be adopted for atrazine statewide, and for acetochlor, alachlor, and metolachlor in the central sands and southeastern karst areas, and in certain south central and southeastern watersheds.

MDA Has Failed To Provide Adequate Leadership On Funding And Use Of Alternatives

MDA Has Not Pursued Adequate Funding

MDA officials responded that they agree with several of the report's recommendations, but simply do not have the funding to do a better job. MCEA questions the MDA's commitment to fulfill these statutory duties in light of the fact that **the MDA has never asked the Minnesota Legislature to increase the pesticide sales fee which funds these activities.** The fee remains at its 1991 level, while the MDA has asked for and received increases in several other agricultural fees.

The MDA's Pesticide Regulatory Account, which funds most of the MDA's pesticide regulatory efforts, consists principally of revenues from a fee on every pound of pesticide sold in Minnesota. Between 1996 and 2000, the account has carried a surplus ranging from \$2.8 to \$3.5 million, but this amount is shrinking and is projected to continue to do so. Despite the account's diminishing revenues and increasing expenditures, the MDA has **never** asked the Legislature to increase the fee, which has not been raised since 1991. In contrast, in the 2001 legislative session, the MDA sought and received a 100 percent increase in half a dozen fees on milk producers and wholesale produce dealers, making it appear that addressing chronic pesticide contamination is simply not a high priority at the MDA.

MCEA challenges the MDA to make good on its good intentions by requesting an increase in funding from the Minnesota Legislature specifically targeted to the activities identified in this report. MCEA will actively support such a request.

Recommendation: MDA should actively seek, as set forth below, additional funding to implement the recommendations in this Report. MCEA estimates that approximately \$1 million per year in additional revenues is needed to carry out these recommendations. Possible revenue sources include raising the manufacturers' fee on pesticide sales in the state, which has not been increased in a decade, and reducing in whole or in part the exemption of agricultural pesticide sales from the state sales tax.

Recommendation: The Minnesota Legislature should increase the revenues in the Pesticide Regulatory Account to enable the MDA to fulfill its mandate to protect Minnesota's resources and citizens from pesticide contamination. Options the Legislature should consider include: 1) Raising the fee on gross pesticide sales paid by pesticide manufacturers; 2) Increasing fees on pesticide dealer licenses and/or applicator licenses; 3) Repealing, in whole or in part, the exemption of agricultural pesticide sales from the state sales tax, (each one percent sales tax paid on such sales raises more than \$4 million in revenues); and 4) Appropriating general funds directly. These additional funds should be targeted specifically to the activities identified in this report.

The MDA Does Not Exercise Its Discretionary Authority To Analyze Environmental And Health Impacts Of Pesticides Before Allowing Them To Be Used

The MDA has the authority to prevent or minimize pesticide contamination by evaluating the potential environmental and health impacts of specific pesticides before they are allowed to be used in Minnesota and by attaching restrictions – on amount, timing, or location of application – to their use. This approach would protect Minnesota's resources while maintaining farmers' access to pesticides, but the MDA conducts no such examination.

Recommendation: Minnesota should act to prevent contamination before it occurs by assessing the environmental and health impacts of new pesticides during the state's pesticide registration process, and, if warranted, impose conditions on use to mitigate potential contamination. Selected products undergoing re-registrations and which raise environmental concerns should also be subject to such review. To reduce the costs of carrying out these functions, Minnesota should take advantage of expertise already housed in various state agencies to assist MDA in assessing risks from pesticides: the Department of Natural Resources (effects on fish and wildlife), Department of Health (human health effects), the Pollution Control Agency (environmental fate and groundwater impacts), and the MDA (crafting use conditions). This will have the added benefit of keeping costs down.

Minnesota's Integrated Pest Management Programs Are Not Coordinated Or Prioritized

Although Minnesota has several fine Integrated Pest Management (IPM) programs administered by the MDA, the University of Minnesota, and Minnesota Extension, the state's efforts are neither coordinated nor prioritized. For example, many of the grants to develop and test new IPM techniques are aimed at fruits and vegetables, crops which account for a small percentage of Minnesota's pesticide use. Also, no

strategic IPM plan exists which lays out the state's priorities, assigns responsibilities for carrying out parts of the plan to different service providers, and sets goals against which progress can be measured. A more integrated structure is needed to insure that programs and policies are consistent and that responsibilities for achieving program goals are clearly defined.

Recommendation: The MDA should fulfill its statutory responsibilities to reduce and eliminate pesticide contamination of groundwater and surface waters. Both the MDA and the Minnesota Legislature should give greater support to pest management programs which seek to reduce dependence on pesticides. State policy should be to speed the transition to a less chemical-intensive agriculture.

Recommendation: Minnesota needs to strengthen non-chemical pest management programs. What is missing is a governing body to integrate, coordinate, and prioritize these efforts, and a long-range plan to establish measurable goals and strategies to achieve them. Minnesota should devise an integrated structure that coordinates the many organizations delivering IPM information and services. New York's program should be used as a model. It consists of a small program staff housed at the state's land-grant university; commodity-based working groups integrating faculty, growers, and crop consultants; and a policymaking and coordinating committee made up of representatives of university and extension faculty, the state department of agriculture, and other important sectors to guide the programs.

This new organizational structure should produce a Strategic Long-Range IPM Plan that sets priorities to govern IPM programs in the state and establishes goals against which results can be measured.

- To help develop priorities, Minnesota should utilize two tools: 1) A statistically valid survey of farmers to determine the major barriers inhibiting them from adopting IPM techniques, and how they might be overcome; 2) A toxicity model that measures the environmental and health risks posed by individual agricultural pesticides to help prioritize pesticides for replacement by IPM techniques or substitution with less harmful chemicals, and to measure the change in total risk over time. Results from use of these tools should help determine funding priorities and shape the state's IPM programs.
- More attention should be placed on developing IPM methods for field crops like corn, soybeans, and wheat, where adoption could result in large reductions in pesticide use and risk statewide.
- Grant programs should issue Requests for Proposals that reflect these priorities and proposals should be evaluated accordingly, to insure that the state's most pressing needs are being addressed.

Recommendation: In directing additional funding to reorganize and expand IPM programs in the state, the Legislature should consider the same sources listed above.

Conclusion

MCEA recognizes that the MDA has a two-fold mission. It is charged with promoting agriculture and with protecting the environment. Realistically, most of the agricultural interests which make up the MDA's core constituency are far more interested in the former, and its environmental protection duties have suffered as a result. This conflict is an important reason behind MCEA's recommendation that the common detection function be transferred to the Minnesota Department of Health. Overall, the actions that MCEA is recommending are firmly rooted in common sense. We do not seek a ban on pesticides. We believe that implementation of the recommended measures will go a long way toward reducing pesticide exposures in Minnesota and will help ensure that our state policies and actions are truly protective and in accordance with the requirements of the law.

CHAPTER 1

INTRODUCTION: THE TRANSITION TO A LESS CHEMICALLY-DEPENDENT AGRICULTURE REQUIRES CHANGES AT THE MINNESOTA DEPARTMENT OF AGRICULTURE

In the summer of 2000, the National Academy of Sciences published a report entitled *The Future Role of Pesticides in U.S. Agriculture*. The report's two main recommendations were as follows:¹

Recommendation 1: There is no justification for completely abandoning chemicals per se as components in the defensive toolbox for managing pests.

Recommendation 2: A concerted effort in research and policy should be made to increase the competitiveness of alternatives to chemical pesticides; this effort is a necessary prerequisite for diversifying the pesticide-management toolbox. . . .

Each of these recommendations was seized by different agricultural interest groups as justification for their own positions. Backers of conventional agriculture raised the banner of the first recommendation, citing additional language in the report that "chemical pesticides will continue to play a role in pesticide management for the foreseeable future. . . ."² Proponents of reducing the use of pesticides in agriculture pointed to the second recommendation in support of their goal.

In the Minnesota Center for Environmental Advocacy's (MCEA's) view, the two recommendations are not contradictory. A transition to more ecologically healthy means of dealing with weeds and pests is needed. While that transition is ongoing, chemical pesticides will continue

The goal is to develop "a diverse toolbox of pesticide-management strategies . . . that integrate chemical approaches into an overall, ecologically based framework to optimize sustainable production, environmental quality, and human health."

– *National Academy of Sciences, 2000.*

to be used. The goal is to develop, as the report stated, "a diverse toolbox of pesticide-management strategies that include safe products and practices that integrate chemical approaches into an overall, ecologically based framework to optimize sustainable production, environmental quality, and human health."³

The key point the report makes is that the transition will occur only as a result of implementing strong public policy measures to advance it, including publicly subsidized research and economic incentives paid with public funds to encourage producers to adopt environmentally preferable practices.

This transition is necessary in Minnesota because, as shown in this report, low concentrations of pesticides are widespread in the state's air, surface waters, and groundwater; because gaps in the federal govern-

1 National Research Council, *The Future Role of Pesticides in U.S. Agriculture*, 2000, pp. 3, 5.

2 *Ibid.*, p. 2.

3 *Ibid.*, p. 4.

ment's testing of pesticides leave many potential risks of exposure unassessed; because considerable evidence exists, largely but not exclusively based on occupational data, that pesticide exposure may be associated with several forms of cancer, Parkinson's disease, birth defects, and brain and nervous system impairments, though no scientific consensus on these issues yet exists; and because many cost-effective non-chemical means of addressing weeds and pests have been and are being developed which pose no such risks to applicators, consumers or the environment.

A number of barriers hamper the transition, however. Some do so directly. For example,

- The Minnesota Department of Agriculture (MDA) recently proposed budget cuts of \$245,000 annually in sustainable agriculture and pesticide alternative programs, reflecting its low priority for these efforts.
- Although Minnesota has many fine programs promoting non-chemical pest management spread among several institutions, there is no long-range plan or organizational structure to coordinate the separate entities and programs and to establish priorities to insure that pesticides creating the greatest environmental and health risks are targeted for reduction.

Other barriers inhibit the transition indirectly, by masking the risks posed by continued over-reliance on chemical pesticides, making the need for a speedy transition seem less imperative.

- The MDA does not collect pesticide use data, so it does not know how much of what pesticides are used where in the state. Without such information, we cannot pinpoint the location of high-risk areas or track whether risks are increasing or decreasing.
- The MDA's groundwater and surface water monitoring networks do not cover all of Minnesota's agricultural regions, leaving us ignorant regarding the location and extent of pesticide contamination in some areas. The MDA is not testing for breakdown products of some commonly-used pesticides, underestimating contamination.
- The MDA does not examine potential health or environmental effects of pesticides during the state registration process, missing an important opportunity to craft conditions of pesticide use that will minimize or avoid potential contamination before it happens and will protect Minnesota's unique natural resources.
- Even with these holes in the system, the levels of pesticide contamination of which we are aware clearly call for action, as mandated in the Minnesota Groundwater Protection Act. Yet the MDA has largely ignored this evidence, failing even to develop the voluntary "best management practices" that farmers may adopt for specific pesticides required by the Act.

The MDA does fund some activities which support the transition described above. However, these efforts comprise a relatively small part of the MDA's overall budget, and the programs operate in isolation, not as integrated parts of the organization's mission. Indeed, it is inaccurate to say that it is the policy of the MDA to accelerate the transition to a less chemical-intensive agriculture. If MDA were committed to such a transition, its Pesticide Management Plan would be the logical place to enunciate that goal and outline a strategy to advance it. Yet all the Plan has to say on this topic is that the MDA does not "promote or discourage differing philosophies on pest management. . . ."⁴

⁴ Pesticide Management Plan Advisory Committee and the Minnesota Department of Agriculture, *Minnesota Pesticide Management Plan (PMP)*, October 1998, p. 3.

The MDA goes well beyond a position of indifference regarding the transition, acting instead to hinder its progress. A disproportionate share of the MDA's proposed 2002-03 budget cuts were targeted to programs promoting sustainable agriculture, including those which support pesticide alternatives. Sixty percent of the department's cuts were focused on six such programs which collectively account for less than five percent of MDA's budget. The cuts of \$245,000 annually amounted to decreases of 25 percent of total program revenues for two programs; 50 percent for two others, and 100 percent for another. Although these cuts were ultimately restored by the Legislature, the budget is a clear statement that the transition to a less chemical-intensive agriculture is not a high priority of the MDA.

In fact, Minnesota's operative "philosophy of pest management" fully supports the use of chemical pesticides, to the tune of more than \$30 million per year. That is the size of the annual subsidy to Minnesota farmers who purchase pesticides, which comes via an exemption for such products from the state sales tax. No other state in the country loses more revenue from this subsidy than Minnesota.⁵ Like other economic subsidies, this one has the effect of increasing sales of the subsidized goods to higher levels than would be the case if the full price were paid.

Given the extent, severity, and uncertainty of the potential health and ecological risks, and the availability of cost-effective alternative methods of pest management, MCEA believes that it is prudent policy for the state of Minnesota to take action now to reduce the amount of pesticides present in the environment, and thereby lower the likelihood of exposures. To do this, Minnesota needs to move aggressively to plug the gaps in the MDA's groundwater and surface water monitoring network; to take action as required under the Minnesota Groundwater Protection Act once evidence of pesticide contamination is found; to examine and address potential environmental and health problems before they occur, during the state pesticide registration process; to comply with statutory requirements to collect sufficient pesticide use data to know how much of which pesticides are used in different parts of the state; and to make a strong commitment to improve the state's programs promoting non-chemical methods of pest management, in order to help Minnesota farmers make the transition described in the National Academy of Sciences study easier to achieve.

MCEA believes that it is prudent policy for the state of Minnesota to take action now, where economically feasible, to reduce the amount of pesticides present in the environment, and thereby lower the likelihood of exposures.

These activities will require the state to shift both its attitude toward pesticides and its resources as well. As a top agricultural state with a long tradition of environmental protection, Minnesota should embrace the future and position itself in the forefront of this transition rather than lag behind, tied to traditional methods. This approach holds the best promise for the future of Minnesota's farmers, the quality of the state's water resources, its wildlife, and the health of its citizens.

How This Report Was Prepared

This report is the culmination of more than two years of investigation by MCEA to assess the environmental and health impacts of pesticide use in Minnesota and the efficacy of state programs to reduce and limit those impacts.

⁵ Minn. Stat. § 297A.25, subd. 9; Friends of the Earth, *F.A.C.T.: Fair Agricultural Chemical Taxes – Tax Reform for Sustainable Agriculture*, 1999, Table 1, p. 10. Based on 1997 sales, the revenue foregone was \$31.2 million. Fifteen of the 45 states collecting sales taxes, including Iowa, South Dakota, and Michigan, do not exempt pesticides from sales taxes.

A draft report was provided to the MDA in July 2001. On July 23rd, MCEA met with five officials from the Department. At that three-hour meeting, MDA identified statements in the report it considered to be inaccurate or incomplete. Further conversations were held with MDA staff members present at the meeting, and requests for additional information were submitted by MCEA. A second meeting, with Commissioner Gene Hugoson and Director of the Agronomy and Plant Protection Division Greg Buzicky, was held on August 8th, 2001.

MCEA also delivered a draft report to the Minnesota Department of Health for its review. On July 28th, 2001 MCEA met with two officials to discuss their comments on the report.

As a result of these meetings, MCEA made revisions to the report to address the concerns of both agencies that we deemed to be well-founded.

CHAPTER 2

NEWLY-AVAILABLE PESTICIDE SALES DATA IS HELPFUL

Until recently, our knowledge of the amount and types of pesticides used in Minnesota agriculture was quite sketchy. Surveys conducted by the U.S. Department of Agriculture provide estimates of pesticide use for only major crops, and contain very large uncertainty factors.

In the summer of 2000, MCEA initiated a cooperative project with the MDA to better utilize the data MDA collects annually from pesticide manufacturers on sales of pesticide products registered in Minnesota and to make it available to the public. The sales data is reported to the MDA so that it can collect the fee on gross pesticide sales which helps fund pesticide regulatory activities.

Sales are reported in pounds of each product sold. Thousands of pesticide products are registered for sale in Minnesota. To aggregate sales by active ingredient, the main chemical component which destroys weeds or insects, it is necessary to, first, determine all products containing a given active ingredient and, second, to multiply the sales in pounds figure reported by the manufacturer by the percentage of active ingredient contained in each product, obtained from the product label. The result is pounds of active ingredient sold.

The MDA had only made these calculations for about one dozen top-selling pesticide active ingredients, and the information was not published. MCEA's work enabled the MDA to calculate this information for all 165 active ingredients sold in 1998 for use in Minnesota's agricultural sector. Using the data provided by MCEA, the MDA has made similar calculations for 1996, 1997, and 1999, and has posted the results on its website at www.mda.mn.us/appd/pesticides/useandsales.html. MCEA commends the MDA for making these calculations for earlier years and for posting the data.

The data for 1998 are shown in Appendix A. Herbicides clearly dominate pesticide use in Minnesota, accounting for about 81 percent of the total 33.7 million pounds of active ingredients in agricultural pesticides. Corn, soybeans, and wheat, Minnesota's largest acreage crops, use the largest volume of herbicides. Fungicides account for about 2.2 million pounds (6.6 percent), and insecticides total 1.6 million pounds (4.6 percent). These are heavily used on the state's potato crop. Other pesticides – such as plant growth regulators and nitrification inhibitors – amounted to 2.6 million pounds of sales in 1998, about 7.8 percent of the total.

Sales volumes are not necessarily accurate indicators of environmental impacts or the number of acres treated. This is particularly true since the development of new types of highly-concentrated herbicides which are used at much lower rates per acre, measured in hundredths of a pound, than are traditional herbicides. These products can be used on vast acreages, but still show rather modest total volumes.

MCEA utilizes this sales data to examine the potential risks posed to wildlife and human health by pesticides sold in Minnesota in Chapters 4 and 5.

Recommendation: The MDA should update its pesticide sales database annually and continue to make this information available to the public. The MDA should publish an annual report containing this information and analyzing trends in pesticide use.

CHAPTER 3

PESTICIDE CONTAMINATION IS WIDESPREAD IN MINNESOTA

Introduction

This chapter shows that a group of about a dozen pesticides are routinely detected at low concentrations in Minnesota's environment. They are in the air, and fall to earth in rain throughout the state, including the Twin Cities. They are present in groundwater and surface water samples in agricultural regions from the Red River Valley to the southeastern karst area. Some are detected at times in public water systems. Pesticide residues are routinely found in more than half the fresh and processed food samples tested by the U.S. Department of Agriculture. And, not surprisingly, pesticides have found their way into our bodies as well.

Heavily-used corn and soybean herbicides – atrazine, alachlor, acetochlor, metolachlor, metribuzin – are detected most often. Other pesticides, including cyanazine, EPTC, triallate, and chlorpyrifos have also been detected regularly.

Measuring pesticides in the environment is difficult and expensive. Assays must be done by instruments capable of measuring at the level of parts per billion or less. Tests for some pesticide degradates can cost several hundred dollars. As a result, testing is typically done quarterly, at a limited number of locations, and for only a limited number of pesticides. The data below report the most recent studies in the areas concerned.

Pesticides Are Mobile in the Environment

Any risks posed by pesticides would not be of great concern if pesticide contamination of the environment were a rare occurrence. Unfortunately, this is not the case. Pesticides are widespread throughout the environment.

Wind currents transport pesticides applied in rural Minnesota to the Twin Cities – where they are deposited in rain.

They travel on wind currents far from the agricultural areas where they are used most heavily. Through surface runoff, infiltration, and via tile inlets and ditches, they migrate

to Minnesota rivers, lakes, and groundwater. Some pesticides remain as trace residues on fresh or processed foods. Any of these pathways can transport pesticides from the outer ambient environment to the inner, cellular, environment of animals and humans, where they may become a health concern.

The environmental fate of pesticides applied to Minnesota farmland depends partly on the chemical and physical properties of the active and inert ingredients, which determine what proportion will volatilize

into the air, adhere to soil particles, or leach to groundwater. Some pesticides are chemically transformed into breakdown products or degradates which can persist for long periods of time; others degrade rather rapidly. Some are soluble in water and highly mobile; others are less so. The environmental conditions of the area in which the pesticide is applied, such as the infiltration rate of soils, also play a role in determining its environmental fate.

For example, half of the atrazine applied normally persists in the environment for 30 to 50 days after application. However, if atrazine reaches groundwater, where little oxygen is present, degradation slows greatly and it can persist for years.⁶

While the widespread nature of pesticide contamination creates the potential for wildlife and human health impacts, two additional factors – exposure and dose – are crucial in determining whether such impacts actually occur. These issues are examined in Chapter 5.

One method of measuring the presence of pesticides in the air is to analyze rain samples. A joint study undertaken by the MDA and the U.S. Geological Survey analyzed rain samples taken from six Minnesota sites during the spring, summer, and fall of 1994, documenting the extent to which pesticides are present

TABLE 1

Pesticides in Minnesota Rain Samples, 1994

Percentage Detections in Rain Samples

	Blue Earth	Crystal Springs	Lamberton	Lake Harriet	Park Rapids	Princeton
Atrazine	100	86	95	96	94	88
Alachlor	100	82	84	87	88	88
Acetochlor	33	32	68	17	24	41
Metolachlor	78	50	47	39	47	59
EPTC	44	18	47	35	35	35
Metribuzin	44	50	68	74	71	53
Cyanazine	56	73	84	61	71	59
Pendimethalin	44	32	37	35	12	35
Simazine	11	18	37	26	41	29
Propachlor	33	18	26	22	12	18
Propazine	22	27	37	13	18	41
Azinphos-Methyl	22	55	58	9	53	53
Methyl Parathion	56	36	84	48	53	35
Chlorpyrifos	11	14	42	13	18	53
Lindane	22	27	21	0	24	12

Source: Wet Deposition of Pesticides in Minnesota, 1989-1994.

⁶ M. Smith et. al., *Atrazine Management and Water Quality: A Missouri Guide*, Missouri Manual 167, University of Missouri-Columbia, 1999, pp. 6-7; Bruce Giebink, *Management Systems and Ground Water Atrazine Concentrations*, Management Systems Evaluation Area, Minnesota Extension Service, March 1995.

in the atmosphere.⁷ The collection sites were Blue Earth (south central), Crystal Springs (southeast), Lamberton (southwest), Lake Harriet (Twin Cities), Princeton (north metro) and Park Rapids (north central).

Thirty-one of the 32 herbicides and insecticides tested for were detected at at least one site. Table 1 shows the percentage of detections of the 15 pesticides found most frequently at each of the six sampling locations. The average concentrations detected were below 1 part per billion (ppb). As a point of comparison, federal drinking water standards limit the corn herbicides atrazine and alachlor to 3 ppb and 2 ppb, respectively.

The ubiquity of detections is obvious. What is most interesting is the similarity of the readings from the urban Lake Harriet site to the results from the sampling stations located in agricultural areas. These are agricultural pesticides not used in urban areas, but are transported there by wind currents. Clearly, those living in urban areas are not exempt from exposure to pesticides applied in agricultural regions of the state.

This phenomenon is not unusual. A 1995 study of Midwestern states, including Minnesota, concluded: "Exposure to Midwestern cities of low concentrations of agricultural pesticides (especially the high-use corn and soybean herbicides) in air and deposition was common."⁸

Low Concentrations of Pesticides Are Present in Minnesota's Surface Waters and Groundwater

MCEA reviewed scores of studies conducted by local, state, and federal agencies over the past 15 years in Minnesota groundwater, rivers, streams, and wetlands located primarily in agricultural areas of the state. Two major conclusions emerged:

- A group of about a dozen pesticides are routinely detected in groundwater and surface water bodies in agricultural regions.
- The concentrations of these pesticides are very low, most often less than 1 ppb. This is well below health standards or benchmarks set by federal and state agencies for drinking water. However, as discussed in Chapter 5, exposure to even low concentrations of pesticides may pose risks to the environment and human health.

The results of these studies are discussed by geographical region in Appendix B. A summary is presented below.

Surface Waters

- In 1997 the U.S. Geological Survey (USGS) reviewed dozens of studies done in a 19,500 square mile area in central Minnesota over a 20-year period. It concluded:⁹

In streams, trace concentrations of pesticides are ubiquitous – herbicides were detected every site sampled except the Kettle River. Herbicides were detected most often in streams draining row-crop agricultural areas; the Minnesota and Cannon Rivers had the most detections, followed by the Sauk, Straight, and Crow Rivers. Concentrations of atrazine, metolachlor, and cyanazine were greatest in July, although these herbicides and others are detectable most of the year at very low (ppt) [parts per trillion] concentrations.

7 Paul D. Capel, Ma Lin, and Paul J. Wotzka, *Wet Deposition of Pesticides in Minnesota, 1989-94*, U.S. Geological Survey Water Resources Investigations Report 97-4026, 1998, Tables 15 through 20.

8 Michael S. Majewski, "Pesticides in the atmosphere of the Mississippi River valley, part II – air," *Science of the Total Environment*, vol. 248, nos. 2-3 (April 5, 2000), pp. 213-216.

9 James D. Fallon et. al., *Water-Quality Assessment of Part of the Upper Mississippi River Basin, Minnesota and Wisconsin – Pesticides in Streams, Streambed Sediment, and Ground Water, 1974-94*, U.S. Geological Survey Water-Resources Investigations Report 97-4141, 1997, p. 31.

- The MDA has six automated surface water sampling sites in southeastern Minnesota, on rivers including the Whitewater, the Blue Earth, and the Minnesota. The average percentage of pesticide detections in baseflow (not during storm events) at these sites during the mid-1990s ranged between 67 and 93 percent for atrazine; between five and 35 percent for acetochlor; and between 21 and 100 percent for metolachlor.¹⁰ Median concentrations for both baseflow and storm runoff were rarely above 1 ppb.
- In south central Minnesota, a 1999 USGS study of the ecological health of the Upper Mississippi basin noted the significant contribution of Minnesota's agricultural areas to the load of pesticides in the river:¹¹

These chemicals enter tributary streams in both contaminated surface runoff and groundwater. The tributary streams act as point sources of agricultural chemicals to the main stem Mississippi River. The Minnesota and Des Moines rivers, for example, are the primary contributors of the herbicides alachlor, cyanazine and metolachlor to the entire Mississippi River main stem.

- Also in the south central region, the MDA took grab samples (literally, dipping a bottle into a stream) at 14 sites in the Minnesota River basin from 1991 through 1993. Atrazine was detected in 53 percent of the samples; alachlor in 30 percent; cyanazine in 50 percent; and metolachlor in 48 percent.¹²

"In streams, trace concentrations of pesticides are ubiquitous -- herbicides were detected at every site sampled except the Kettle River. . . [T]he Minnesota and Cannon Rivers had the most detections, followed by the Sauk, Straight, and Crow Rivers." – *U.S. Geological Survey, 1997.*

- The U.S. Fish and Wildlife Service sampled 30 private and public wetlands in an intensively farmed area in west central Minnesota in

1993 and found concentrations of triazines,¹³ alachlor, and 2,4-D in every sample taken. Concentrations of alachlor in four wetlands in one area exceeded U.S. Environmental Protection Agency (EPA) drinking water standards. The report concluded, "[W]idespread, low-level herbicide deposition is occurring in the Prairie Pothole Region of Minnesota. . .," adding that these areas "may be receiving herbicides at concentrations which can adversely impact their flora and fauna."¹⁴

- Between 1993 and 1995, the USGS sampled eight rivers in Minnesota's Red River Valley and detected 42 pesticides and two breakdown products. Eleven of the pesticides were detected in more than 20 percent of the samples, including atrazine (92 percent), deethylatrazine (66 percent), metolachlor (61 percent), and cyanazine (57 percent).¹⁵

In the Red River Valley, the USGS sampled eight rivers and detected 42 different pesticides. Eleven pesticides were detected in more than 20 percent of the samples.

10 Recommendations From the Common Detection Advisory Committee to the Commissioner of Agriculture on the status of pesticides in Minnesota's water resources, December 1998, App. C. Hereafter referred to as CDAC Report.
11 U.S. Geological Survey, *Ecological Status and Trends of the Upper Mississippi River System, 1998: A Report of the Long Term Resource Monitoring Program*, April 1999, p. 7-15.
12 CDAC Report, App. C.
13 A group of chemically-related pesticides including atrazine, cyanazine, metribuzin, and others.
14 Keren L. Ensor and Stanley L. Smith, *Herbicide Concentrations in Wetlands in West Central Minnesota, 1992*, U.S. Fish and Wildlife Service, Twin Cities Field Office, June 1994, pp. 10, 13.
15 L.H. Tornes, M.E. Brigham, and D.L. Lorenz, *Nutrients, Suspended Sediment, and Pesticides in Streams in the Red River of the North Basin, Minnesota, North Dakota and South Dakota, 1993-95*, U.S. Geological Survey Water-Resources Investigations Report 97-4053, 1997, Table 16, pp. 65-66.

Groundwater

- A joint MDA-Minnesota Department of Health (MDH) study in the central sand plain (west and northwest of the Twin Cities), and southeastern and southwestern portions of Minnesota sampled 157 private drinking wells in 1986. Atrazine was found in 49 percent of the wells, at a median concentration below 0.1 ppb; eight other pesticides were also detected.¹⁶
- Between 1986 and 1994, the MDA's groundwater monitoring network was located in the central sand plain and the southern portion of the state. On average, atrazine was found in 30 percent of the wells, while alachlor, cyanazine, metolachlor, and metribuzin were detected in one to three percent.¹⁷ This network, which was composed of wells drilled by other government agencies for purposes other than pesticide detection, was abandoned after 1996 because of concerns regarding the accuracy of its measures of the extent of pesticide contamination.

In 2000, atrazine was detected in 76 percent of the MDA's groundwater wells. Metribuzin was detected in 28 percent, and metolachlor in 19 percent.

In 1998, the MDA obtained Governor Carlson's support for a \$500,000 appropriation to develop a new groundwater monitoring network located entirely in the Sand Plain and to improve its surface water monitoring abilities as well.

- In 2000, initial results from the MDA's new network showed that pesticide contamination continues to be a problem in this area. Atrazine and its breakdown products were detected in 76 percent of the wells; metolachlor in 19 percent; and metribuzin and its breakdown products in 28 percent.¹⁸
- Minnesota Pollution Control Agency (PCA) studies in 1998-99 in St. Cloud and Cottage Grove found herbicides in 64 and 68 percent of the samples, respectively, mostly degradates of atrazine, metolachlor, alachlor, and acetochlor. In five samples from Cottage Grove, the concentration of combined alachlor parents and degradates exceeded the federal drinking water standard.¹⁹
- In northwestern Minnesota's Red River Valley, the USGS detected pesticides in 52 percent of the wells tested. Among the seven pesticides detected, atrazine and one of its degradates was found most often.²⁰

Low Concentrations of Pesticides Are Present in Some Minnesota Drinking Water Supplies

The federal Safe Drinking Water Act requires testing drinking water for just 16 of the 165 active ingredients used in Minnesota agriculture. Samples are not tested for breakdown products.

Minnesota Department of Health testing revealed 158 detections of pesticides in residential drinking water supplies in 47 Minnesota cities between 1993 and 1998.

According to the results of these tests compiled by the MDH, some 158 detections in 47 different cities across the state were reported between 1993 and 1998 in community (residential) water supplies, as shown

16 Minnesota Department of Health and Minnesota Department of Agriculture, *Minnesota Pesticide Monitoring Surveys Interim Report*, presented at Pesticides and Groundwater: A Health Concern for the Midwest, a conference held in St. Paul, Minnesota on October 16, 1986.

17 Minnesota Department of Agriculture, *Water Quality Monitoring Program, Common Detection Data Report: November 1985 through September 1994*, June 1996.

18 Minnesota Department of Agriculture, Monitoring and Assessment Unit, *2001 Common Detection Data Report*, May 25, 2001, p. 8.

19 Minnesota Pollution Control Agency, Ground Water Monitoring and Assessment Program, *Effects of Land Use on Ground Water Quality, St. Cloud Area, Minnesota - 1998 Results, March 1999*, pp. 62-63 and 1999 Results, July 2000, p. 30.; Minnesota Pollution Control Agency, Ground Water Monitoring and Assessment Program, *Ground Water Quality in Cottage Grove, Minnesota, June 2000*, pp. 35-36.

20 Timothy K. Cowdery, *Shallow Ground-Water Quality Beneath Cropland in the Red River of the North Basin, Minnesota and North Dakota, 1993-95*, U.S. Geological Survey Water Resources Investigations Report 97-4001, 1997, pp. 1, 21, 23.

in Table 2. Atrazine accounted for more than one-third of those detections, followed by metolachlor and 2,4-D. Median concentrations were .7, .8, and .4 ppb, respectively.

Among non-residential water supplies, such as schools and restaurants, 150 detections were reported in 44 cities. Again, atrazine was the pesticide most frequently detected, followed by 2,4-D, alachlor, and bentazon.

Low Concentrations of Pesticides Are Present in Many Fresh and Processed Foods

U.S. Department of Agriculture tests for 1998 show that a wide variety of both fresh and processed foods contain low levels of pesticide residues. Overall, 61 percent of all samples of fruits and vegetables (taken from 10 states, not including Minnesota) contained at least one residue.²¹

TABLE 2

Pesticides Detections in Residential and Non-Residential Water Supplies in Minnesota, 1993-1998

	Residential		Non-Residential	
	No. of detections	No. of communities	No. of detections	No. of communities
Atrazine	55	14	60	11
Metolachlor	30	4	12	1
2,4-D	30	20	37	25
Alachlor	15	4	17	2
Bentazon	15	10	17	6
Others	13	9	7	5

Source: Minnesota Department of Health, unpublished data.

Some 8,500 samples were tested, 84 percent of which were of domestically produced foods. Of these, only 12 residues exceeded the tolerances (standards) set by the EPA to protect public health. In 324 cases, pesticides were detected on foods on which they were not supposed to be applied.²²

Results from fresh and processed foods tested are shown in Table 3. Of the 15 foods tested, 10 contained residues from more than a dozen pesticides. For example, 94 percent of the fresh pears tested contained one or more of 39 different pesticide residues. Fifty-four percent of pears contained residues of the insecticide azinphos-methyl.²³ The EPA's reassessment of the health risks of this pesticide under the 1996 Federal Food Quality Protection Act raised concerns which led to a 1999 agreement between the EPA and the manufacturer greatly restricting its use.²⁴

Fifty-one percent of the soybean samples, which included samples from Minnesota, contained pesticide residues. Ten percent contained residues of the insecticide chlorpyrifos.²⁵ A similar EPA reassessment

21 U.S. Department of Agriculture, Agricultural Marketing Service, *Pesticide Data Program, Annual Summary, Calendar Year 1998*, Table 2, p. 14.
 22 *Ibid.*, p. xii, Appendix L.
 23 *Ibid.*, App. I.
 24 See p. 38.
 25 *Ibid.*, Appendix G.

revealed concerns regarding potential impacts on brain development in test animals. In June 2000, the EPA and the pesticide manufacturer signed an agreement withdrawing the use of chlorpyrifos in the home and for some agricultural uses.²⁶

Low Concentrations of Pesticides Are Present in Humans

It should be no surprise that, given their omnipresence in the air, water, and food, pesticide residues are also in our bodies. A study conducted in the early 1990s found six pesticide breakdown products in the urine of more than 50 percent of the 1,000 adults in the sample. For one substance, a breakdown product of the insecticide chlorpyrifos, 31 percent of the sample had a concentration of 5 ppb or greater, compared with less than 6 percent in a similar study done 15 years earlier.²⁷ As noted above, chlorpyrifos uses were restricted in 2000 due to concerns over its effects on brain development in test animals.

A recent study by the MDH assessed the presence of pesticide residues in the urine of children from 102 urban and rural Minnesota homes. Residues of chlorpyrifos were found in the urine of 92 percent of the children tested, while residues of 2,4-D and malathion were detected in 54 and 36 percent, respectively. The study stated that all estimated pesticide exposures were below “a level of concern.”²⁸

The vast majority of the pesticide detections reviewed in this chapter are at very low concentration levels. While this fact may provide comfort to some, it is by no means clear that such exposures result in negligible health impacts. That issue is examined at length in Chapter 5.

TABLE 3

U.S. Department of Agriculture Testing Results of Pesticide Residues on Food, 1998

	Samples with different residues detected (%)	Number of different residues detected
Fresh		
Pears	94	39
Strawberries	91	37
Tomatoes	62	37
Sweet Potatoes	59	14
Winter Squash	42	37
Cantaloupe	40	20
Processed		
Strawberries, Frozen	89	16
Spinach, Canned	85	16
Winter Squash, Frozen	79	13
Apple Juice	63	19
Green Beans	60	18
Grape Juice	39	10
Orange Juice	17	10
Soybeans	51	11
Milk	15	5

Source: U.S. Department of Agriculture, Agricultural Marketing Service, *Pesticide Data Program, Annual Summary, Calendar Year 1998*, Table 2, p. 14.

²⁶ See p. 37.

²⁷ Robert Hill, Jr. et. al., "Pesticide residues in urine of adults living in the United States: reference range concentrations," *Environmental Research*, vol. 71, no. 2 (November 1995), pp. 102, 104.

²⁸ Minnesota Department of Health, *Comparative Risks of Multiple Chemical Exposures*, Final Report to the Legislative Commission on Minnesota Resources, July 2000.

CHAPTER 4

AGRICULTURAL PESTICIDE USE IN MINNESOTA POSES POTENTIAL ECOLOGICAL RISKS

"There is evidence that pesticides have indirect, sublethal, and very subtle impacts that impair the ability of wildlife to eat, survive and reproduce. And what the population implications are, no one really knows."

—Dr. Mary G. Henry, Deputy Chief of the Division of Environmental Quality,
U.S. Fish and Wildlife Service

Broadcasting millions of pounds of pesticides into the environment annually inevitably affects animals and plants other than those which are targeted. The U.S. Fish and Wildlife Service has identified 170

pesticides which are fatal to fish as a result of short-term exposure, 91 pesticides which are toxic to birds, and 70 pesticides toxic to mammals. About half of these pesticides have been associated with documented kills in the field.²⁹

However, observed, reported and confirmed kills represent only the tip of a very wide pyramid, the largest portion of which are mortality events which are simply not observed.³⁰ One reason is that carcasses are scavenged quickly. A study which placed 78 carcasses of song birds in 23 corn fields found that between 62 and 92 percent of them were scavenged within 24 hours.³¹

Of course, non-mortality effects on wildlife are even more rarely observed in the field, and the extent of their impacts can only be estimated. "There is evidence that pesticides have indirect, sublethal, and very subtle impacts that impair the ability of wildlife to eat, survive and reproduce," says Dr. Mary G. Henry, Deputy Chief of the Division of Environmental Quality of the U.S. Fish and Wildlife Service. "And what the population implications are, no one really knows."³²

Appendix C is based on the pesticide sales data presented in Appendix A. It lists 44 pesticides sold in Minnesota which have been identified as acutely toxic to wildlife (i.e.,

Forty-four pesticides sold in Minnesota, accounting for 11 million pounds, are acutely toxic to fish. Thirty-seven pesticides, representing 6.3 million pounds in sales, are acutely toxic to aquatic invertebrates, important food sources for fish.

half of the exposed laboratory organisms were killed within a few hours or days after an oral dose below the threshold shown in the note below the table). Again, this information indicates only that contact with these pesticides creates the potential for mortality episodes. The number of actual exposures to such doses cannot be known.

29 Linda Lyon, U.S. Fish and Wildlife Service, Division of Refuges, *Environmental concerns of common pesticides*, June 1999.

30 Nimish B. Vyas, "Factors influencing estimation of pesticide-related wildlife mortality," *Toxicology and Industrial Health*, vol. 15, nos.1-2 (1999).

31 R. Balcomb, "Songbird carcasses disappear rapidly from agricultural fields," *Auk*, vol. 103 (1986), pp. 817-820.

32 Personal interview, April 2001.

Millions of Pounds of Pesticides Are Toxic to Fish and Aquatic Invertebrates, Posing Risks to Ducks as Well

What is most dramatic is the number and amount of pesticides used in Minnesota that are acutely toxic to fish. Thirty-seven pesticides are so categorized, amounting to sales of more than 11 million pounds, one-third of total state sales. Two dozen pesticides, accounting for sales of over 6 million pounds, are acutely toxic to aquatic invertebrates, including crustaceans and insects which are important food sources for fish and waterfowl.

In fact, it is the effect of pesticides on these food sources and on the aquatic plants which serve as their habitat which poses risks to duck populations. Female ducks depend on these invertebrates as sources of protein and calcium during egg-laying; ducklings are dependent on insects during their first few days of life. As one study concluded:³³

Herbicides that enter wetland systems may have direct toxic effects on aquatic plants and invertebrates, and therefore, may indirectly affect the reproduction and survival of waterfowl by altering food and cover . . . [T]he feeding habits and foraging behavior of juvenile and adult waterfowl may . . . make them particularly vulnerable to pesticide-induced reductions in aquatic invertebrates and plants.

Of course, not all pesticides reach wetlands and water bodies at lethal concentrations. However, studies have shown that exposure to sub-lethal concentrations of pesticides used in Minnesota also harm fish, causing skeletal deformations,³⁴ immune system suppression,³⁵ and reproductive abnormalities,³⁶ among other effects.

“[T]he feeding habits . . . of juvenile and adult waterfowl may . . . make them particularly vulnerable to pesticide-induced reductions in aquatic invertebrates and plants.”

– *Proceedings of the National Symposium on the Protection of Wetlands from Agricultural Impacts, 1988.*

Sensitive aquatic communities are also susceptible to disruption from non-lethal levels of pesticides. One study, in which freshwater ecosystems contaminated with the insecticide fenvalerate lost up to one-third of their species, concluded, “The probable impoverishment of the community structure in such waters due to repeated inputs of pesticides, followed by secondary changes, may therefore be a threat to the successful maintenance of a species-rich and diverse environment.”³⁷ Other studies have shown that atrazine concentrations as low as 1 ppb reduced photosynthesis among algae by 21 to 82 percent, reducing the food source of a variety of organisms.³⁸

33 Christian E. Grue et. al., "Agricultural chemicals and the quality of prairie-pothole wetlands for adult and juvenile waterfowl – what are the concerns?" in P.J. Stuber (coord.), *Proceedings of the National Symposium on the Protection of Wetlands from Agricultural Impacts*, U.S. Department of the Interior, Fish and Wildlife Service Biological Report 88 (16), 1988, p. 59. See also P.J. Sheehan et. al., *The Impact of Pesticides on the Ecology of Prairie Nesting Ducks*, Technical Report Series, No. 19, Canadian Wildlife Service, 1987, pp. 7.28, 9.4 and 9.21.

34 G.W. Holcombe et. al., "The acute toxicity of kelthane, Dursban, disulfoton, pydrin, and permethrin to fathead minnows *Pimephales promelas* and rainbow trout *Salmo gairdneri*, *Environmental Pollution (Series A)*, vol. 29 (1982), pp. 167-178; J. Couch et. al., "Vertebral dysplasia in young fish exposed to the herbicide trifluralin," *Journal of Fish Disease*, vol. 2 (1979), pp. 35-42.

35 K. O'Halloran et. al., "Response of fish immune cells to in vitro organotin exposures," *Aquatic Toxicology*, vol. 40 (1998), pp. 141-156.

36 C.I. Wong et. al., "Androgen receptor antagonist versus agonist activities of the fungicide vinclozolin relative to hydroxyflutamide," *Journal of Biological Chemistry*, vol. 270 (1995), pp. 19998-20003; Steven L. Goodbred et. al., *Reconnaissance of 17 β -Estradiol, 11-Ketotestosterone, Vitellogenin, and Gonad Histopathology in Common Carp of the United States Streams: Potential for Contaminant-Induced Endocrine Disruption*, U.S. Geological Survey Open-File Report 96-627, 1996.

37 P. Woin, "Short- and long-term effects of the pyrethroid insecticide fenvalerate on an invertebrate pond community," *Ecotoxicology and environmental safety*, vol. 41, no. 2 (October 1998), pp. 137-156.

38 F. deNoyelles et. al., "The responses of phytoplankton communities in experimental ponds to atrazine, the most heavily used pesticide in the United States," *Ecology*, vol. 63, no. 5 (1982), pp. 1285-1293; P.B. Hamilton et. al., "The impact of atrazine on lake periphyton communities, including carbon uptake dynamics using track autoradiography," *Environmental Pollution*, vol. 46 (1987), pp. 83-103.

Impacts on Bees and Earthworms May Lower Agricultural Productivity

Appendix C also reveals that 16 pesticides sold in Minnesota are acutely toxic to mammals, and a dozen are toxic to birds and bees. With respect to the latter, it is no small irony that many non-targeted organisms susceptible to pesticide poisoning provide valuable services – at no cost – that enhance agricultural production. Because humans depend on pollination for one-third of the food we eat, the potential risk is large. It has been estimated that pollination losses due to pesticides amount to fully 10 percent of the total value of pollinated crops, \$15 billion in 1998.³⁹ Further, these impacts are long-lived: it usually takes five years or longer for bee populations reduced by pesticide applications to recover.⁴⁰

A single application of the insecticide carbaryl at labeled rates has been shown to reduce earthworm populations by 60 to 99 percent.⁴¹ Nine other insecticides and fungicides used in Minnesota also cause significant earthworm mortality.⁴² Earthworms play a valuable ecological role in enhancing crop growth. They make the soil porous for maximum plant growth and increase its ability to absorb and hold water; neutralize soil acidity and make nutrients more available to plants, stimulate nitrogen-fixing soil microorganisms and help control soil erosion. Some of these functions can be accomplished – though not as well – by human intervention, but only at a significant cost of energy and resources.⁴³

Amphibians May Be Harmed At Low Concentrations

Appendix C does not address a phenomenon that was first discovered in Minnesota more than five years ago, but which has since been found in many areas throughout the U.S. and the world: deformed frogs. Various limb deformities among several species of frogs have been attributed to exposure to pesticides or other toxic chemicals, ultraviolet radiation, and parasites. While many researchers continue to study the problem, no consensus has yet developed regarding causal factors. However, David Gardiner, a biologist in the Department of Developmental and Cell Biology at the University of California at Irvine, who is studying Minnesota water samples in which deformed frogs were found, under a grant from the EPA, recently stated, “All the evidence we’ve seen to date regarding frog deformities in Minnesota indicates that pesticides are still a prime suspect.”⁴⁴

“All the evidence we’ve seen to date regarding frog deformities in Minnesota indicates that pesticides are still a prime suspect.”

– David Gardiner, Department of Developmental and Cell Biology,
University of California at Irvine

A recent study of gray treefrog tadpoles indicates that traditional laboratory tests of the kind used to establish regulatory standards may greatly underestimate the impacts of many pesticides on wildlife. Extending the period of exposure beyond the typical four

days significantly increased mortality, even at much lower pesticide concentrations. Exposed to levels of the insecticide carbaryl at low concentrations (.05 ppb), 10 to 60 percent of the tadpoles died by the 11th day. Further, when a caged natural predator was present, increasing tadpole stress, exposure to the pesticide became two to four times more lethal, killing 60 to 98 percent of the tadpoles.

The authors concluded, “[U]nder more realistic conditions of increased exposure times and predatory stress, current application rates for carbaryl can potentially devastate gray treefrog populations. Further, because predator-induced stress is ubiquitous in animals and carbaryl’s mode of action is common to many pesticides, these negative impacts may be widespread in nature.”⁴⁵

39 David Pimentel et. al., “Environmental and economic costs of pesticide use,” *Bioscience*, vol. 42, no. 10, 1992, p. 754; University of Nebraska Cooperative Extension, *Protecting Bees When Using Insecticides*, 1998.

40 P.G. Kevan and R.C. Plowright, “Fenitrothion and insect pollination,” in W.R. Ernst et. al. (eds.), *Environmental effects of fenitrothion use in forestry: impacts on insect pollinators, songbirds, and aquatic organisms*, 1989, pp. 13-42, quoted in World Wildlife Fund Canada, *Beneficial bugs at risk from pesticides*, June 1999, p. 18.

41 D.A. Potter et. al., “Toxicity of pesticides to earthworms (Oligochaeta: Lumbriidae) and effect on thatch degradation in Kentucky bluegrass turf,” *Journal of Economic Entomology*, vol. 83, no. 6 (1990), pp. 2362-2369.

42 Diazinon, carbofuran, mancozeb, chlorpyrifos, terbufos, fonofos, tefluthrin, chlorethoxyfos, and phorate. Beneficial bugs at risk from pesticides, p. 40; Chris DiFonzo, “Soil insecticides impact on earthworms,” *Michigan State University Field Crop Advisory Team Alert*, vol. 15, no. 3 (April 27, 2000), p. 3.

43 *Beneficial bugs at risk from pesticides*, pp. 38-39.

44 Personal interview, February 2001.

45 Rick A. Relyea and Nathan Mills, “Predator-induced stress makes the pesticide carbaryl more deadly to gray treefrog tadpoles (*Hyla versicolor*),” *Proceedings of the National Academy of Sciences*, vol. 98, no. 5 (February 13, 2001), pp. 2491-2496.

Endocrine Disruption Effects Have Been Documented in Animals

In recent decades, research has focused on a newly-discovered mechanism by which exposure to certain toxic chemicals can disrupt normal development patterns in wildlife and, perhaps, in humans as well. Known as endocrine disruptors, these chemicals can affect the endocrine system, which operates by secreting hormones to control important developmental and homeostatic mechanisms, including the reproductive system, brain development, and other important functions. They can interfere with endocrine function in several ways: via hormone synthesis, storage, release, transport, receptor recognition, binding, and postreceptor activation.

These chemicals can easily pass from the mother to the developing organism during gestation, where they can have great impact at extremely low concentrations, well below EPA food tolerances. Exposures during periods when critical organs or systems are developing can produce effects in the offspring which are irreversible.

“Impaired reproduction and development causally linked to endocrine disrupting chemicals are well documented in a number of species and have caused local or regional population changes.” – *European Union Report, 1999.*

Several cases of harmful effects on wildlife from exposure to endocrine disrupting pesticides have been identified: Distorted sex organ development and function in male alligators in a Florida lake following a pesticide

spill; the development of male sex organs among female marine snails exposed to tributyltin compounds used in antifouling paints on ships; and feminization of male gull embryos exposed to a variety of organochlorine insecticides, which may contribute to population declines and skewed sex ratios in herring gulls in the Great Lakes.⁴⁶

Laboratory studies reveal similar effects. A committee created by the European Union to study endocrine disrupting effects drew the following conclusions in 1999:⁴⁷

There is strong evidence obtained from laboratory studies showing the potential of several environmental chemicals to cause endocrine disruption at environmentally realistic exposure levels. In wildlife populations, associations have been reported between reproductive and environmental effects and endocrine disrupting chemicals. . . . Impaired reproduction and development causally linked to endocrine disrupting chemicals are well documented in a number of species and have caused local or regional population changes. [Emphasis in original.]

The committee added that additional laboratory studies of wildlife are needed to establish more causal links with endocrine-disrupting chemicals.

A National Academy of Sciences report published in 2000 reviewed several studies of endocrine effects on wildlife and concluded that they “have shown that exposure of these animals during development to a variety of concentrations of [endocrine disruptors] . . . can produce structural and functional abnormalities of the reproductive tract.”⁴⁸ Similarly, a panel established by the National Toxicology Program of the National Institute of Environmental Health Sciences reported in May 2001, “Low-dose effects . . . were demonstrated in laboratory animals exposed to certain endocrine active agents.”⁴⁹

46 U.S. Environmental Protection Agency, Office of Research and Development, *Special Report on Environmental Endocrine Disruption: An Effects Assessment and Analysis*, February 1997, pp. 7-8.

47 Working Group on Endocrine Disruptors of the Scientific Committee on Toxicity, Ecotoxicity and the Environment, European Union, *CSTEE Opinion on Human and Wildlife Health Effects of Endocrine Disrupting Chemicals, with Emphasis on Wildlife and Ecotoxicology Test Methods*, March 1999, p. 6.

48 National Academy of Sciences, *Hormonally Active Agents in the Environment*, 2000, p. 4.

49 National Toxicology Program, *Endocrine Disruptors Low Dose Peer Review*, May 14, 2001, p. vii.

For example, female newts born to mothers exposed to 5 ppb of the pesticide endosulfan during pregnancy had malformed glands that play an important role in mating by synthesizing a pheromone used to attract males. As a result, mating success declined by 67 percent.⁵⁰

Another study found prostate weights of mice born to mothers exposed to 20 ppb of the insecticide methoxychlor to be 60 percent higher than offspring of unexposed mothers.⁵¹

Other Unintended Ecological Effects

Indirect ecological damage refers to the poisoning of predators and parasites of harmful insects, resulting in what are called secondary pest problems. A well-known case occurred in 1995, when spraying of 200,000 acres of Texas cotton fields infested with boll weevils also wiped out a host of beneficial insects that normally controlled cotton aphids, beet armyworms, and sweet potato whiteflies. As a result, these pests went unchecked, and 80 percent of the crop was lost.⁵²

Another ecological irony of reliance on pesticides is the increasing number of weeds, insects, and plant

“The alteration to fish and wildlife habitat – including the food base and pollinators – caused by widespread distribution of pesticides in Minnesota’s environment is of great ecological concern. These pesticide effects are difficult to quantify, yet are likely far more pervasive than we will ever be able to document.”

– Dave Warburton, environmental contaminants biologist,
U.S. Fish and Wildlife Service, Twin Cities Field Office

pathogens that have become immune to specific pesticides and, often, to entire classes of pesticides. In 1986, the National Research Council estimated that there were 48 weed species resistant to herbicides and 100 species of plant pathogens resistant to fungicides. Ten years later, the EPA estimated that these numbers had grown to 270 and 150, respectively, and that

500 species of insects and mites were resistant to insecticides. A report by the country’s major professional association of plant disease scientists concluded that the capacity of pathogens to adapt themselves to fungicides “makes it difficult to be optimistic that organic chemistry will be able to solve the fungicide resistance problem.”⁵³

It has been estimated that 10 percent of all pesticide applications (and costs) are directed to combat increased resistance. (The initial reaction is to apply heavier doses or make more frequent applications, with attendant increased health and ecological impacts.) In some cases, acreages have been abandoned because pesticides have become ineffective as a result of pest resistance.⁵⁴

On yet another ironic note, there is evidence that pesticide residues in soils may actually stimulate the rate of pest reproduction, either by affecting their metabolism or by making plants more nutritious.⁵⁵

These ecological impacts of pesticide application remind us of the risks of introducing poisons into sensitive and highly interconnected ecosystems. Perhaps the greatest irony is that as we destroy nature’s ability to combat pests and to enhance agricultural productivity, we are forced to become even more dependent on these technological substitutes.

50 D. Park et. al., “Endosulfan exposure disrupts pheromonal systems in the red-spotted newt: a mechanism for subtle effects of environmental chemicals,” *Environmental Health Perspectives*, vol. 109, no. 7 (July 2001), pp. 669-673.

51 W.V. Welshons et. al., “Low-dose bioactivity of xenoestrogens in animals: fetal exposure to low doses of methoxychlor and other xenoestrogens increases adult prostate size in mice,” *Toxicology and Industrial Health*, vol. 15, no. 1/2 (1999), pp. 12-25.

52 Charles M. Benbrook et. al., *Pest management at the crossroads* (Yonkers: Consumers Union), 1996, pp. 145-146.

53 *Ibid.*, pp. 48-53.

54 Pimentel, pp. 753-754.

55 Michael J. Raupp et. al., *Biological control of insect and mite pests of woody landscape plants: concepts, agents and methods*, Maryland Cooperative Extension Service, 1993.

The impact of pesticides on wildlife is hard to see, but no less significant as a result. Dave Warburton, environmental contaminants biologist with the U.S. Fish and Wildlife Service's Twin Cities Field Office, characterized the impact as follows: "The alteration to fish and wildlife habitat – including the food base and pollinators – caused by widespread distribution of pesticides in Minnesota's environment is of great ecological concern. These pesticide effects are difficult to quantify, yet are likely far more pervasive than we will ever be able to document."⁵⁶

⁵⁶ Personal interview, February 2001.

CHAPTER 5

PESTICIDES AND POTENTIAL HUMAN HEALTH RISKS: WHAT WE KNOW, WHAT WE DON'T KNOW, WHAT IS UNCERTAIN, AND WHAT WE SHOULD DO

Introduction

One of the most important facts uncovered in MCEA's research, and one which we believe is unknown to most Minnesotans, is the high degree of scientific uncertainty regarding the health effects of exposure to low levels of pesticides, such as those routinely found in Minnesota rivers and groundwater and as residues on more than half the foods sampled by the U.S. Department of Agriculture.

This issue is important because, as shown below, MCEA's analysis found that millions of pounds of pesticides sold in Minnesota have been identified as carcinogens, endocrine disruptors, and reproductive toxins. The relevant question is: At what level of exposure are such effects produced?

There is no question that exposures to high concentrations of pesticides harm human health, as we know from the thousands of pesticide poisonings reported annually. Similarly, animal testing conducted by the EPA provides evidence that high concentration exposures can lead to cancer, reproductive system abnormalities, and other serious impacts.

Scientists also agree that exposure to certain chemicals can permanently alter the development of the brain, nervous, reproductive, and immune systems of animals exposed during gestation. These "endocrine disruptors," which include many pesticides, can produce these effects at concentrations well below those at which federal standards are set.

Although the human endocrine system is very similar to that of animals, there is as yet no consensus as to whether a similar mechanism is at work in humans. But we know that many of the kinds of effects consistent with those which endocrine disruptors produce in animals – such as testicular cancer and other reproductive abnormalities, and learning and behavioral disabilities – are growing. Such links have not been proven, however, and chemical tests are still being developed to screen substances for endocrine disrupting properties.

Another missing part of the puzzle is that the EPA does not require the kinds of tests that would reveal these more subtle effects in animals, such as tests of the developing brain, nervous and immune systems. Nor are tests required to be conducted specifically on developing animals.

Amid all these uncertainties, two things are clear: No one can say for sure that exposure to low concentrations of pesticides does or does not cause harm. And there is no assurance that further decades of study will produce a consensus one way or the other.

Given what we know and the magnitude of the risks attached to questions we don't yet know enough about, MCEA believes it is prudent policy for the state of Minnesota to take action, where economically feasible, to reduce the amount of pesticides present in the environment, and thereby lower the likelihood of exposures.

As Dr. Deborah Swackhamer, professor of environmental chemistry at the University of Minnesota, and director of the Midwest Ecological Risk Assessment Center, has said:⁵⁷

Given that these compounds are manufactured specifically to induce toxicity in plants and animals in the environment, coupled with the fact that many of them currently or historically have been found to contaminate our environment, pesticides pose a high potential ecological and human health risk. We need to be very cautious in our use and distribution of these compounds, and always give this risk high priority when considering the benefits of their use.

What We Know: Research Categorizes Potential Health Risks of Pesticides Sold in Minnesota

How the EPA Regulates Pesticides to Protect Public Health

When the federal law regulating pesticides, the Federal Insecticide, Fungicide, and Rodenticide Act, was passed by Congress in 1947, the shorthand bill description read, "AN ACT To regulate the marketing of economic poisons. . . ." These chemicals are poisons; their function is to kill. The targets for killing include plants, insects, and other "pests" that interfere with the optimal growth of crops, ornamental plants, lawns, or which infiltrate man-made structures.

But humans are not necessarily resistant to these poisons, which invariably spread beyond their point of application. The EPA's testing of pesticides and its setting of standards are designed to protect public health from exposure to pesticides at levels which can cause harm.

Before a pesticide can be legally sold in the U.S., it must first be registered by the EPA. Under the Federal Food Quality Protection Act, passed in 1996, the EPA must find that the pesticide can be used with "reasonable certainty of no harm." To make this determination, EPA requires the manufacturer to conduct a battery of animal tests at independent laboratories and submit the results to the EPA for its review.

The EPA's assessment of human health risks has four steps: identifying potential health effects; extrapolating the dose levels at which adverse effects are found in test animals to humans; assessing human exposure to the pesticide via food, water, through personal use, and at the workplace; and risk characterization, combining these steps to describe the overall risk.

For pesticides used on food, EPA uses this information to set a tolerance, or maximum residue limit, the amount of pesticide residue allowed to remain on each food on which the pesticide is used. Tolerances are based on the lowest dose at which adverse effects have been detected, adjusted by a large safety factor, e.g., 1/100th of that level. Thus, many pesticides which EPA has determined cause cancer or other health problems are registered, but tolerances are set well below the level at which the pesticides are believed to cause these effects in humans, based on current testing and research. The EPA also sets maximum rates at which pesticides can be used on various crops, so that these tolerances will not be exceeded. These application rates are printed on the product label along with other restrictions on use, and have the force of law.

⁵⁷ Personal interview, March 2001.

Despite Underreporting, Pesticide Poisonings Are Widespread

One source of information regarding health impacts of pesticide exposure is a database maintained by the American Association of Poison Control Centers. In 1999, 60 regional centers around the country were notified of 68,942 pesticide poisonings in that year. Of these, 13,793 cases (20 percent) were treated at health care facilities. "Moderate" outcomes (such as high blood pressure, rapid heartbeat, and lung infections) were reported in 2,640 of these cases, and "major" outcomes (such as coma and respiratory failure) in 199 cases. Fifteen deaths were reported. Regarding underreporting, the Association estimated that if all states had the rate of incidence per 1,000 population of the state with the highest incidence rate, the number of reported incidents would rise by 227 percent.⁵⁸

Laboratory Studies Have Found Potential Health Risks

MCEA utilized the information developed on the amount of sales of various pesticides used in Minnesota to analyze the potential health impacts of exposure to these toxins. Of the 165 active ingredients sold in Minnesota for agricultural uses in 1998, 52 percent have been identified by the EPA or state environmental regulatory agencies as posing risks of cancer or reproductive harm, as affecting the developing endocrine system, or as acute toxins or nerve toxins.

This is not to say that exposure to these pesticides insures that an individual will automatically develop these effects. That depends on a number of factors: concentration and length of time of the exposure, safety precautions taken,⁵⁹ and many others. Genetics also plays a role by affecting the body's ability to detoxify pesticides.⁶⁰

Appendix D shows the agricultural pesticides sold in Minnesota that are associated with such effects.

20 Million Pounds of Pesticides Sold in Minnesota Are Known, Probable, or Possible Carcinogens

Appendix D shows that 22 active ingredients sold in Minnesota, collectively accounting for 7.4 million pounds sold, have been identified by the EPA as known or probable carcinogens. An additional 34 active ingredients (12.9 million pounds) are classified by the EPA as possible human carcinogens. Nine of the 11 pesticides which recorded sales of 1 million pounds or greater are known or suspected carcinogens.

More Than 3 Million Pounds Are Reproductive Toxins

A 1986 law passed in California requires the state to list chemicals known to cause reproductive harm, including birth defects, infertility, sterility, and impairment of normal growth and development. Appendix D identifies the 19 active ingredients sold in Minnesota in 1998 which are on that list, amounting to 3.4 million pounds.

Almost Twelve Million Pounds Are Endocrine Disruptors

The extent to which endocrine disrupting effects similar to those observed among animals may occur among humans is still unknown. Effects consistent with such a hypothesis have been increasingly observed in recent decades, such as increased incidence of testicular, prostate, and breast cancer. However, as one study concluded, "Although there are associations between endocrine disrupting chemicals . . . and human health disturbances, a causative role . . . has not been verified."⁶¹

58 S. Litovitz et. al., "1999 Annual Report of the American Association of Poison Control Centers Toxic Exposure Surveillance System," *American Journal of Emergency Medicine*, vol. 18, no. 5 (September 2000), pp. 518, 556-558.

59 A survey of Wisconsin farmers certified to apply restricted use pesticides in counties with high pesticide use is somewhat discouraging on this point. Fifty-four percent of those surveyed reported "never or almost never" using protective gear; 12 percent gave the same response with respect to gloves. Thirty-two percent reported that their skin was exposed to pesticides during their most recent application; the same percentage reported inhaling pesticides. Melissa J. Perry and Peter M. Layde, "Sources, routes, and frequency of pesticide exposure among farmers," *Journal of Occupational and Environmental Medicine*, vol. 90, no. 8 (August 1998), pp. 697-701.

60 Scientists have found at least a 15-fold difference in humans in the ability to metabolize a toxic breakdown product of the pesticide chlorpyrifos. Those with a genetic makeup making them highly resistant to the effects of the pesticide parathion appear to be very susceptible to the effects of diazinon, and vice-versa. Joel Grossman, "What's hiding under the sink: dangers of household pesticides," *Environmental Health Perspectives*, vol. 103, no. 6 (June 1995), pp. 550-555.

61 *CSTEE Opinion* . . . , p. 5.

One of the better documented cases of human endocrine effects from environmental exposure found that children of mothers who ate Great Lakes fish contaminated with PCBs, dioxins, and pesticides had lower IQs and more neurodevelopmental problems than unexposed children.⁶² In a second case, sons of mothers who were exposed to the drug DES during pregnancy had reproductive tract abnormalities at four times the rate of unexposed males.⁶³

In weighing the strengths and weaknesses of the data pertaining to human endocrine effects, the EPA stated:⁶⁴

The observation that humans have experienced increased incidences of developmental, reproductive, and carcinogenic effects, and the formulation of a working hypothesis that these adverse effects may be caused by environmental . . . [endocrine disruptors] is supported by observations of similar effects in aquatic and wildlife species. In other words, a common theme runs through both human and wildlife reports. The hypothesis is also strengthened by the fact that cancer and noncancer effects . . . are related in large part to reproductive structure and function.

The EPA cited as weak points of the hypothesis the fact that the body has mechanisms which can regulate minor increases of environmental hormones, and that the low concentrations of such chemicals and their low level of bonding with target receptors make an adverse response in adults unlikely. However, EPA admitted that whether the fetus and the young can regulate these changes "is uncertain."⁶⁵

EPA concluded: "With few exceptions (i.e., DES), a causal relationship between exposure to a specific environmental agent and an adverse effect on human health operating via an endocrine disruption mechanism has not been proven. However, . . . certain persistent chemicals might be responsible for some of the recently-reported reproductive, developmental, and carcinogenic effects operating through an endocrine disruption mechanism. . . ."⁶⁶ A great deal of research is currently being conducted to assess the effects of endocrine disrupting chemicals on humans.

Thirty pesticides sold in Minnesota in 1998 are classified by the State of Illinois and other sources as endocrine disruptors, totaling 11.8 million pounds. These include four of the state's 10 largest-selling pesticides – atrazine, alachlor, metolachlor, and 2,4-D – all of which are corn herbicides.

EPA Risk-Setting Process Flawed

Herbert Needleman, M.D.,
University of Pittsburgh Medical School

A year ago, I was appointed to EPA's Scientific Advisory Panel (SAP), and I began to try to understand the issue of pesticides and their regulation. I participated in the regulation of malathion in August 2000. I want to tell you about this because it is informative and helpful in understanding how things get regulated or how they do not get regulated. The issue was, "Is malathion a carcinogen?" EPA reviews laboratory animal (rats and mice) data, looking at four dose levels – low, medium, high and very high. Then the animals are sacrificed and examined by pathologists for cancer. In February 2000, the Cancer Assessment Review Committee (CARC) classified malathion as a likely human carcinogen. The evidence produced from the rodent studies was persuasive that malathion was a carcinogen and it was likely to have this effect in humans. In April, CARC reconvened and downgraded the definition to "suggestive of carcinogenicity, but not sufficient to assess human carcinogenic potential." There were no new studies done that led to this revision. Instead, the manufacturer requested a review committee to reevaluate the pathology slides. The number of carcinomas in exposed mice, originally 16, was reduced to eight. If one is permitted after looking at exposed groups and diagnoses to exclude selected groups and to change selected diagnoses, one can achieve, with little effort, any association [one] wants. If EPA permits this type of analysis for government regulation, its credibility will be severely and justifiably damaged. The conclusions drawn by CARC violate the canons of epidemiology. If written up and submitted to a high quality scientific journal, they would be rejected out of hand. They would never see the light of day.

– *Beyond Pesticides/National Coalition Against the Misuse of Pesticides, Pesticides and You*, vol. 20, no. 3 (Fall 2000), pp. 15-16.

62 *Hormonally Active Agents*, p. 5.

63 Gill, W.B. et. al., "Association of diethylstilbestrol exposure in utero with cryptorchidism, testicular hypoplasia and semen abnormalities," *Journal of Urology*, vol. 122 (1979), pp. 36-39, quoted in Special Report on Environmental Endocrine Disruption, p. 39.

64 *Special Report on Environmental Endocrine Disruption*, p. 5

65 *Ibid.*, p. 6.

66 *Ibid.*

Nearly Three Million Pounds Are Acute Toxics

The EPA rates pesticides according to their acute toxicity, which refers to the immediate effects of exposure. The categories are based on the dose that kills 50 percent of the test animals exposed to it through ingestion, absorption through the skin, or inhalation. Highly acute pesticides can be lethal at very low doses.

Of the 33 million pounds of active ingredients sold in Minnesota in 1998, 7.4 million pounds have been identified as known or probable carcinogens, 3.4 million pounds as reproductive toxins, and 11.8 million pounds as potential endocrine disruptors.

Appendix D shows that 19 active ingredients totaling sales of 2.7 million pounds are classified as high acute toxicity pesticides. Alachlor and the insecticides terbufos and carbofuran are the largest selling pesticides in this category.

Nearly 3 Million Pounds Are Nerve Toxins

Pesticides in some chemical classes – organophosphates, carbamates, pyrethroids, and organochlorines – are nerve toxins, killing insects by interfering with the electrical signals delivered by the nervous system. In humans, exposure to these nerve toxins, similar to those developed for chemical warfare, can have effects ranging from dizziness and blurred vision to vomiting, twitching, abdominal cramping, breathing difficulty, and, if untreated, death.

Appendix D lists 21 nerve toxins sold in Minnesota, totaling 2.7 million pounds. The biggest sellers include the corn herbicide EPTC and the insecticide terbufos.

We now turn from examining the known risks of pesticide exposure to considering the unknown risks, which are no less a cause for concern.

What We Don't Know: Why Pesticides Registered by the EPA May Not Be Safe

Most people believe in two related myths regarding pesticide regulation: that the purpose of such regulation is to protect human health, and that pesticides are thoroughly tested and are not permitted to be marketed unless they have been proven to be safe.

Nothing could be further from the truth.

Myth No. 1: Pesticides Have Always Been Regulated To Protect Public Health

It will surprise most people to learn that during the first 50 years of pesticide regulation by the federal government, safety was just one element of a larger cost-benefit analysis that determined whether pesticides were registered for use. Regulators were required to allow sale of a pesticide, despite potential harm, unless it posed “an unreasonable risk to the environment, taking into account the **economic, social,** and environmental costs and benefits of [its] use. . . .”⁶⁷ [Emphasis added.]

This circumstance was readily acknowledged by the EPA in a 1993 White Paper: “EPA registration does not mean a pesticide is safe. . . [A]n EPA registration does not constitute a general finding of ‘safety,’ but rather, that EPA has not found that the risks exceed the benefits associated with its use.”⁶⁸

67 7 U.S.C. § 136 (bb).

68 U.S. EPA, *Lawn Care Pesticides White Paper*, February 1993, Appendix VI, p. lxxiii.

Safety did not become the sole basis for pesticide regulation until passage of the Federal Food Quality Protection Act in 1996. This law allows the EPA to establish a tolerance (limit) for pesticide residues on food only if it is “safe,” which is defined as “reasonable certainty that no harm will result from aggregate exposure” to the pesticide from all dietary and other exposures.⁶⁹

Food Quality Protection Act: A Positive, But Partial, Step

The Food Quality Protection Act made several fundamental changes in how the EPA assesses and manages pesticide exposure risks:

- Previously, the EPA only considered exposure from food, ignoring exposures from drinking water, home and garden uses, and other sources. Now, an aggregate exposure from all sources must be taken into account in setting tolerances (allowable pesticide residues on specific foods).
- Cumulative effects from different pesticides that affect the body in the same way (e.g., targeting the nervous system) must be taken into account in setting tolerances.
- If there is not enough information on health effects, a 10-fold safety factor is to be used to protect infants and children.
- The EPA is to develop methods to test pesticides for endocrine-disrupting effects.
- All existing tolerances (almost 10,000 for about 450 pesticides) are to be re-evaluated within 10 years to be sure they are safe for children.

It is simply too soon to tell whether the implementation of the Act by the EPA will result in greater protection of public health. However, it is clear that there are a number of issues pertaining to safety that the Act does not address, but which are crucial in order for the public to have confidence that its health is being adequately protected from pesticide-related risks. These issues are also relevant with respect to the findings above that pesticide contamination is widespread in Minnesota, but generally at concentrations well below standards and benchmarks set by the EPA and the MDH to protect public health.

Myth No. 2: Thorough Testing Means That All Pesticides Marketed Are Safe

If this myth were true, EPA would require the proper tests to adequately measure all the potential health risks posed by pesticide exposure, providing enough evidence to warrant a conclusion that exposures to concentrations below those levels are not harmful. Unfortunately, as shown below, this is not the case. One thing is certain: standards cannot protect us against risks that go unmeasured.

Why Exposure to Low Pesticide Concentrations May Not Be Safe: EPA’s Testing Gaps

There are serious omissions in the EPA’s pesticide testing regime – inadequate testing of neurodevelopmental, immune, and endocrine effects; not testing developing animals; truncating tests before effects are likely to appear; inadequate testing of inert ingredients and the effects of pesticide mixtures – that call on us to reexamine the degree of confidence we have that current standards are fully protective of human health and that exposures to concentrations below those levels are not harmful. It is not so much what we know that is cause for worry, but how much we don’t know. As Dr. David Wallinga, a physician who has closely examined the EPA’s testing requirements, stated, “Just because EPA approves a pesticide doesn’t mean it’s safe, especially for kids.”⁷⁰

⁶⁹ 21 U.S.C. 408(b)(2)(A)(i) and (ii).
⁷⁰ Personal interview, March 2001.

Tests Are Not Conducted For Many Important Health Effects

First, tests for many relevant health effects are simply not routinely required. Examples include tests for effects on the developing brain, and the immune and nervous systems. Although EPA considers 140 pesticides to be neurotoxicants, only nine have undergone neurodevelopmental toxicity testing, even though EPA guidelines for performing such tests have been available for a decade.⁷¹ Neurotoxicity tests that examine postnatal functioning, such as ability to perform complex tasks, learning and memory are rarely done.⁷²

In the fall of 1999, the EPA required manufacturers of the 34 cholinesterase-inhibiting neurotoxicants to conduct and submit tests of acute, subchronic, and developmental neurotoxicity within two years. This is helpful, but even if similar tests are required for the remaining pesticides identified as neurotoxicants, that provides no protection with respect to two additional groups of pesticides. The first group includes those that are not currently identified as neurotoxicants, but are cause for concern. In 1998, a group of EPA scientists examining these issues stated that we do not “currently have sufficient information to predict how many agents that are not neurotoxic . . . will cause developmental neurotoxicity.”⁷³ The second group includes new pesticides coming onto the market. Although the EPA has said that it plans to require neurodevelopmental toxicity tests for all pesticides, no official steps have yet been taken.

Developing Animals Are Not Always Tested

Second, even though we know that infants and children are more susceptible to the risks of pesticides, many tests are not required to be conducted on developing animals. For example, infants have a very low level of an enzyme needed to metabolize and break down organophosphate pesticides. Laboratory studies have shown that the lethal dose for some organophosphates in immature animals is only one percent of the lethal dose of adult animals.⁷⁴ Yet EPA’s guidelines for acute, subchronic and chronic toxicity, carcinogenicity, metabolic and pharmacokinetic tests, neurotoxicity, and immune system tests do not require testing of developing animals.⁷⁵

In May 2001, the report of a panel convened by the National Toxicology Program of the National Institute for Environmental Health Sciences concluded that “endpoints such as cancer of reproductive organs or neurodevelopmental effects are generally not evaluated in multigenerational studies,”⁷⁶ precluding findings of effects on developing organisms.

As the 1993 landmark National Academy of Sciences report, *Pesticides in the Diet of Infants and Children*, concluded:⁷⁷

[C]urrent and past studies conducted by pesticide manufacturers are designed primarily to assess pesticide toxicity in sexually mature animals. Only a minority of testing protocols have supported extrapolation to infant and adolescent animals. Current testing protocols do not, for the most part, adequately address the toxicity and metabolism of pesticides in neonates and adolescent animals or the effects of exposure during early developmental stages and their sequelae in later life.

The report recommended that “testing guidelines for a rat chronic toxicity/carcinogenicity study be modified to include in utero exposure during the last trimester, exposure through the mother’s milk, and after weaning, exposure through the diet.” With respect to neurotoxicity testing it warned that “data strongly suggest that exposure to neurotoxic compounds at levels believed to be safe for adults could result in loss of permanent brain function” if exposure occurred pre-natally or during early growth.⁷⁸ Low

71 Ted Schettler et. al., *In Harm's Way: Toxic Threats to Children's Development* (Boston: Greater Boston Physicians for Social Responsibility), May 2000, pp. 107-108.

72 Natural Resources Defense Council, *Putting Children First: Making Pesticide Levels in Food Safer for Infants and Children*, April 1998, p. 39.

73 U.S. EPA, Draft report of the toxicity working group of the EPA 10X task force: *Toxicity data requirements for assessing risks of pesticide exposure to children's health*, April 28, 1998, p. 12, quoted in *In Harm's Way*, p. 109.

74 J.M. Spyker and D.L. Avery, "Neurobehavioral effects of prenatal exposure to the organophosphate diazinon in mice," *Journal of Toxicology and Health*, 1977.

75 *Putting Children First*, pp. 27-37; L. Claudio et. al., "Assessment of the U.S. Environmental Protection Agency Methods for Identification of Hazards to Developing Organisms, Pt. 1: The Reproduction and Fertility Testing Guidelines," *American Journal of Industrial Medicine*, vol. 35, no. 6 (June 1999), pp. 543-553.

76 *Endocrine Disruptors Low Dose Peer Review*, p. vii.

77 National Academy of Sciences, *Pesticides in the Diets of Infants and Children*, 1993, p. 4.

78 *Ibid.*, quoted in *Putting Children First*, pp. 29, 31.

concentrations of pesticides are most likely to affect these more susceptible developing animals, but if they are not tested, we cannot assume that standards allowing higher exposures protect them.

Ted Schettler, a physician who has investigated regulatory responses to children exposed to toxic chemicals, found that, eight years after the Academy's report, and five years after passage of the 1996 Act, these problems are still unresolved:

"A thorough examination of EPA's pesticide testing requirements shows that fetuses, infants, and children are not adequately protected. Required tests do not routinely evaluate the impacts of pesticides on brain development and function."

– Dr. Ted Schettler, author, *In Harm's Way: Toxic Threats to Children's Development*.

A thorough examination of EPA's pesticide testing requirements shows that fetuses, infants, and children are not adequately protected. Required tests do not routinely evaluate the impacts of pesticides on brain development and function. Limited data show the exquisite sensitivity of the immature brain to pesticide exposures that have no discernable impacts on adults. The EPA has rarely exercised its authority to require neurotoxicity testing, leaving us with serious data gaps despite evidence of widespread exposure to neurotoxic pesticides.⁷⁹

Tests Often Ended Before Effects Can Be Seen

Third, developmental neurotoxicity tests do not follow animals long enough to determine effects. For example, EPA guidelines for the rarely done neurodevelopmental toxicity test have been criticized as being too short to reflect the entire period during which the development of a child's brain is vulnerable to pesticide exposure. That period extends from the third trimester to the end of the second year, corresponding to the first 21 to 28 days of life in rats or mice, not 10 days, as the guidelines indicate.⁸⁰

Inert Ingredients Not Tested

A fourth reason that current standards may underassess risk is because they ignore so-called "inert" ingredients in pesticides. The federal law regulating pesticides classifies any component of a pesticide product that is not the active ingredient as "inert," though they are certainly not inactive in a chemical sense. These inerts, which include solvents, sticking or wetting agents to increase the pesticide's effectiveness, can comprise 99 percent or more of the volume of household pesticides, and usually smaller percentages of agricultural pesticides.

There are three problems with the 2,300 inert ingredients classified by the EPA. First, most of them are not required to be identified on the product label, but are treated as confidential business information, so we don't even know the chemicals to which we are being exposed. Second, EPA's testing of inerts is inadequate: no tests of chronic toxicity, cancer, or reproductive effects are required, nor is testing of the actual combination of inert and active ingredient to which we are exposed. Third, of those inerts that are required to be identified on the label, 26 percent have been categorized by federal or state government agencies as hazardous to human health: probable carcinogens, neurotoxins, or substances that cause reproductive damage.⁸¹ To the extent that other untested inerts share these harmful characteristics, the health risks of pesticide exposure that are unaccounted for in current standards increase.

79 Personal interview, March 2001.

80 H.A. Tilson, "The concern for neurodevelopmental toxicity: is it justified, and what is being done about it?" *Environmental Health Perspectives*, vol. 103, Supp. 6 (September 1995), pp. 147-152; L. Claudio et. al., "Testing methods for developmental neurotoxicity of environmental chemicals," *Toxicology and Applied Pharmacology*, vol. 164, no. 1 (April 2000), pp. 1-14; both quoted in *In Harm's Way*, p. 111.

81 Northwest Coalition for Alternatives to Pesticides, *Toxic secrets: "inert" ingredients in pesticides, 1987-1997*, 1998, pp. 3, 5.

Tests on Endocrine System Not Yet Developed

Fifth, none of the standards accounts for the possible effects on the human endocrine system. If such effects in humans are found to occur in a similar fashion to those detected in animals, very low exposures, well below the concentrations at which EPA tests the effects of pesticides on animals, can have serious and irreversible impacts on brain development, the functioning of the immune system and the ability to successfully reproduce, if they occur at a crucial point in development.⁸²

These effects were determined by Congress to be so important that the Food Quality Protection Act mandated the EPA to develop a method to test pesticides to screen for potential endocrine disruptors. Recommendations for such a screening program were finalized in 1998, but it will be several years before such a program is in place. In the meantime, no tests for such effects are conducted. As the EPA stated in 1997, even its newly-developed reproductive and developmental testing guidelines, and its two-year cancer bioassay guidelines “were not designed to identify mechanisms of action of endocrine disruption,

Without the assurance that testing accurately reflects the actual risks posed by pesticide exposure, the notion that pesticides registered by the EPA are “safe” is unfounded.

subtle functional deficits, or ‘transplacental carcinogenesis’ that might result following exposures at critical stages of development not currently included in testing protocols.”⁸³

These gaps still exist, as documented in the findings of the National Toxicology Program’s peer review panel on low-dose endocrine effects: “[T]he current testing paradigm used for assessments of reproductive and

developmental toxicity should be revisited to see if changes are needed regarding dose selection, . . . age when animals are evaluated, and the endpoints being measured.”⁸⁴ Current standards do not protect us against the potential for harm from endocrine effects.

Pesticide Combinations Not Tested

Sixth, the standards are based on toxicity tests conducted on a single compound. In the real world, we are exposed to combinations of pesticides. For example, in the USGS’s national water quality studies, almost every surface water sample and half the groundwater samples with pesticide detections contained two or more pesticides.⁸⁵ More than half of all stream samples contained five or more pesticides.⁸⁶ And, as shown in Chapter 3, our food intake potentially exposes us to dozens of different pesticides.

Are the effects of exposure to combinations of pesticides additive, multiplicative, or antagonistic? Only additional study of specific pesticide combinations can answer this question.

One study examined the combined effects of the insect repellent DEET and the insecticide chlorpyrifos on hens. Neither chemical alone had any effect on the level of a brain enzyme called NTE, but a combined dose reduced levels of the enzyme by 26 percent.⁸⁷

Lacking information on the interactive effects of exposure to combinations of pesticides, we cannot accurately characterize the risks from exposures to low concentrations of these mixtures.

Conclusion: Many Critical Risks Remain Unassessed

82 Theo Colborn et. al., *Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival? A Scientific Detective Story* (Plume/Penguin: New York), 1997.

83 *Special Report on Environmental Endocrine Disruption*, p. 83.

84 *Endocrine Disruptors Low Dose Peer Review*, p. vii. A recent study on human endocrine effects addressed these very issues: “In light of the clinical experience in endocrine disease . . . we consider the traditional toxicologic low-dose testing (at best in the parts per million range) . . . may not be suitable for determining endocrine effects . . . [I]t is also important to expand the study spectrum to more sensitive endpoints, especially those relevant to endocrine effects . . . [including] behavioral and cognitive function.” Françoise Brucker-Davis et. al., “Significant Effects of Mild Endogenous Hormonal Changes in Humans: Consideration for Low-Dose Testing,” *Environmental Health Perspectives*, vol. 109, Supp. 1 (March 2001), p. 25.

85 U.S. Geological Survey, *The Quality of Our Nation’s Waters: Nutrients and Pesticides*, U.S. Geological Survey Circular 1225, 1999, p. 6.

86 *Ibid.*, p. 20.

87 Mohamed Abou-Donia et. al., “Increased Neurotoxicity Following Concurrent Exposure to Pyridostigmine Bromide, DEET, and Chlorpyrifos,” *Fundamental and Applied Toxicology*, vol. 34 (1996), pp. 201-222.

The potential effects of low concentrations of pesticides – especially with respect to endocrine effects and in pesticide mixtures, where their ability to cause harm may be great – have simply not been adequately explored.

This situation is similar to that faced at EPA in the early 1990s, when its re-registration program – requiring older pesticides to undergo recently-developed testing for certain health effects – was underway. The agency stated clearly that claims of safety had to await completion of those tests:⁸⁸

EPA believes that most pesticides – despite having an EPA registration – have not been adequately studied to determine their effects on people or the environment . . . EPA is now requiring many additional tests to bring these pesticide registrations up to current scientific standards. . . [T]his is another reason for not saying these pesticides have been tested and found to be safe.

Until the testing gaps described above are addressed, even the reassessments required under the Food Quality Protection Act – which will take at least another five years to complete – cannot reassure us that all potential risks of pesticide exposure are accounted for in health standards. Additional generations of children will continue to be exposed to unassessed risks.

As David Wallinga, M.D., who has closely studied EPA pesticide testing for many years, warns:⁸⁹

Pesticides are designed to be toxic to living things. Because humans share many of the same basic building blocks of life with animals and insects, pesticides can injure people as well. Children are quite vulnerable to injury from pesticide and other chemical exposures very early in life. This is especially true in the womb and just after birth when the brain, reproductive and other organ systems are still developing. Recent animal studies indicate that even low exposures to certain pesticides very early in life can impact learning, behavior and other critical brain functions.

Many pesticides disrupt the work of hormones. In animals, these pesticides have been found to affect the development of nipples, testicles and penises in males, decrease semen quality, change the timing of sexual maturity, and lead to abnormal behavior. Similarly, atrazine, the most widely used pesticide in the U.S., indirectly interferes with estrogen. As a medical doctor, I am concerned that our current pesticide practices make our children unwitting guinea pigs in a large-scale chemical experiment.

What Is Uncertain: Real-World Studies Examine Links Between Pesticide Exposure and Health Effects

EPA standards are based solely on laboratory tests of animals. Yet thousands of studies have been conducted to investigate links between pesticide exposures occurring to actual people through use of pesticides at their job or at home and a wide range of potential health effects: spontaneous abortions and stillbirths, birth defects, a variety of childhood and adult cancers, Parkinson's disease, and impaired neural development in children. Some studies look at a sample of those exposed to pesticides, such as pesticide

⁸⁸ *Lawn Care Pesticides White Paper*, Appendix VI, p. lxxiii.
⁸⁹ Personal interview, October 2001.

Some studies have found statistically significant correlations linking pesticide exposure to increased risk of infertility, spontaneous abortion, premature births and birth defects. Other studies have not found such links.

applicators, and compare the incidence of selected diseases with those in an unexposed group. Others examine cases of specific diseases and seek evidence of pesticide exposure.

These epidemiological studies suffer from a number of methodological weaknesses. For example, since these diseases are relatively rare, it

is difficult to amass a sample of sufficient size to achieve results which are statistically significant, that is, which could not have occurred for reasons unrelated to pesticide exposure.

Also, measures of pesticide exposure, the key variable the studies seek to correlate with the presence of health effects, are very poor. In some studies, exposure is assumed simply because a person worked in "agriculture." Finally, some studies fail to account for other factors that can play a role in causing disease, such as smoking, age, and exposure to other toxic chemicals.

Epidemiological studies are, by their nature, suggestive. They can only establish correlations between pesticide exposure and disease; they cannot establish causality, i.e., identify the biological mechanism by which pesticide exposure actually causes the disease. This fact does not diminish their value, for they can be useful in alerting scientists to a link between exposure and harmful effects. Such studies linking cigarette smoking with lung cancer resulted in a shift in public policy to discourage smoking even though it was only in the last few years that the scientific details of the precise mechanism which causes the disease was discovered.

What do these studies show? Some conclude that there is a positive and statistically significant relationship between pesticide exposure and the onset of these conditions. Some studies do not find a link. Results of more than 60 studies are presented in Appendix E. Several are review articles which examine many studies done on the same topic and attempt to characterize the current state of knowledge. Conclusions drawn by their authors are presented below:

- After examining more than 100 studies on pesticides and reproductive outcomes, the authors of a 1997 review article stated, "[W]e conclude that there is increasing evidence for reproductive and developmental effects of both maternal and paternal exposures. Areas of particular concern include infertility and time to pregnancy, spontaneous abortions, neural tube defects, and limb reduction defects."⁹⁰
- "The epidemiologic data linking specific pesticide exposures to . . . non-Hodgkin's lymphoma, leukemia, and multiple myeloma . . . are the strongest, whereas the data on soft-tissue sarcoma and for Hodgkin's disease are weak."⁹¹
- "The most convincing evidence suggests that herbicides can be human carcinogens arises from studies on non-Hodgkin's lymphoma . . . Most studies have revealed an elevated risk and those that have examined dose-response relationships have usually noted statistically significant trends."⁹²
- One researcher assessed the results of adult studies on pesticides and non-Hodgkin's lymphoma: "Despite such obvious and substantial exposure misclassifications, cohort studies have shown a surprising degree of consistency in linking pesticide-related activities to the risk of non-Hodgkin's lymphoma . . . Again, despite problems of exposure assessment, findings from case-control studies have lent support to the pesticides hypothesis."⁹³

90 L.E. Sever et. al., "Reproductive and developmental effects of occupational pesticide exposure: the epidemiologic evidence," *Occupational Medicine: State of the Art Reviews*, vol. 12, no. 2 (April-June 1997), pp. 305-325.

91 Dennis D. Weisenberger, "Human health effects of agrichemical use," *Human Pathology*, vol. 24, no. 6 (June 1993), p. 573.

92 Howard I. Morrison et. al., "Herbicides and cancer," *Journal of the National Cancer Institute*, vol. 84, no. 24 (December 16, 1992), pp. 1866-1874.

93 J.D. Buckley et. al., "Pesticide exposures in children with non-Hodgkin lymphoma," *Cancer*, vol. 89, no. 11 (December 1, 2000), p. 2316.

- The authors of a review on pesticides and childhood cancer concluded, "Most of the methodologic limitations . . . would cause studies to understate risk . . . , would bias true positive associations toward the null. Despite these limitations and the almost certain underestimate of risks that is occurring, it is striking that many of the reported increased risks are of greater magnitude than those observed in studies of pesticide-exposed adults."⁹⁴
- "[E]xisting data are insufficient to conclude that exposure to pesticides is a clear risk factor for [adult] brain tumors," stated reviewers of 17 studies.⁹⁵
- The authors of a review of 20 studies on pesticides and Parkinson's disease concluded, "More than half have shown statistically significant associations between pesticide exposure and [Parkinson's]. This is impressive, considering the variability in study design, case ascertainment, selection of controls, definitions of pesticide exposure, and, most importantly, geographical differences in pesticide usage."⁹⁶

The conclusions of most of these scientists lend support to the hypothesis that pesticide exposure can increase the risk of developing several serious health problems. However, other studies have reached different conclusions. Only one thing is certain: There is no firm consensus among scientists at the present time as to whether or not environmental exposures increase the risk of developing these conditions. Given this lack of consensus, how should we proceed?

Conclusion: What We Should Do

What are we to conclude from the material presented in this chapter and the sampling in Appendix E of what is an avalanche of studies and statistics on the potential health effects of pesticide exposure? How can we use this information to guide policy?

Delayed Action Entails Costs

Some would say that more study is needed before conclusions can be drawn which can serve as a basis for policy. But, if 30 years of study have produced no solid conclusions, there is no assurance that additional decades of research will resolve these questions. The methodological problems cited above cannot be fixed quickly with a few well-designed studies.

The science of this issue itself precludes one hundred percent certainty. The health effects to which pesticide exposure have been linked are **non-specific**: prostate cancer that may result from exposure to pesticides looks no different from prostate cancer caused by something else; there is no marker to identify pesticide exposure as the cause. These health effects also have **multiple** causes: for example, we know that genes play a role because of the considerable range across the population in the body's ability to detoxify and excrete organophosphate pesticides. Other factors influence the development of these diseases as well. This situation is very different from, say, the disease malignant mesothelioma, cancer of the lining surrounding the lung, which is uniquely associated with exposure to asbestos.

Further, we must consider the costs of waiting for a consensus which may never occur. As one study reminds us, "Even moderate risk elevations, however, appear noteworthy, given that **the population exposed to these agents is potentially widespread.**"⁹⁷ [Emphasis added.] And, one must add, the life-threatening or lifetime-impairing nature of these effects must also be borne in mind in considering a course of action.

94 S.H. Zahm and M.H. Ward, "Pesticides and childhood cancer," *Environmental Health Perspectives*, vol. 106, Supp. 3 (June 1998), p. 905.

95 Nicolaas I. Bohnen et. al., "Brain tumor and exposure to pesticides in humans: a review of the epidemiologic data," *Journal of Neurological Science*, vol. 132, no. 2 (October 1995), p. 119.

96 D.G. Le Couteur et. al., "Pesticides and Parkinson's disease," *Biomedicine and Pharmacotherapy*, vol. 53, no. 3 (April 1999), p. 123.

97 Hajo Zeeb and Maria Blettner, "Adult leukemia: what is the role of currently known risk factors?" *Radiation and Environmental Biophysics*, vol. 36, no. 4 (February 1998), p. 220.

History of Toxics Regulation Urges Caution

If history is to be our guide, it urges caution. Historically, particularly with respect to known neurotoxins such as lead, mercury, and PCBs, it has been the case that levels once deemed to be “safe” have been lowered significantly over time as more knowledge is gained regarding their effects.

For example, the initial threshold for blood lead levels was set at 60 micrograms per deciliter in 1960. This was lowered to 10 micrograms per deciliter in 1990 after neurodevelopmental effects at lower levels of exposure were observed. Since then, evidence indicates that such effects occur at even lower concentrations, and many neurotoxicologists believe that even the smallest exposure to lead will impact the developing brain.⁹⁸

More than 50 pesticides have been withdrawn from U.S. markets after more sophisticated testing revealed health risks – usually after decades of use.

A similar pattern has occurred with respect to mercury. The U.S. Food and Drug Administration set an acceptable level equivalent to 0.5 micrograms per kilogram of body weight per day in 1979. After studies showing that many prenatal exposures at lower levels produced developmental delays, the World Health Organization set a threshold at 0.3 micrograms in 1990. On the basis of additional studies describing impaired neurological functioning among children, the EPA issued standards in 1997 that were significantly more protective than those previously promulgated, at a level of 0.1 micrograms. Industry challenged this standard, convincing Congress to commission a study by the National Academy of Sciences on the issue before the EPA could move forward. The Academy’s study, issued in 2000, validated the scientific basis for the EPA’s lower limit.⁹⁹

More recently, the decision to reduce the allowable amount of arsenic in drinking water – which has stood unchanged for 50 years – from 50 ppb to 10 ppb or lower followed another National Academy of Sciences report which concluded “that the health risks posed by arsenic are much greater than previously assumed. . . .”¹⁰⁰

Such patterns, one recent study concluded, “raise serious questions about the adequacy of the current regulatory regime, which permits exposures up to ‘toxic thresholds’ that eventually become obsolete only after more and more children are injured.”¹⁰¹

This same principle applies to the more than 50 pesticides that are no longer marketed in the U.S., listed in Table 4, many of which were voluntarily withdrawn by their manufacturers as a result of negotiations with the EPA. (Such voluntary withdrawal allows continued sales overseas.) Reassessments of pesticides under the 1996 Federal Food Quality Protection Act have begun to incorporate what we have learned about the greater sensitivity of infants and children to pesticides and have required more protective standards, which some older pesticides are unable to meet.

For example, in June 2000 the EPA took action on chlorpyrifos, one of the most widely used insecticides by homeowners, based on laboratory tests of rats which revealed that: 1) “increased sensitivity following a single oral exposure to neonates was seen at substantially lower doses”; and 2) offspring of mothers administered chlorpyrifos showed structural alterations in brain development, no matter how low the dosage.¹⁰² The manufacturer agreed to withdraw all residential uses of chlorpyrifos, lower application rates and frequencies for some agricultural uses, and withdraw its use on tomatoes.¹⁰³

98 *In Harm's Way*, p. 6.

99 *In Harm's Way*, p. 14; National Academy of Sciences, *Toxicological Effects of Methylmercury*, 2000. In March 2001, the Center for Disease Control reported that 10 percent of women of childbearing age had mercury levels near those associated with a five percent increase in abnormal scores on childrens' cognitive function tests. The CDC concluded, “[M]easures of this magnitude indicate a narrow margin of safety and suggest that efforts aimed at decreasing human exposure to methylmercury should continue.” Center for Disease Control, *Morbidity and Mortality Weekly Report*, vol. 50, no. 8 (March 2, 2001), pp. 140-143.

100 “EPA to Use Tough Rules on Arsenic in Water,” *Washington Post*, reprinted in *Star Tribune*, September 11, 2001, p. A4.

101 *In Harm's Way*, p. 15.

102 U.S. Environmental Protection Agency (EPA), “Overview of Chlorpyrifos Revised Risk Assessment,” June 2000, p. 3.

103 *Ibid.*, p. 4; EPA, “Chlorpyrifos Revised Risk Assessment and Agreements with Registrants,” June 2000.

TABLE 4

Pesticides Banned or Severely Restricted in the United States

Banned

aldrin	benzene hexachloride [BHC]	binapacryl
Repellent-11	cadmium compounds	calcium arsenate
captafol	carbon tetrachloride	chloranil
chlordane	chlordecone (kepone)	chlordimeform
Toxaphene	chlorobenzilate	CPMA
copper arsenate	DBCP	DDT
dieldrin	dinoseb and salts	ethylene dibromide
ethylene dichloride	endrin	EPN
ethyl hexyleneglycol [6-12]	fluoroacetamide	hexachlorobenzene
lead arsenate	leptophos	mercury compounds
methyl parathion	mevinphos	mirex
monocrotophos	nitrofen	OMPA
phenylmercury acetate	phenylmercuric oleate	phosphamidon
2,4,5-TCP	pyriminil	safrole
silvex	sodium arsenite	TDE
Terpene	polychlorinates	thallium sulfate
2,4,5-T	vinyl chloride	PMDS

Severely Restricted

arsenic trioxide	bromoxynil butyrate
carbofuran (granular only)	daminozide/alar
ethylene oxide – agricultural uses only	heptachlor
lindane	methamidophos
ethyl parathion	pentachlorophenol
sodium arsenate	tributyltin compounds

Source: U.S. Environmental Protection Agency, Office of Pesticide Programs, "U.S. List of 'Banned' or 'Severely Restricted' Pesticides and U.N. PIC Pesticides," July 19, 2001, www.epa.gov/oppfead1/international/us-unlist.htm.

A reassessment of the insecticide methyl parathion in 1999 led the EPA to conclude, "The acute dietary risk to children age one to six exceeded the . . . amount that can be consumed safely in one day or less by 880%." Its use on all fruits and some vegetables was withdrawn by the manufacturer.¹⁰⁴

Similarly, EPA's 1999 assessment of the insecticide azinphos-methyl concluded, "The acute dietary risk from food alone is unacceptable for nursing infants and children age one to six." The agreement called for the manufacturer to withdraw some agricultural uses, lowered the allowable residues on apples and pears by 50 percent, and established maximum seasonal use rates on these fruits.¹⁰⁵

Each of these pesticides has been in use for decades. It is the children of the baby boomers and subsequent generations who are most likely to show the effects of fetal exposure to pesticides at levels now deemed to be unsafe. Whether the increases in learning and behavioral disabilities seen in recent decades¹⁰⁶ is connected to these exposures is unknown at this time. But it is clear that scientific advancements, more accurate measuring techniques, the discovery of more subtle effects, and increased interest in previously ignored effects will continue, and should warn us against putting too much faith in current standards.

104 EPA, "Methyl Parathion Risk Management Decision," August 2, 1999.

105 EPA, "Azinphos-Methyl Risk Management Decision," August 2, 1999.

106 *In Harm's Way*, pp. 10-11.

"It is the goal of the state that groundwater be maintained in its natural condition, free from any degradation caused by human activities."

– *Minnesota Groundwater Protection Act*

Reducing Exposure and Supporting Alternatives Is Prudent

MCEA is not seeking a ban on pesticides. We urge the EPA to expand its testing regime to include risks currently uncovered and to effectively implement the Food Quality Protection Act in order to realize Congress's goal of protecting infants and children

from harmful pesticide exposures. However, these are actions upon which Minnesota has little influence and which are sure to be opposed by pesticide manufacturers.

MCEA believes that a prudent course of action – given the numerous health risks not currently tested for; the severity of the health effects that may be associated with exposure, and the irreversible nature of some of them; the risk that additional decades of study may bring us no closer to a scientific consensus; the history of discovering toxic health effects at ever-lower levels of exposure over time; and the availability of cost-effective non-chemical means of preventing pest and weed infestations – is for the state of Minnesota to change the way it approaches the use and regulation of pesticides:

- **The MDA should thoroughly fulfill its statutory responsibilities to reduce and eliminate pesticide contamination of groundwater and surface waters.** MCEA's analysis of the MDA's pesticide regulatory program and recommendations for improvement are contained in Chapter 6.
- **Both the MDA and the Minnesota Legislature should give greater support to integrated pest management programs which seek to reduce dependence on pesticides.** It should be the policy of the state to speed up the transition to a less chemical-intensive agriculture called for by the National Academy of Sciences, as described in the introduction to this report. MCEA's examination of Minnesota's integrated pest management infrastructure and recommendations for improvement are contained in Chapter 7.

Consumers Support Action to Reduce Pesticides in Food

Although science is still uncertain regarding the effects of low-level pesticide exposures, a poll indicates that a majority of consumers would prefer less exposure to pesticides in food and is willing to accept some economic hardship to be spared the risk of exposure. A poll taken for Philip Morris (owner of Kraft, Oscar Mayer, Post and other food companies) in the summer of 1999 found that consumers "are not comfortable with the use of pesticides in food production and will accept higher prices (57 percent), a smaller food selection (68 percent), seasonal availability (72 percent), and biotechnology (73 percent) as trade-offs for not using chemicals in food production." Jay Poole, Vice President of Agricultural Relations for Philip Morris stated, "[T]his research shows that many of us in agriculture have miscalculated where consumers' most pronounced concerns exist."¹⁰⁷

Absence of Certainty is Not Synonymous with Absence of Risk

Uncertainty is a component of both risks and benefits that results from imperfect knowledge about the probability or magnitude of the consequences of a change. While high uncertainty may obscure both the probability of a risk and the magnitude of harm, uncertainty does not eliminate risk. Unrecognized risks are still risks; uncertain risks are still risks; and denied risks are still risks. . . ."

– *John Cairns, Jr., Absence of Certainty is Not Synonymous with Absence of Risk (Editorial), Environmental Health Perspectives, vol. 107, no. 2 (February 1999), p. A56.*

107 American Farm Bureau Press Release, "Consumer and farm study reveals gaps on key ag, food production issues," published on Agnet, <www.plant.uoguelph.co/safefood>, January 11, 2000.

CHAPTER 6

THE MINNESOTA DEPARTMENT OF AGRICULTURE HAS FAILED TO PROTECT THE ENVIRONMENT AND PUBLIC HEALTH

Introduction

MCEA's examination of MDA's statutory duties to regulate pesticides has found that MDA has violated state law by failing to take action to protect the environment and public health from pesticide contamination. These violations occur in three areas:

- **Monitoring pesticide contamination:** The MDA's monitoring efforts are inadequate because some agricultural regions lack groundwater monitoring, surface water monitoring, or both. When other entities' monitoring detects pesticides, MDA often fails to continue the monitoring in those areas necessary to determine the extent, frequency or trends of detections, as required by Minnesota's Groundwater Protection Act (the Act). In addition, the MDA does not monitor for degradation products of some common pesticides that break down quickly in the environment, greatly underestimating the extent of pesticide contamination.
- **Taking protective action:** The MDA has ignored documented contamination of groundwater and surface waters by arbitrarily establishing a threshold for taking action to address contamination that violates the Act. As a result, except for a single instance in 1991, MDA has failed to develop and promote the adoption of voluntary "best management practices" (BMPs) by farmers to reduce contamination by specific pesticides.
- **Collecting data on pesticide use:** The MDA has ignored the Legislature's directive to collect and automate information on the actual use of pesticides in urban and rural areas. The MDA does not know how much of what pesticides are used in which areas of the state.

This section will document these failures and make recommendations to correct them.

MDA's Pesticide Regulatory Responsibilities

The Act declares, "It is the goal of the state that groundwater be maintained in its natural condition, free from **any** degradation caused by human activities. It is recognized that for some human activities this degradation prevention goal cannot be practicably achieved. However, where prevention is practicable, it is intended that it be achieved."¹⁰⁸ [Emphasis added.]

108 Minn. Stat. § 103H.001.

To that end, the MDA has broad discretionary authority to prevent groundwater contamination by pesticides, and several non-discretionary duties that are enumerated in the Act, the Pesticide Control Law, and the Pesticide Management Plan (the Plan). Those that will be discussed in this chapter are described below:

- **Develop a state Pesticide Management Plan:** The MDA is charged with developing a plan whose goal is the “prevention, evaluation, and mitigation of occurrences of pesticides or pesticide breakdown products in groundwaters and surface waters” and which is to include “components promoting prevention, developing appropriate responses to the detection of pesticides or pesticide breakdown products in groundwater and surface waters, and providing responses to reduce or eliminate continued pesticide movement to groundwater and surface water.”¹⁰⁹ Minnesota’s Plan, which also serves as a generic state management plan required by the EPA to deal with pesticide threats to groundwater, was approved by the EPA in 1996.
- **Monitor pesticide impacts:** The MDA is charged with determining and monitoring the impacts of pesticides on the environment, including the extent of pesticide contamination of Minnesota’s water resources.¹¹⁰ MDA’s Plan, in several places, acknowledges and incorporates the need and obligation to monitor pesticides in both groundwater and surface waters as an integral part of preventing pesticide contamination.¹¹¹ Further, the Plan states that “[i]t is the responsibility of the Commissioner of Agriculture to collect information on the occurrences, concentration, and use of pesticides in Minnesota” and that such information will be collected and analyzed by MDA’s monitoring program.¹¹²
- **Assess common detection:** The MDA’s key activities under the Act revolve around the concept of “common detection,” defined as “detection of a pollutant that is not due to misuse or unusual or unique circumstances, but is likely to be the result of normal use of a product or a practice.”¹¹³ The MDA is to evaluate monitoring data and determine whether detection of any pesticide meets the definition. If conditions indicate a likelihood that detection of a pollutant or pollutant breakdown product is common detection, MDA must begin developing BMPs and continue monitoring.
- **Develop and promote BMPs:** BMPs – voluntary guidelines for selecting and using pesticides which are designed to minimize and prevent groundwater and surface water contamination – are a major tool provided in the Act. Generic BMPs which apply to all pesticides are to be used as a preventive measure.¹¹⁴ Once common detection has been declared, the MDA must develop pesticide-specific BMPs, appropriate educational materials, and a pesticide-specific management plan.¹¹⁵ If voluntary BMPs prove to be ineffective in reducing contamination, the MDA Commissioner may adopt mandatory standards, called “water resource protection requirements.”¹¹⁶ The MDA has never proposed mandatory standards.
- **Evaluate BMPs:** Both the Act and Minnesota’s Plan require the MDA to monitor the use and effectiveness of BMPs. An evaluation team is to make recommendations on the location of pesticide management areas and BMP promotion areas and develop a strategy to assess the effectiveness of pesticide- or crop-specific management plans, including measuring the BMP adoption rate and establishing a monitoring plan.¹¹⁷

109 Minn. Stat. § 18B.045, subd. 1.

110 Minn. Stat. §§ 103H.251 and 18B.04 (1).

111 *PMP*, pp. 31-33, 35.

112 *PMP*, pp. 41, 43.

113 Minn. Stat. § 103H.005, subd. 5.

114 Minn. Stat. § 103H.151, subd. 2.

115 Minn. Stat. § 103H.251, subd. 1(b) and *PMP*, pp. 63-67.

116 These may consist of “design criteria, standards, operation and maintenance procedures, . . . restrictions on use and practices, and treatment requirements” and must be based, in part, on “economic factors.” Minn. Stat. § 103H.275, subd. 1(b), 2(a), and § 103H.005, subd. 15.

117 Minn. Stat. § 103H.151, subd. 4; *PMP*, pp. 69-77.

- Register pesticides for use in Minnesota: All pesticides used in the state must be registered annually by the MDA.¹¹⁸
- Collect pesticide use data: The Pesticide Control Law requires the MDA to collect information biennially on urban and rural pesticide use.¹¹⁹
- Collect revenues to support regulatory activities: The MDA's Pesticide Regulatory Account receives revenues from a 0.4 percent fee paid by pesticide manufacturers on gross sales of all pesticides in the state, other registration fees, pesticide dealer and applicator license fees, and other sources which it uses to support regulatory programs.¹²⁰
- Prevent contamination of groundwater: The commissioner has broad authority to prevent groundwater contamination by pesticides, by rule, special order, or delegation through written regulatory agreements with officials of other agencies.¹²¹

MDA Monitoring and Analytical Gaps Impair Assessment of Pesticide Contamination

MDA has failed to meet its statutory duties to monitor for pesticides and their breakdown products in violation of Minn. Stat. §§ 18B.045 and 103H.251.

Agricultural Areas Are Not Adequately Monitored

Adequate monitoring data is the foundation of the MDA's protective efforts. Yet MCEA's review of pesticide contamination data revealed gaps in MDA's groundwater and surface water monitoring network that prevent it from making a thorough assessment of pesticide contamination in all agricultural regions of the state. The gaps constitute violations of MDA's obligations under pesticide control and groundwater protection laws.

Minnesota Statutes § 103H.251 requires MDA to evaluate the detection of pollutants in groundwater of the state. If conditions indicate a likelihood of common detection, MDA must continue to monitor.¹²² Further, regardless of common detection, following any pollution detection, MDA is required to develop and implement groundwater monitoring in the state to evaluate the pollutant's frequency and concentration trend.¹²³ Finally, Minn. Stat. § 18B.045 imposes an obligation on MDA to develop a plan to prevent, evaluate and mitigate occurrences of pesticides in both Minnesota's ground water and surface waters. MDA recognized these obligations by making groundwater and surface water monitoring "a key component" of the Plan.¹²⁴

MDA's pesticide monitoring network does not cover all agricultural regions.

Previous monitoring by MDA and others has detected pesticides in both groundwater and surface water. A joint MDA/MDH study conducted in 1985-87 found pesticides in southeastern, southwestern, and west central Minnesota, in both monitoring wells and wells servicing public water supplies.¹²⁵ From 1986 to 1994, MDA's groundwater monitoring network in the central sand plain and southern Minnesota and found atrazine in 30 percent of wells monitored.¹²⁶ PCA groundwater studies in 1998-99 in St. Cloud and Cottage Grove found herbicides in 64 and 68 percent, respectively, of the wells tested.¹²⁷ In 1997, the USGS surveyed studies done over a 19,500 square mile area of central and southern Minnesota and concluded that herbicides were "ubiquitous."¹²⁸

118 Minn. Stat. § 18B.26.

119 Minn. Stat. § 18B.064.

120 Minn. Stat. §§ 18B.05 and 18B.26, subd. 3.

121 Minn. Stat. § 18B.10.

122 Minn. Stat. §103H.251, subd. 1(b).

123 Minn. Stat. § 103H.251, subd. 2.

124 *PMP*, October 1998, p. 35.

125 Minnesota Department of Health and Minnesota Department of Agriculture, *Pesticides and Groundwater: Surveys of Selected Minnesota Wells*, prepared for the Legislative Commission on Minnesota Resources, February 1988.

126 Minnesota Department of Agriculture, *Water Quality Monitoring Program, Common Detection Data Report: November 1985 through September 1994*, June 1996.

127 Minnesota Pollution Control Agency, Ground Water Monitoring and Assessment Program, *Ground Water Quality in Cottage Grove*, Minnesota, June 2000, pp. 35-36.

128 James D. Fallon et al., *Water-Quality Assessment of Part of the Upper Mississippi River Basin, Minnesota and Wisconsin – Pesticides in Streams, Streambed Sediment, and Ground Water, 1974-94*, U.S. Geological Survey Water-Resources Investigations Report 97-4141, 1997, p. 31.

Despite these detections, the MDA has no groundwater or surface water monitoring sites in southwestern Minnesota or in St. Cloud or Cottage Grove, where the PCA is about to abandon its networks. In 1998, the MDA concentrated its groundwater monitoring network entirely within the central sand plain, extending west as far as Otter Tail County. Failing to monitor where pesticides have been detected is a violation of MDA's statutory duties to evaluate pollutants in surface waters and groundwater.

Recommendation: The MDA needs to close the gaps in its groundwater and surface water monitoring networks. As a first priority, groundwater wells should be established in the southwest, while surface water monitoring stations are needed in the southwest, northwest and west central parts of the state. The MDA must also arrange to continue groundwater and surface water monitoring in St. Cloud and Cottage Grove. Additional surface water grab sampling in the southeastern karst area should be conducted.

MCEA estimates the cost of these recommended monitoring additions as follows: Drilling and constructing 30 groundwater wells and purchasing nine surface water stations: \$135,000. Sampling costs: \$171,000 annually. Personnel: Two full-time positions, \$120,000 annually.

The MDA should also analyze the need for additional groundwater and surface water monitoring in all agricultural areas of the state in light of its statutory duties in this regard.

MDA Does Not Test For Pesticide Breakdown Products of Some Common Pesticides

The MDA's failure to test groundwater samples for breakdown products of several commonly used pesticides is a violation of Minn. Stat. § 103H.251, subd. 1(b).

Some pesticides ("parent" compounds) released in the environment quickly break down into new compounds called breakdown products or degradates. As a rule of thumb, the MDH assumes that

The MDA has never tested groundwater or surface waters for breakdown products of three common pesticides which account for 6 million pounds in sales, greatly underestimating the extent of contamination.

breakdown products pose health risks equivalent to those of their parent compounds. The potential for these breakdown products to contaminate Minnesota's water resources is recognized in Minnesota law, as is the MDA's obligation to evaluate such detections and mitigate them.

The Act requires the MDA to treat breakdown products no differently from parent compounds in assessing whether common detection has occurred. The MDA is

to evaluate whether "conditions indicate a likelihood of the detection of the pollutant **or pollutant breakdown product** to be a common detection. . . ." ¹²⁹ [Emphasis added.] A similar approach was taken by the Legislature when it directed that the MDA's Plan "must include components promoting prevention, developing appropriate responses to the detection of pesticides **or pesticide breakdown products** in groundwater and surface waters. . . ." ¹³⁰ [Emphasis added.]

The MDA currently tests for breakdown products of atrazine and metribuzin. The MDA has never tested for degradation products of the common pesticides alachlor, acetochlor and metolachlor, which collectively accounted for more than six million pounds of active ingredients sold in Minnesota in 1998. It never sends samples out to an independent laboratory for such testing, as the PCA has done. Although it

129 Minn. Stat. § 103H.251, subd. 1(b).
130 Minn. Stat. § 188.045, subd. 1

purchased an instrument a few years ago for its own laboratory which would allow such testing, it has still not tested for degradation products of these parent compounds. MDA officials say that the instrument's capacity is taken up with analyses for the Department's pesticide clean-up program. Not testing for degradates vastly underestimates the extent of groundwater contamination. When the PCA conducted groundwater testing for alachlor, acetochlor and metolachlor at St. Cloud and Cottage Grove, it found that degradates represented more than 96 percent of the mass of all herbicides detected in groundwater. Such results are common in other locales.¹³¹

The MDA's counterpart agency in Wisconsin has tested for two alachlor degradates since 1994. It also tests for two degradates of both acetochlor and metolachlor. These breakdown products are detected in more than 20 percent of groundwater samples, Wisconsin officials said.¹³²

Recommendation: In order to accurately measure the extent of groundwater and surface water contamination by pesticides, the MDA must test for breakdown products of pesticides which degrade rapidly in the environment, including alachlor, acetochlor, and metolachlor.

Recommendation: If the MDA does not fill gaps in its monitoring network and test for degradates, the Minnesota Legislature should amend the Minnesota Groundwater Protection Act to require that monitoring under the Act must be done in accord with protocols developed jointly by the Minnesota Department of Health, the Minnesota Pollution Control Agency, and the MDA.

MDA's Implementation of the Minnesota Groundwater Protection Act: A Decade of Inaction

Distorting the Common Detection Process

A critical part of MDA's obligations to protect groundwater is the determination that detection of a pollutant is common detection. Under the Plan, such a determination sets in motion several protective actions by the MDA, culminating in the development of BMPs.

The MDA has violated its responsibilities relative to common detection.

- The Common Detection Advisory Committee (CDAC), the body created by the MDA to advise the Commissioner regarding common detection, uses a definition of common detection which imposes restrictions that are not contained in the statutory definition and which conflict with the Minnesota Groundwater Protection Act. MDA ignored legal advice that the CDAC's definition appears to be inconsistent with the statute.
- The CDAC is dominated by representatives of organizations whose interests are in maintaining or increasing pesticide use. Although the CDAC agreed to meet annually, it did not meet for two and one-half years prior to June 2001.
- Despite evidence of widespread pesticide contamination of groundwater and surface waters, as discussed in Chapter 3 and Appendix B, the MDA has failed to develop and implement BMPs for specific pesticides. Since 1989, the MDA has only developed voluntary BMPs once, for atrazine in 1991, and they were quickly rendered moot by federal actions.

¹³¹ In a study of 131 municipal wells in Iowa in 1995-98, the proportion of total concentration accounted for by degradates was 94.2 percent for acetochlor, 99.2 percent for alachlor, and 86.3 percent for metolachlor. D.W. Kolpin et. al., "Finding minimal herbicide concentrations in groundwater? Try looking for their degradates," *Science of the Total Environment*, vol. 248, nos. 2-3 (April 5, 2000), pp. 115-122.

¹³² Personal interview with Jim Vandenbrook, Chief, Water Quality Section, Agricultural Chemical Management Bureau, Wisconsin Department of Agriculture, Trade, and Consumer Protection, April 2001.

MDA Obtains Legal Opinion on Definition of Common Detection – And Ignores It

In 1996, following the EPA's approval of the Plan, the MDA created the CDAC to examine the monitoring evidence from groundwater wells and surface water monitoring sites and to make recommendations to the Commissioner regarding whether the data supported the designation of certain pesticides as having common detection status.

The CDAC began meeting in the summer of 1996, and its first item of business was to develop a working definition of the term "common detection." As noted, the statutory definition is quite simple: "detection of a pollutant that is not due to misuse or unusual or unique circumstances, but is likely to be the result of normal use of a product or practice."¹³³

The statute also indicates what types of information are to be evaluated in assessing common detection status: "Assessment of . . . the likelihood of common detection status must include applicable monitoring, pollutant use information, physical and chemical properties of the pollutant, hydrogeologic information, and review of information and data from other local, state, or federal monitoring databases."¹³⁴

The Common Detection Advisory Committee's interpretation of "common detection" is at variance with the Groundwater Protection Act – and a legal opinion from MDA's own lawyers.

The issue that arose at the CDAC's initial meeting was the potential conflict between the statute and a list of "guidelines" established in the Plan for the CDAC to use as the basis for evaluating common detection status. For example, among the "guidelines" the CDAC is to examine is the relationship between concentrations of a pesticide detected in groundwater or surface water and a corresponding Health Risk Limit (HRL) developed by the MDH, and the economic costs associated with placing a pesticide in common detection status.¹³⁵ Neither factor appears in the statutory definition of common detection.

To clarify the relationship between the statute and guidelines, the CDAC requested a legal opinion from the MDA's assistant attorney general. Among the questions asked of MDA's counsel: "[W]hat does the statutory definition of 'common detection' mean? . . . Are the . . . guidelines provided in the PMP . . . consistent with the statute? Does the statute impose or imply boundaries on these . . . guidelines?"¹³⁶

The response was clear on the primacy of the statute over the guidelines: "The most important point . . . is that the factors in the PMP have no legal status. The only enforceable standards are found in the [statute]. The PMP guidelines must be applied in conformance with the law, and if a particular PMP guideline's application goes against the law's command or policy, it is of no effect."¹³⁷

With respect to how the guidelines should be applied, the attorney's memorandum states, "They must be read and applied in the context of the broad statutory plan. When their application is doubtful, the final determination must lean in favor of the inclusive rather than the exclusive. That is, if there is a doubt as to whether a pesticide should be classified as common detection, it should be so classified."¹³⁸

Regarding the definition itself, the opinion stated:¹³⁹

If, for example, a pesticide is detected only once, after a storm of the century, that could be considered closer to an "incident" than to "common detection." However, if it appears after every big storm or annually, it would probably be deemed "common detection." Common sense rules, along with the law's intent. "Unique" means just that – a one-time occurrence. "Unusual" is less restrictive, but still very restrictive, with a meaning towards "rare."

133 Minn. Stat. § 103H.005, subd.5.

134 Minn. Stat. § 103H.251, subd. 2.

135 PMP, April 1996, p 46.

136 Memorandum from Daniel Stoddard, Supervisor, Incident Response Unit, to Paul Strandberg, Assistant Attorney General, re: "Legal Opinion on 'Common Detection,'" June 26, 1996.

137 Memorandum from Paul Strandberg to Dan Stoddard re: "Common Detection," July 3, 1996, p. 2.

138 *Ibid.*, p. 1.

139 *Ibid.*

The definition and regulatory language of the statute, the memorandum declares, “are intended to stop pollution which does not result from misuse . . . when a pollutant is first detected, not when negative effects become apparent.”¹⁴⁰

This legal opinion clearly establishes the pre-eminence of the statute vis-a-vis the guidelines. It reinforces the notion of a low threshold for the definition of common detection, in line with the Act’s non-degradation goal. It supports the Act’s call for quick action following initial detections of contamination. Given the extent of pesticide detections noted earlier in this report, common detection is a standard that several pesticides would easily meet in some areas.

This legal opinion was presented to the CDAC at its second meeting in July 1996, at which the conflict between the criteria for common detection established by the statute and the Plan guidelines was readily recognized. Under the heading “Meaning of Common Detection – discussion,” the minutes note, “Statute is more conservative than the Pesticide Management Plan. PMP goes beyond the statute.”¹⁴¹ The identical opinion was held by State Senator Steve Morse, the Act’s chief author, as was known to the MDA. The minutes of the CDAC’s first meeting stated, “At the last legislative water commission hearing, senator [sic] Morse went down these points . . . He felt the seven points went outside the scope of the statute.”¹⁴²

MDA’s water monitoring staff recommended establishing pesticide management zones in several areas showing contamination in 1996. These recommendations were never addressed by the Common Detection Advisory Committee or the Commissioner.

Despite this knowledge and advice, the CDAC used and continues to use the Plan guidelines as the basis for its recommendations to the Commissioner regarding common detection. The MDA, though it knew that the common detection guidelines of the Plan went beyond the scope of the Act, did nothing. It has never rejected Committee recommendations because they are inconsistent with the Act.

MCEA’s concern is not only that the higher thresholds developed by the CDAC to assess common detection have no basis in the Act, but also that its use of these thresholds is the major reason that only a single pesticide has attained common detection status, despite overwhelming evidence of widespread contamination by several pesticides, as shown earlier in this report. The degradation prevention goal of the Act argues against a less protective definition such as the CDAC is using.

Committee’s Use of of Guidelines Is Biased Against Finding Common Detection

The authors of the Plan’s less protective guidelines knew exactly the effect their adoption would have on Committee recommendations with respect to common detection. The Plan itself predicts that “it is expected that committee recommendations and subsequent decisions will consider many factors resulting in a likelihood that few pesticides will be placed in common detection status.”¹⁴³

The way in which the CDAC has interpreted and applied the guidelines fulfills that prediction. Below are three examples.

Committee’s Use of Health Risk Limits Suffers From Vagueness

In comparing concentrations of pesticide detections with Health Risk Limits (HRLs) set by the MDH, the

140 Memorandum from Paul Strandberg to Dan Stoddard re: “Common Detection,” July 3, 1996, p. 1.

141 *Minutes of the CDAC*, July 16, 1996, p. 1.

142 *Minutes of the CDAC*, June 24, 1996, p. 11.

143 *PMP*, October 1996, p. 46.

CDAC not only ignores the statute, but also provides no guidance with respect to such a comparison. It is unclear what relationship to HRLs the CDAC seeks in order to declare common detection status. In 1996 the CDAC found that median values of detections of the pesticide MCPA in storm runoff ranged up to 2.4 times the HRL. Even these levels were not sufficient for the CDAC to recommend that MCPA be considered common detection.¹⁴⁴

Committee's Use of Trend Data Is Problematic

The CDAC's use of trend data is also problematic because it has drawn conclusions from concentration trends without reference to trends in pesticide use data in areas where detections are found. The Legislature recognized this important connection when it stated that the MDA "must" include "pollutant use information" in its assessment of the likelihood of common detection.¹⁴⁵ However, no such data is mentioned in the CDAC's report. This is not surprising, because the MDA does not routinely collect site-specific (or even statewide) pesticide use data.

Without such information, errors may result. "There are no apparent trends associated with alachlor," the CDAC states in its "Rationale" denying alachlor common detection status. This could be good news (if alachlor use is increasing) or bad news (if it is decreasing). In the absence of pesticide use information, the CDAC's conclusions regarding common detection which are based on detection trends alone are inferences unsupported by sufficient evidence.

Committee's Statewide Focus Is a Problem

MCEA also believes that the way the CDAC interprets the geographical extent of contamination detections incorrectly interprets the Act. For example, the report states, "Metribuzin has only been detected in sand plain wells," and, "Detections of alachlor have limited geographic distribution."¹⁴⁶ Given the Act's stress on non-degradation, these detection patterns should be interpreted as a reason to act to reduce contamination in the affected regions, not as an excuse not to act because contamination is not spread throughout the state.

The MDA has specific tools to deal with such situations. "Special attention and efforts may be focused within areas where significant pesticide contamination . . . exists," according to the Plan's discussion of BMP promotion areas.¹⁴⁷ In fact, recommendations for precisely such geographically-specific actions were made to the CDAC by MDA's water quality monitoring staff in 1996:¹⁴⁸

Surface water pesticide management zones should be established for the Minnesota, Missouri, Cedar, and Des Moines river basins. Special BMP promotion areas should be set up in the Whitewater, Blue Earth, Sand Creek, and two or three more watersheds in the Minnesota, Des Moines, or Missouri basins. . . .

Ground water pesticide management zones should be established for the central sands, and southeastern karst for corn herbicides collectively. . . . Special BMP promotion areas should be established in the outwash sands portions of Wadena, Sherburne, Stearns, and Pope counties, as well as the karst areas of Winona and Fillmore counties.

These recommendations were made by MDA technical staff with expertise in hydrology and hydrogeology and who were most familiar with the monitoring data. Their recognition of the need for a regional approach closely corresponded with the findings of a literature review on pesticides and BMPs done for

144 CDAC Report, October 1996, p. 23.

145 Minn. Stat. §103H.251, subd. 2.

146 CDAC Report, October 1996, pp. 12, 15.

147 PMP, p. 67.

148 Common Detection Data Report, November 1985 through September 1994, June 1996, p. 64.

the MDA prior to the 1996 Common Detection Advisory Committee meetings. That report stated, “The effectiveness of BMPs to prevent non-point source pesticide contamination of water resources depend [sic] on a strong interaction with local conditions . . . In fact, few non-point source BMPs can be universally applied.”¹⁴⁹ The CDAC never addressed the recommendations in its report. MDA staff said they were instructed by management not to make recommendations to the CDAC in the future and they have not done so.

Committee's Use of Guidelines Violates Law

These criticisms of the particulars of the CDAC’s methodology should not blind us to the big picture. As the Plan states on page 1, “Degradation prevention is the foundation” of the Act. “Minnesota recognizes that prevention is the best strategy for protecting water quality,” it says elsewhere, and “**Minnesota does not allow degradation to occur up to a certain limit before requiring that action be taken.**”¹⁵⁰

That last statement contrasts starkly with the CDAC’s decisions, which freely admit to some level of degradation, but which say, in effect, that there isn’t “enough” degradation to warrant common detection status.

“[V]ery low levels of contamination . . . are likely present in most surface waters for most pesticides,”¹⁵¹ the CDAC stated in its 1996 report, but it felt that no declaration was warranted as a result. On the East Fork of the Blue Earth River from 1993 through 1995, alachlor was detected in 17, 31, and 35 percent of the surface water baseflow samples, respectively. The figures for dicamba were 50, 25, and 55 percent, and for metolachlor, 29, 63 and 76 percent.¹⁵²

In its most recent Common Detection Data Report published in May 2001, the MDA summarized pesticide detections in surface water from 1992 through 2000. Metolachlor was present in 41 percent of the baseflow samples and 61 percent of the storm samples. The corresponding figures for acetochlor were 25 and 55 percent, and for 2,4-D, 14 and 38 percent.¹⁵³

The MDA’s data also indicates that detections for some pesticides have been increasing over time. The percentage of samples containing acetochlor jumped from 27 percent in 1995 to 55 percent in 1999, while the percentage for metolachlor rose from 27 to 75 percent during this period.¹⁵⁴

The CDAC’s actions show not only that degradation is allowed to occur up to a certain threshold before action is taken, but also that the threshold implicitly set by the CDAC is a violation of the statutory definition of common detection.

MDA Creates Unbalanced Common Detection Advisory Committee

In creating the Common Detection Advisory Committee, the MDA specified that one representative from each of the following organizations or interest groups be appointed as members:

- Pesticide manufacturers
- Pesticide manufacturers’ trade association
- Pesticide retailers
- Producers
- Commodity groups
- Minnesota Extension Service
- State government
- Local government
- University of Minnesota College of Agriculture
- Environmental organizations

149 Joseph P. Benish, Roger L. Becker, and Jerry Spetzman, *Pesticides in Minnesota Water Resources and Best Management Practices for Prevention of Contamination*, Literature Review prepared for the Minnesota Department of Agriculture, February 1996, p. 44.

150 *PMP*, pp. 1, 7-8.

151 *CDAC Report*, October 1996, p. 10

152 *Ibid.*, Appendix C.

153 *2001 Common Detection Data Report*, p. 16.

154 *Ibid.*, pp. 17, 23. The MDA’s regression analysis indicates that median concentrations of metolachlor in baseflow changed little over this period, while the trend line for acetochlor shows a decline from 1995 through 1999. However, no additional statistics regarding these regressions were reported, making the analysis impossible to assess.

This group is heavily weighted toward organizations with a large financial stake in maintaining the status quo in relation to pesticide use, while scientific expertise that could be useful with respect to water quality issues is underrepresented.

For example, having three representatives from groups whose financial interest is to maximize pesticide sales – pesticide manufacturers, their trade association, and pesticide retailers – is clearly redundant and gives the CDAC a bias toward maintaining or increasing pesticide sales and use. Having representatives from both the Extension Service and the College of Agriculture is also redundant, because many Extension professionals also hold joint appointments in the College. Although the Plan states that members will have scientific or technical expertise in relevant areas, that is precisely what is missing from the CDAC in such areas as pesticide chemistry, public health, hydrology, hydrogeology, and toxicology.

The makeup of the CDAC is clearly intended to support the status quo relative to pesticide use with little regard for science.

The Case of Atrazine Shows Common Detection Process as Used by MDA to Be Ineffectual

Atrazine is the only pesticide whose widespread contamination of Minnesota's water resources has motivated the MDA to invoke its authorities under the Act and do more than promote generic BMPs. As such, it provides a valuable case study of how poorly the MDA has carried out its responsibilities under the Act.

Since the mid-1980s, atrazine has been the pesticide detected most often in groundwater and surface waters in Midwestern states, including Minnesota. As this evidence came to light, the EPA and Ciba-Geigy, the major manufacturer of atrazine, reached an agreement in February 1990 to amend the product label by reducing the maximum allowable application rate for corn and sorghum to 3.0 pounds of active ingredient per acre per calendar year.¹⁵⁵ Use restrictions posted on labels are mandatory; it is a violation of federal law to use pesticides in a manner inconsistent with their labeling.

That action was not enough to satisfy some states that their resources were being adequately protected. In 1991, both Iowa and Wisconsin took additional measures, described below, by reducing maximum application rates even further and imposing other mandatory restrictions on atrazine use.

Minnesota acted as well. In May 1991, MDA Commissioner Elton Redalen, utilizing his authority to prevent contamination of groundwater, adopted voluntary best management practices for atrazine.¹⁵⁶ The BMPs encouraged limiting applications to 1.5 pounds per calendar year in designated geographically sensitive areas. Applicators were also encouraged to limit the timing of applications, to establish buffer areas around sinkholes and drainage wells, and to use unspecified integrated pest management techniques for pest control.¹⁵⁷

In August 1992, Ciba-Geigy and the EPA again lowered the maximum application rate on the atrazine label, to between 1.6 and 2.0 pounds per application, depending on the erodibility of the land and how much plant residue is left on it, and to a maximum of 2.5 pounds per calendar year. The intent was to protect surface water by reducing the amount and speed of runoff from treated fields. The new label also prohibited the use of atrazine in irrigation systems, and contained additional elements present in MDA's voluntary BMPs as well.¹⁵⁸

155 Ciba-Geigy, Inc., "A Guide for Understanding the Atrazine Ground and Surface Water Risk Reduction Measures," n.d., p. 1.

156 Although the official notice of this action (see following footnote) does not mention the term, internal MDA documents reveal some confusion as to whether or not atrazine was found to be in common detection at the time these BMPs were adopted. An unsigned draft special order for the atrazine BMP adoption states that "MDA has determined atrazine to be in common detection" (Minnesota Department of Agriculture, *Special Order, In the Matter of the Voluntary Best Management Practices for Atrazine and products containing Atrazine*, n.d., p. 2.) A draft letter seeking volunteers to help MDA develop the BMPs states that "contamination . . . is a result of normal use," the key element of the definition of common detection. (Minnesota Department of Agriculture, Draft letter from Calvin E. Blanchard, Pesticide Registration Supervisor, MDA, October 24, 1990.) A 1993 MDA memorandum states, "Two years ago, the Commissioner of Agriculture issued a special order declaring that the corn herbicide, atrazine, was in common detection status." (Memorandum from Jerry Spetzman to Greg Buzicky et. al., Re: "Voluntary Atrazine Best Management Practices," March 18, 1993.) Later documents refer to the MDA's "unofficial" designation of atrazine as a commonly detected pesticide. (CDAC Report, October 1996, p. 11.)

157 "Notice of Adoption of Voluntary Best Management Practices for the Herbicide Atrazine," *Minnesota State Register*, vol. 15, May 11, 1991, pp. 2432-2434.

158 Ciba-Geigy, pp. 2-3. MDA's voluntary BMPs recommended a 150-foot setback from sinkholes or water bodies for mixing or loading atrazine; the label change incorporated a 50-foot setback. The label change also required 66-foot application setbacks from streams and rivers and a 200-foot application setback around lakes and reservoirs. MDA recommended establishing buffer zones around sinkholes and drainage wells, but no specific distances were specified. MDA officials indicated that Minnesota's atrazine BMPs served as the model for the EPA's label changes. However, Jack Hausenger, Associate Director of the Special Review and Reregistration Division in EPA's Office of Pesticide Programs, who served as Branch Chief at the time of the label changes, recalled that EPA conferred mostly with the U.S. Department of Agriculture on this issue. "The states didn't play that big a role," he said. "I don't remember Minnesota being a big player." Interview, September 20, 2000.

These mandatory federal changes largely rendered MDA's voluntary BMPs moot.¹⁵⁹ They also made any evaluation of the BMPs' effectiveness impossible, because most of the MDA's voluntary recommendations had been made mandatory by the federal label changes.

By 1994, the MDA had established a Management Team for atrazine, a body charged in the Pesticide Management Plan with developing a plan to mitigate and eliminate groundwater contamination by specific pesticides. The group disbanded without devising such a plan.¹⁶⁰

The Common Detection Advisory Committee's 1996 report recommended giving atrazine official common detection status in groundwater in the sand plains and karst regions of the state, but not in surface waters. The CDAC also passed a resolution at one of its meetings declaring it had "reached consensus that even though label changes have been made, the opportunity remains for improved BMPs and BMP education. Therefore, the . . . committee recommends that the commissioner develop improved BMPs for the use of atrazine. . . ."¹⁶¹ This latter recommendation was not contained in the CDAC's final report. According to MDA staff, it was rescinded at a later meeting, but no minutes of these meetings are available to verify why such an action was taken, and Committee members contacted by MCEA did not recall the reason.¹⁶²

The Commissioner officially designated atrazine as a common detection, per the CDAC's recommendation, in May 1997. However, in the four years since, the MDA has not convened a management team, developed BMPs, or initiated any of the actions that the Act and the Plan require following designation.

In response to an MCEA inquiry on this point, the MDA stated, "The MDA did not repeat the mitigation steps outlined in the PMP for a compound newly declared in common detection status because those steps had already been taken during 1991-93,"¹⁶³ referring to the application limits quickly rendered moot by federal label changes. But this begs the question: If the continued presence of atrazine six years later warranted common detection status, that is an admission that the earlier actions were insufficient to

The MDA's voluntary best management practices adopted for atrazine in 1991 were superseded by EPA's mandatory label changes the following year. MDA has taken no action with respect to atrazine since, despite overwhelming evidence of continued contamination.

reduce contamination, and that additional steps should be taken, as the CDAC (temporarily) recognized in 1996. This the CDAC and the MDA have failed to do.

In fact, the MDA's inaction constitutes an additional violation of the Plan, which states, "[I]f the MDA chooses not to develop a management plan for a specific pesticide in common detection status . . . , then use of that pesticide

will be further restricted or cancelled in Minnesota."¹⁶⁴ No such action has been taken. The designation of atrazine as a common detection pesticide has been an empty gesture, because no measures have been put in place to actually reduce its environmental impacts.

In 1998, the CDAC recommended that atrazine's common detection designation in sand plains and karst areas "should be evaluated annually."¹⁶⁵ Because the CDAC did not meet in 1999 or 2000, no such evaluation was conducted. Further, as a result of the CDAC's failure to renew atrazine's common detection designation, it automatically expired on January 1, 2001.¹⁶⁶

It is clear that groundwater and surface water contamination by atrazine was not solved by the MDA's actions a decade ago: atrazine was detected in 76 percent of the wells in the MDA's new monitoring network in 2000. MDA's record with respect to atrazine clearly reveals its failure to adequately implement the Act.

159 This was recognized early the following growing season by the MDA staff member responsible for inquiries regarding the BMPs: "The previously voluntary atrazine BMPs are now label requirements. It is no longer appropriate to promote MDA approved voluntary atrazine BMPs. I have briefly discussed this with . . . Department Council [sic], and she is willing to take the necessary steps to cancel the Commissioner's Order." Memorandum from Jerry Spetzman, Pesticide Registration Advisor, MDA, to Greg Buzicky et. al., MDA, Re "Voluntary Atrazine Best Management Practices," March 18, 1993. MDA staff said the Order was not rescinded. Interview with Dan Stoddard, Assistant Director, Agronomy and Plant Protection Division, MDA, December 11, 2000.

160 Stoddard interview.

161 *Minutes of the CDAC*, September 20, 1996, p. 3.

162 Interview with Dan Stoddard, Assistant Director, Agronomy and Plant Protection Division, MDA, December 11, 2000. Minutes of the remaining two 1996 CDAC meetings are missing from the MDA's files. Memorandum from Charles A. Tyler, Data Practice and Records Management, MDA, to Bob Eleff, MCEA, Re: "Follow-Up to Your Data Request, Number 00-228," December 20, 2000.

163 Minnesota Department of Agriculture, "Statement on MDA Work With Regard To Atrazine," January 2001.

164 *PMP*, p. 80.

165 *CDAC Report*, October 1998, p. 11.

166 "Notice of Declaration of Common Detection for Atrazine. . . ."

The Result of MDA's Inaction: No Pesticide-Specific BMPs

The upshot of the MDA's poor implementation of the Act over the past decade is that – except for the atrazine BMPs adopted in 1991 that were superseded by federal action in 1992 – no pesticide-specific BMPs have been adopted. Nothing has been done to reduce contamination of Minnesota's groundwater and surface waters by specific pesticides because the MDA holds fast to the fiction that there is not "enough" contamination to take action.¹⁶⁷

The hurdles that MDA has erected before pesticide-specific BMPs are developed are very high: "either upon the determination of common detection status or a requirement by U.S. EPA to provide technical support for management plans for specific pesticides."¹⁶⁸

We have already seen how MDA violates the law relative to the definition of common detection, making such a determination highly unlikely. If this definition continues to be used, MCEA does not believe that the MDA will ever find any additional pesticide common detection. Even with respect to atrazine, the only pesticide given common detection status, no BMPs were adopted following the declaration.

As for the EPA's requiring state management plans for specific pesticides, this is an event that has been forecasted to occur since the inception of the Pesticide Management Plan process back in 1985, but which has been delayed again and again. Although the most recent projected issuance of a final rule was January 2001, the rule was not signed before the end of the Clinton Administration, and will be held up once again while the Bush Administration re-examines it and decides whether to issue it as written, or to make further changes.

Given the long lead times associated with these activities, even once the rule is issued Minnesota's groundwater resources will continue to remain at risk for many years. The EPA is likely to give states three years to prepare pesticide-specific management plans (as outlined in the most recent set of draft rules), and will take at least another year to review and approve them. That would place MDA's implementation in 2005, when it would begin to develop pesticide-specific BMPs, a process likely to take one to two years, followed by a three-year promotional campaign. At the earliest, the MDA would begin to evaluate BMPs around 2010, 21 years after passage of the Act. Some time after that, if BMPs are found to be ineffective, the Commissioner may elect to impose mandatory controls on pesticide use.

This timetable does not accord with the level of environmental protection Minnesotans expect from their state government. The MDA's decision to use the declaration of common detection status, a finding they have made next-to impossible, or EPA-ordered pesticide-specific management plans as the "trigger" for pesticide-specific BMP development and evaluation has stalled action to protect groundwater far too long.

Other Midwestern States Have Taken Action to Protect Groundwater

In contrast to the MDA, other Midwestern cornbelt states have addressed groundwater contamination by corn herbicides with mandatory regulatory action.

Wisconsin

In April 1991, the Wisconsin Department of Agriculture, Trade and Consumer Protection implemented its Atrazine

Both Wisconsin and Iowa prohibit atrazine use in sensitive geological areas.

167 In 1997, the MDA developed a series of "generic" BMPs in a series of two-page fact sheets. The measures are very general: "Use the lowest appropriate rate to minimize pest resistance . . . Avoid spray drift . . . Apply pesticides uniformly . . . Select pesticides with minimal impact on non-target species." Minnesota Department of Agriculture, *Pesticide Use: Application How-To's and Pesticide Use: Selection How-To's*.

168 *PMP*, October 1998, p. 69.

Rule, restricting the use of atrazine throughout the state to between 1 and 2 pounds per acre, depending on soil texture. The rule also created six atrazine prohibition areas, in which the pesticide cannot be applied, and one atrazine management area in the Lower Wisconsin River Valley, where additional restrictions on use – such as time or method of application – can be imposed. In March 1993, the allowable atrazine rate was further lowered to 0.75 pounds per acre in coarse soils and 1.0 pounds in medium and fine soils (1.5 pounds if no atrazine was applied in the previous year). By 1997, there were 96 atrazine prohibition areas in the state, covering approximately 1.2 million acres.¹⁶⁹ Wisconsin also created a small prohibition area for metolachlor by special order in the mid-1990s.

Wisconsin imposes additional restrictions on atrazine. It can only be applied from April 15 to July 31, and cannot be used with irrigation unless an irrigation management plan has been approved by the department.¹⁷⁰

In 1996 Wisconsin evaluated the impacts of the rule by comparing samples collected from a total of 429 wells in 1994 and 1996. It found that average atrazine plus degradate concentrations in wells with detections had declined from 0.96 to 0.54 ppb between 1994 and 1996 (statistically significant at the 95 percent confidence level), but that the decline in the number of wells with atrazine detections in that period, from 12 to 8.5 percent, was not statistically significant.¹⁷¹

Iowa

Iowa has created pesticide management areas where the use of atrazine is limited to a maximum of 1.5 pounds per acre. These areas include seven entire counties and parts of 16 additional counties. In the state as a whole, atrazine cannot be applied within 50 feet of a well, sinkhole, lake or other similar area. Any product containing atrazine cannot be mixed, loaded or repackaged within 100 feet of such areas.¹⁷²

MDA's Implementation of the Minnesota Groundwater Protection Act: Conclusions and Recommendations

MDA's record during the past decade provides little evidence that MDA has fulfilled its responsibilities to protect Minnesota's water resources from pesticide contamination.

MCEA's analysis of the MDA's implementation of the Act clearly indicates that MDA has done little to prevent or minimize the contamination of the state's groundwater resources by pesticides. Common detection status mandates the development of a whole suite of strictly voluntary protection efforts and, because a finding that these voluntary measures have been ineffective is required before the MDA can issue any mandatory regulations, it is the gateway to such regulation as well. Yet the key to this door has been placed in the hands of a committee dominated by pesticide industry interests, accountable to no one, operating under criteria established by itself that conflict with the Act, and which until recently, had not held a meeting for two-and-a-half years.

The decisions made by the MDA – to create a committee whose membership is heavily weighted against pesticide use regulation to advise the Commissioner on whether regulation should occur; to allow that committee to set an inordinately high threshold before MDA takes protective action, in apparent violation of the Act and its own counsel's legal interpretation of it; to decide not to create pesticide-specific BMPs until forced to do so by the EPA; to make little use of the Commissioner's authority to protect groundwater; and to fail to convene the CDAC for more than two years – fly in the face of the anti-degradation goal

169 Richard T. Proost, Kevin B. Shelley, and Jeffrey K. Postle, *Protecting Wisconsin's Resources through Integrated Weed Management* (University of Wisconsin Extension), n.d., p. 7.

170 Wisconsin Department of Agriculture, Trade and Consumer Protection, *Groundwater Protection: An Evaluation of Wisconsin's Atrazine Rule*, January 1997, pp. 9-10.

171 *Ibid.*, pp. 10-12.

172 Iowa Administrative Code, 45.51(4).

of the Act. Given the extensive contamination of groundwater and surface water and the potentially serious ecological and health effects of these chemicals discussed in this report, MDA's failure to aggressively protect the integrity of Minnesota's abundant water resources places all its citizens, particularly children, and the ability of those resources to support diverse fish and wildlife populations, at risk.

Recommendation: The Minnesota Legislature should amend the Act to transfer the decision regarding designation of pesticides as common detection (and related funding from the Pesticide Regulatory Account) to the Minnesota Department of Health.

The Common Detection Advisory Committee should be abolished. Decisions on common detection should not be made by an unbalanced committee of interest groups, but by accountable professional staff with relevant scientific expertise. The MDH has staff with the technical skills -- in groundwater monitoring, water quality, toxicology, public health, and environmental regulation -- to make what should be a technical decision. Their process, the evidence they consider, and their reasoning should be open to public scrutiny and comment.

The definition of common detection used by the MDH should conform to that stated in the Act: "detection [that] is likely to be the result of normal use of a product or practice." This definition should be applied in accord with the Act's goal of non-degradation. Specifically, statewide contamination should not be a requirement for common detection status. Responses targeted to geographic areas of the state where problems are found should be the norm.

"A statistically designed pesticide use survey, capable of determining use and trends at the county or subcounty level, should be conducted on an annual basis." - MDA, 1988

The MDH's first priorities should be to re-designate atrazine as a common detection pesticide statewide and to assess the current need for the creation of Special BMP promotion areas and pesticide management zones recommended for corn herbicides (including acetochlor, alachlor, and metolachlor) by the MDA's monitoring staff in 1996. (See p. 49)

Once common detection status is declared, the MDA should quickly develop and implement specific BMPs and set an evaluation plan in place.

MDA Has Ignored Legislative Directives to Collect Pesticide Use Data

Few would argue that in order for the MDA to effectively protect Minnesota's resources against pesticide contamination, it needs to know some basic information about how pesticides are actually used in the state. This point was recognized by the EPA in a study of the role of pesticide use data in the regulatory process: "In order to evaluate the risks of pesticide use and the benefits derived from pesticide use, and to evaluate the potential ramifications of regulatory decisions about the sale and use of pesticides, regulators must have information about how, where, when, why, and how much each pesticide is used. . . ."173

Having that information would enable the MDA to address several issues: Are environmental and health risks posed by pesticide use rising or diminishing? Are particular areas of the state at risk because of sensitive hydrogeological conditions? To what degree are farmers substituting non-chemical means of pest management for chemical solutions?

Currently, the MDA cannot answer any of these questions.

MDA Does Not Collect Required Use Data

In 1989, the Minnesota Legislature mandated the collection of pesticide use data by the MDA. The Pesticide Control Law states: "The commissioner shall monitor urban and rural pesticide use on a biennial basis. Information shall be collected and automated consistent with section 103B.151, subdivision 1."174 The latter statute directs the Minnesota Environmental Quality Board to "ensure that groundwater monitoring and related data is provided and integrated into the Minnesota land management information system. . . ."175 The state's land management information system is a geographic database, indicating that pesticide use data is to be collected at a level less aggregated than statewide. Simply put, the legislature directed the MDA to gather information enabling it to know how much of what types of pesticides are used where in the state.

MDA has failed to effectively meet its statutory obligation to collect pesticide use data. It collects virtually no data on urban use and very little on rural use.

In 1990, the MDA conducted an extensive pesticide use survey funded by the Legislative Commission on Minnesota Resources. Over 17,700 questionnaires were mailed to farmers grouped into 25 multi-county clusters. According to MDA, this level of geographical detail was sought because "[a] statewide mailing would not supply the Department of Agriculture with enough data precision to adequately support its groundwater protection responsibilities."176

MDA received usable information from about 35 percent of those surveyed. Within each cluster, data was collected, by crop and by pesticide product used, on the number of applications; number of acres to which pesticides were applied; method of application; whether pesticides were self- or custom-applied; and on other questions.¹⁷⁷

This was the most comprehensive survey of pesticide use ever done in Minnesota. Unfortunately, despite MDA's statutory obligation, it was the last time the Department ever sought to collect such information from all agricultural areas of the state.¹⁷⁸ In the years since, it has collected use data from fewer than two dozen farmers in each of three small geographic areas.¹⁷⁹ This limited data, like that from the 1990 survey, was not "automated" so that it could be entered into the state's Land Management Information System, contrary to the requirements of the law.

173 EPA, Office of Pesticide Programs, *The Role of Use-Related Information in Pesticide Risk Assessment and Risk Management*, August 21, 2000, p. 1.

174 Minn. Stat. § 188.064.

175 Minn. Stat. § 103B.151, subd. 1(6).

176 Minnesota Department of Agriculture, Agronomy Services Division, Environmental Quality Section, *1990 Pesticide Use in Rural Minnesota*, May 5, 1992, p. 2.

177 *Ibid.*

178 A February 1988 report issued jointly by MDA and Minnesota Department of Health recommended that "A statistically designed pesticide use survey, capable of determining use and trends at the county or subcounty level, should be conducted on an annual basis." Minnesota Department of Health and Minnesota Department of Agriculture, *Pesticides and Groundwater: Surveys of Selected Minnesota Wells*, Prepared for the Legislative Commission on Minnesota Resources, February 1988, p. 50.

179 Minnesota Department of Agriculture, *Survey of Farmers within the Saint Peter Wellhead Protection Area*; Minnesota Department of Agriculture, *Survey of Farmers within the Middle Fork of the Whitewater River*. The MDA also surveyed about a dozen farmers near some of its new groundwater monitoring wells in the central sand plain regarding their pesticide use. Minnesota Department of Agriculture, "Central Sands Monitoring Data," printout dated August 26, 1999.

The Legislature also requires the MDA to collect records of the sales of all Restricted Use Pesticides from the state's pesticide dealers. These records must be submitted to the MDA annually along with the dealer's license application form.¹⁸⁰ This is the only data on sales or use which has some degree of geographic identification below the statewide level, and which could provide some clues to regional pesticide use. Although several years of data have been entered in a computer file, the MDA has never analyzed it to understand trends and patterns of pesticide use in different parts of the state.

A 1999 poll found that 85 percent of Minnesotans thought the MDA should collect data on the location and amount of pesticides used in the state and make it available to the public.

With respect to data on urban pesticide use, the MDA has conducted a number of projects in urban areas, but none of them collected quantified information on pesticide use that would permit the assessment of health

risks or the analysis of changes in use over time, on either a statewide or regional basis.

A survey requested by the legislature of 20 schools around the state collected some data on the conditions under which pesticides are applied, but no information on specific active ingredients, amounts, or frequency of use.¹⁸¹

The MDA has conducted several projects aimed at educating homeowners to reduce runoff from pesticides and fertilizers used on lawns in various parts of the state: around Lake Harriet in Minneapolis; near Lake Alimagnet, which drains watersheds in Burnsville and Apple Valley; in Rochester, St. Peter, Dakota County, and other locations. As part of these projects, surveys were conducted regarding pesticide and fertilizer use, but they almost never asked what types or amounts of pesticides were used.

For example, the Dakota County survey asked only, "When was weed killer applied?"¹⁸² In St. Peter and Rochester, homeowners were asked how often they applied herbicides to lawns, where they purchased pesticides, and where they obtained information on pesticide use.¹⁸³ Few of these surveys asked specifically about use of insecticides; none asked about the use of pesticides inside the home.

While these are all fine programs with worthy goals, their principal function was not to amass quantified data on pesticide use, and little along those lines was produced.

The Minnesota Legislature recognized the value of pesticide use information more than a decade ago when it ordered the MDA to collect and computerize such data. Yet, the MDA has done little to fulfill that mandate, and our ignorance regarding the patterns and trends of actual pesticide use has remained complete.

Minnesotans believe pesticide use information to be of great value. A statewide poll conducted in July 1999 found that 74 percent of those surveyed thought it was "very important" for the state "to know the location and amount of pesticides that are being used in food production in Minnesota." When informed that the MDA does not collect such information, 85 percent of those polled said that the MDA should do so, and should publish this information.¹⁸⁴

Presented in the following pages are two options for a pesticide use data collection system that address the statutory requirement.

180 Minn. Stat. § 188.37, subd. 1.

181 *Pesticide Use, Storage, and Integrated Pest Management In and Around State-Owned Buildings and Public K-12 School Buildings, Report to the Legislature, January 15, 2001; Quantitative Research Regarding Pest Management Practices in Minnesota K-12 Schools*, December 1999.

182 Decision Resources, Ltd, *Survey Overview*, n.d., reporting on a phone survey conducted in October 1997.

183 South Zumbro River Watershed Partnership, *Homeowner Yard and Lawn Survey*, n.d.

184 The poll of 624 registered voters throughout the state was conducted by Mason-Dixon Research, Inc. The margin of error is ± 4 percent.

Option 1: A Survey-Based System

One method of obtaining pesticide use data is based on a federal data source, annual surveys conducted by the National Agricultural Statistics Service (NASS), an arm of the U.S. Department of Agriculture, that provide estimates of statewide totals of various pesticides used on corn, soybeans, and wheat. The estimates are based on small samples and, as a result, the data have large variances. For example, based on the 191 Minnesota corn farmers sampled in 1999, there is a 95 percent probability that the true mean of total acetochlor used lies somewhere between 1.5 and 6.5 million pounds, a very wide range.¹⁸⁵

An important fact regarding the NASS pesticide surveys is that they are done in-person on-site, and have high response rates. MDA officials are concerned that a voluntary mail survey, such as the one conducted in 1990, would have a low response rate and a potentially biased sample. "There is declining voluntary cooperation on surveys as requests for information increase," MDA reported to the Legislature.¹⁸⁶ The prestige of the in-person NASS surveys helps avoid this problem.

In addition to implementing U.S. Department of Agriculture survey projects, NASS also conducts surveys paid for by public and private clients on a wide range of agricultural topics. The MDA has recently arranged with NASS to expand the sample of Minnesota corn farmers beyond the 250 to be included in its fall 2001 survey. An additional 350 farmers will be interviewed, making a total of 600 interviews conducted across three of the state's nine agricultural districts, which comprise between nine and 11 counties each. Based on costs of \$100 per interview, federal officials estimate that the total cost of the expansion will be approximately \$45,000, which the MDA will fund from grants it has recently received.¹⁸⁷

MCEA is encouraged that the MDA is acting to obtain this data, but information on one crop in a portion of the state does not meet the requirement established by the Legislature in 1989. To gauge what a more complete pesticide use survey using agricultural districts as the level of analysis might cost, MCEA examined the only available source of state-level pesticide use estimates, which revealed that just five crops – corn, soybeans, wheat, potatoes, and sugar beets – accounted for about 95 percent of total Minnesota pesticide use in 1997.¹⁸⁸ The bulk of planted acreage for these crops is concentrated in relatively few districts. While 95 percent of the corn crop is planted in five districts and 98 percent of the soybeans in six, 95 percent of wheat is planted in only two districts. For all five crops, surveying 20 districts would cover more than 95 percent of planted acreage.¹⁸⁹

If the sample size for each district were the same as that contemplated in the MDA's corn survey (i.e., 200), these five crops could be surveyed at a cost of roughly \$400,000, with an additional \$100,000 for sampling, automating, and analyzing the data.¹⁹⁰ Given these relatively modest costs, MCEA would recommend dividing the districts in half – into clusters of four to six counties – to obtain greater geographic detail. That would result in a budget of approximately \$1,000,000. To further reduce costs, half the crops could be surveyed each year, at an annual budget of \$500,000.

Such a system would not provide many of the benefits of a universal site-specific data collection system of the type recently created in three states, as discussed in the next section. MCEA believes that the latter system is preferable in that it allows analysis of pesticide use to be conducted at much smaller geographic levels. Unfortunately, the costs of such a system and, more importantly, the political sensitivity of requiring all farmers to report pesticide use to the state make it difficult to enact.

However, a statistically valid survey at the sub-district level would allow for some trend analysis of the

185 The NASS estimate was 3.61 million pounds. Using statistics provided by NASS, MCEA constructed a 95 percent confidence interval around this figure.

186 *Biennial Report to the Legislature*, 1998-1999, p. 19.

187 Personal interview, George Howse, deputy state statistician, Minnesota Agricultural Statistics Service, April 2001.

188 The database is generated by the National Center for Food and Agriculture Policy, <www.ncfap.org/nfcap/ingredient/index.asp>. The site warns users, "There is no way to determine the accuracy of any of the estimates in the database."

189 U.S. Department of Agriculture and Minnesota Department of Agriculture, *Minnesota Agricultural Statistics*, 2000, pp. 34-41, 52. The only uncertainty is with respect to potatoes, where a small number of very large producers prevented disclosure of location for almost half of the planted acreage in 1999.

190 A problem with the federal survey is shrinking coverage. No surveys of Minnesota pesticide use on soybeans or wheat, each of which is planted on 7 million acres in the state, will be conducted in 2001 because of federal budgetary cutbacks. Only corn farmers will be surveyed with respect to their pesticide use. No federal commitments have yet been made to conduct pesticide surveys in 2002. As federal support wanes, Minnesota would have to pick up more of the survey costs. Personal interview, George Howse, deputy state statistician, Minnesota Agricultural Statistics Service, April 2001.

changing reliance on pesticides. Combined with a model measuring the toxicity of individual pesticides (See p. 83), this data could help track the change in risk over time within these regions. It could also be used to establish priorities for the development of non-chemical pest management techniques and to gauge their success at the regional level.

Recommendation: The MDA should comply with the statutory requirement in Minn. Stat. § 18B.064 to collect pesticide use data and enter it into the state's Land Management Information System. The data should be collected through a NASS-conducted on-site survey that provides statistically reliable data at the sub-agricultural district level for the crops which account for the bulk of the state's pesticide use: corn, soybeans, wheat, sugar beets, and potatoes. The information collected should include the type and amount of pesticide used, method of application, acreage treated, crop type, target organism, number and dates of applications, name of applicator and identification number, and location. The MDA should publish an annual analysis of the data, and should make the data available on its website.

MCEA estimates that this recommendation will cost approximately \$500,000 annually.

Option 2: A Site-Specific Pesticide Use Data Collection System

Since 1999, state legislatures in Wisconsin, Massachusetts, and Oregon have passed legislation creating pesticide use data collection systems, bringing to nine the number of states which have such programs. (See Appendix F for a short description of these programs.) Such systems typically require reporting by all applicators of each individual pesticide application, type and amount of pesticide used, location of application, and other information. If rightly conducted, these systems can produce data of the highest accuracy, compared with surveys which have a built-in statistical margin of error, including those with the modest sample sizes proposed above. Further, a site-specific collection system has greater utility in a geographic sense, because it provides accurate data from the smallest sub-watershed through any number of larger geographic units.

Federal law requires farmers to keep records of their use of "restricted use pesticides," which include four of the state's largest sellers. Minnesota law requires commercial pesticide applicators to provide customers with a copy of the record of applications of all pesticides.

Such site-specific data is useful for several purposes:

- To identify surface water and groundwater supplies at risk of contamination, so that appropriate protective measures can be taken.
- To interpret monitoring data, which is difficult unless it can be linked with pesticide use patterns.
- To correlate pesticide use and the presence of endangered species in a specific geographic area, so that appropriate protective measures can be taken.
- To provide accurate pesticide exposure data to medical researchers to help them understand the relationship between exposure and disease, and diagnose pesticide-related illnesses. That is why the American Medical Association supports improved pesticide use reporting.¹⁹¹
- To enable accurate analysis of trends in pesticide reliance over time. Simple volume trends do not accurately reflect the degree of pesticide dependence, especially since the advent of herbicides applied at very low rates. The percentage of crops treated, rate of application, number of treatments, and number of different pesticides applied need to be understood.
- To secure the public's right to know about the pesticides to which it may be exposed, so that risks can be evaluated and appropriate protective measures taken.
- To enable, in conjunction with a tool measuring the toxicity of individual pesticides (see p. 83), calculation of the aggregate risk posed in a given area, and to track the change in risk over time as new farming practices or non-chemical pest management methods are adopted.
- To provide accurate data on pesticide use rates, rather than having risk estimates based on label rates. Barbara Buck, of the Western Growers Association, called California's use-reporting law "a positive step for agriculture. . . . We are tired of special interest groups who distort the use of pesticides in agriculture. This real data will help government come out with realistic scientifically based figures."¹⁹²

191 The Association's House of Delegates passed such a resolution in December 1994. American Medical Association Council on Scientific Affairs, "Educational and informational strategies to reduce pesticide risks," *Preventive Medicine*, vol. 26, no. 2 (March/April 1997), p. 199.

192 K. Benson, "Pesticide Use Reporting Closes Information Gap," *American Vegetable Grower*, February 1990, p. 65.

Much of This Data Is Already Compiled By Users and Applicators

An objection sometimes made against such a system is the alleged record-keeping burden it places on applicators. In fact, a significant proportion of applicators already are required to keep records of their pesticide use. The significant number of farmers whose pesticides are applied by a commercial firm, such as a coop, should have those records at hand, because commercial applicators in Minnesota are required

“[A] federally registered pesticide product may be appropriate for use in some areas of the country, but could cause serious contamination in others. EPA, therefore, relies on states to be vigilant and innovative in identifying vulnerable areas and tailoring registration decisions to protect their own environmental resources.

– *New York State Department of Environmental Conservation*

by state statute to keep such records for five years and to give a copy of the record of each application to the customer.¹⁹³

In addition, the Federal Pesticide Recordkeeping Program, authorized by the 1990 federal Farm Bill, requires private applicators (farmers) to keep records of each application of

Restricted Use Pesticides.¹⁹⁴ In Minnesota, four of the 10 pesticides with the highest volume of sales – including atrazine and acetochlor, the top two sellers – are Restricted Use Pesticides.

Recommendation: To better understand the costs and benefits of a full pesticide use reporting system, the Minnesota Legislature should direct the MDA to monitor the development of the newly-created systems in Wisconsin, Oregon, and Massachusetts. By March 2002, it should, in consultation with the MDH, the PCA, and the Minnesota Department of Natural Resources, issue a report comparing the approaches, costs, coverage, and types of data collected by each state, and the uses to which such data can be put. The report should also present and discuss options for a similar system that could be implemented in Minnesota, associated cost estimates, and the steps that would need to be taken to implement it.

Pesticide Registration: A Contamination Prevention Opportunity Foregone

Much of the discussion in this report has concerned what the MDA can do to reduce pesticide contamination **after** it has been detected. However, public health could be better advanced by taking protective action **before** contamination occurs. Examining the likely environmental impacts of pesticides during the state’s registration process – and crafting conditions of use which minimize contamination – would give the MDA an opportunity to prevent contamination from occurring in the first place. Although not required by statute, it could be a useful tool to reduce pesticide exposures.

MDA Does Not Use Its Authority to Examine the Impacts of Pesticides It Registers

The federal law governing pesticide regulation, the Federal Insecticide, Fungicide and Rodenticide Act, authorizes states to develop their own registration process, specifically allowing them to be **more** restrictive than the EPA: “A State may regulate the sale or use of any federally registered pesticide . . . , but only if and to the extent the regulation does not permit any sale or use prohibited by this Act.”¹⁹⁵

The Minnesota Legislature has also given the Commissioner of Agriculture sufficient powers to intervene in the registration process to protect public health and the state’s abundant water resources. The Commissioner has broad authority to “approve, deny, or cancel the registration of any pesticide” – no criteria for taking such actions are specified – and “may impose state use and distribution restrictions on a pesticide as part of the registration to prevent unreasonable adverse effects on the environment.”¹⁹⁶

193 Minn. Stat. § 18B.37, subd. 2(d).

194 <www.ams.usda.gov/science/prb/prbqa.htm>.

195 Federal Insecticide, Fungicide, and Rodenticide Act, Section 24(a).

196 Minn. Stat. § 18B.26, subd. 5(b). Pesticide manufacturers are entitled to a hearing if any of these actions are taken.

Thus, the state registration process can be a key leverage point for regulatory action to protect public health and environmental resources. Unfortunately, the MDA has seldom used its legal authority for such purposes. MDA officials could not recall a single instance when a product was prospectively denied registration or had conditions attached to its registration to mitigate potential environmental effects as a result of the state's routine application review.¹⁹⁷ In fact, substantive review of a product's environmental impacts is not part of MDA's registration process.

This makes little sense. If a county highway department in Minnesota adds a lane on an existing road over one mile long, state law requires it to analyze and report on the project's environmental impacts and advance ways to lessen them. Yet when the MDA registers a pesticide identified by the EPA as a carcinogen or as acutely toxic to fish, allowing it to be spread on millions of acres of land in the state, no similar examination is conducted.

New York places use restrictions on 20 to 25 percent of the pesticides it registers. No decision has ever been challenged in court.

While the EPA reviews the environmental effects of pesticides, it does not take into account such factors as the susceptibility of groundwater underlying the karst region in southeastern Minnesota or the central sand plains when it makes its registration decisions. Only the MDA can do that. Unless MDA routinely reviews the EPA's work through the prism of Minnesota's unique conditions, we are all at risk. As the agency conducting pesticide registration in the State of New York, the New York State Department of Environmental Conservation (NYSDEC), put it,

[A] federally registered pesticide product may be appropriate for use in some areas of the country, but could cause serious contamination in others. EPA, therefore, relies on states to be vigilant and innovative in identifying vulnerable areas and tailoring registration decisions to protect their own environmental resources.

*This requires the state technical review to emphasize the impact of product use in their state.*¹⁹⁸

NYSDEC identified several reasons why it conducts a separate state review of pesticide registration:

- EPA's analysis may contain errors or inconsistencies.
- Local conditions might not be protected by the broad criteria used by the EPA in certain situations and circumstances.
- Some risks judged important in New York are not considered in EPA's review.
- New York and EPA use different criteria to evaluate pesticide risk.
- New York may believe that some types of studies are better predictors of real-world impacts than those used by the EPA, e.g., mesocosm studies versus lab toxicity studies.
- EPA will sometimes register a product even though its staff called for additional research or a revised study. New York's review can make sure these studies are completed and key issues resolved before state registration is granted.
- New York may set thresholds of harm at lower levels than the EPA does. NYSDEC is quite concerned about "the perception that the EPA registration decisions may not be consistently protective of fish and wildlife resources. Years of experience have shown that, unless an adverse impact is demonstrably severe, a registration will not be denied [by the EPA] because of the effects on fish and wildlife populations."¹⁹⁹

197 On one occasion MDA used the state registration process to limit a product's environmental effects after receiving several complaints, including one from a member of the Minnesota Pollution Control Agency Board, regarding crop damage resulting from the soybean herbicide clomazone drifting onto adjacent lands. The MDA responded by attaching conditions to the product's registration requiring the manufacturer to train applicators to avoid drift and to provide them with spray nozzles which reduced potential drift.

A second case concerned the corn herbicide Balance, an extremely toxic product likely to leach into groundwater. Notified by EPA officials of this likelihood before federal registration occurred, MDA and pesticide regulators in Wisconsin and Michigan convinced the EPA not to register the product for use in those states. In 2001, the Commissioner reaffirmed his decision not to allow Balance to be used in Minnesota, and EPA reflected that decision on the product label.

198 New York State Department of Environmental Conservation, Division of Solid and Hazardous Materials, *New York State Pesticide Product Registration Workshop*, Albany, New York, December 12, 1995, p. 19.

199 *Ibid.*, pp. 46-47.

These reasons reveal the large gaps in protection for Minnesota's natural resources and the health of its citizens that result from the MDA's failure to conduct substantive review of pesticide applications for environmental and health effects as part of the registration process.

Three States Review Pesticide Impacts Before Registering Them for Use

Three states conduct an independent environmental review as a routine part of their pesticide registration process. The different approaches taken by California, New York, and Massachusetts give Minnesota a range of options from which to choose in creating a similar process here.

California²⁰⁰

California's program befits the size of the state's agricultural sector. Funded by an assessment of 1.7 percent on state pesticide sales – more than four times higher than Minnesota's – as well as revenue from pesticide dealer licenses and registration application fees, the California Department of Pesticide Regulation's registration program conducts an in-depth review that in some areas goes beyond that of the EPA. Depending on the level of concern, the Department can examine data in up to six areas: toxicology (acute and chronic), chemistry (product and residue), fish and wildlife impacts, product efficacy, phytotoxicity, and worker safety impacts. California reviews the full studies submitted to the EPA by the manufacturer, as well as the underlying data. Due to its sheer size – as of 1999, some 70 staff worked on pesticide registration, and 28 toxicologists analyzed registration applications – California's program is unlikely to be replicated in Minnesota, but the MDA could certainly benefit from examining California's analysis of pesticides seeking registration in both states.

New York

New York's program that reviews the environmental impacts of pesticides is housed in the state's equivalent to the PCA, not its Department of Agriculture and Markets. New York reviews the summary reviews written by EPA staff of the full studies submitted to the EPA by pesticide manufacturers; full studies may be requested if necessary. One staff member in NYSDEC's Geotechnical Support Section reviews environmental fate data, field dissipation studies, and other data to insure that groundwater supplies are protected. One person in the New York State Department of Health evaluates the human health risks posed by the product. A staff member in NYSDEC's Division of Fish and Wildlife measures the potential impacts on those resources. The results of these analyses are sent to the project manager in NYSDEC's Bureau of Pesticides and Radiation. This regulatory program is funded entirely from registration fees of \$300 per product paid by pesticide manufacturers.

Program staff estimate that 20 to 25 percent of the products which undergo review have restrictions attached to their use, such as limits on the number, timing or rate of applications, larger buffer zones, or use prohibitions in certain sensitive areas. In the past five years, two products were denied registration; another three or four were withdrawn when it became clear that registration would be denied. As the director of the program said, "The intent is to come to favorable decisions." No registration decision has ever been challenged in court.²⁰¹ Three of the program's recent decisions are summarized below:

- In 1998 NYSDEC registered three products containing the active ingredient S-metolachlor, a corn (and in Minnesota a soybean) herbicide. Groundwater and surface water contamination led the Department to require the manufacturer to develop and implement a plan to address various issues including patterns of use/misuse, identifying alternative practices and products,

200 This section is based on an interview with Regina Ceracino, Registration Ombudsman at the California Department of Pesticide Regulation, November 3, 1999.

201 Interview with Maureen P. Serafini, Manager, Pesticide Product Registration Section, Division of Hazardous Materials, New York State Department of Environmental Conservation, November 1999.

monitoring, education, and others. The Department also prohibited the use of these products on Long Island, which has sandy soils susceptible to groundwater leaching and whose drinking water is provided from a sole-source aquifer. If the manufacturer submits an acceptable management plan that would protect Long Island groundwater, the Department indicated it would remove the restriction.²⁰²

Reviewing pesticide health effects during registration provides an opportunity to modify pesticide use to protect state resources while preserving farmers' access to these products.

- NYSDEC's 1997 approval of three products containing the herbicide dimethenamid also contained several conditions, based on its classification by the EPA as a possible human carcinogen and its high mobility in certain soil types. The Department's concerns regarding toxicity to aquatic plants due to runoff were allayed by a study conducted at its

request by the manufacturer which showed that dimethenamid was removed from water more quickly than laboratory studies had shown. The registration conditions NYSDEC imposed included:

- Use on Long Island is prohibited.
- The manufacturer must submit to the NYSDEC a methodology its lab can use to detect dimethenamid and one of its breakdown products in water samples, and must conduct such analyses for NYSDEC.
- The manufacturer must provide to NYSDEC sales records of these products at the retail level for four years so the Department knows where in the state it should test for dimethenamid and its breakdown product.
- The manufacturer must submit data on any detections of dimethenamid or its breakdown product nationwide.²⁰³
- In 1997 NYSDEC denied registration to two products containing the new active ingredient acetochlor, which was identified by the EPA as a probable human carcinogen and which tested positive in several genotoxicity tests. NYSDEC's greatest concern, however, was that acetochlor's breakdown products were found to have the potential to leach to groundwater at levels exceeding the state's drinking water standards. Toxicity to aquatic plants and invertebrates from runoff was also an issue. Although acetochlor was registered by the EPA contingent upon a pound-for-pound national reduction in the use of six other corn herbicides, the Department found that "acetochlor has toxicological and environmental fate profiles comparable to, and in some cases worse than, those of the other compounds." It felt that "the identified risks and lack of compelling benefits" called for a denial of registration.²⁰⁴

Massachusetts²⁰⁵

The Massachusetts Department of Food and Agriculture also incorporates independent review into its registration process, and does so with a barebones staff. A single environmental chemist reviews environmental fate issues, especially groundwater impacts, while a lone toxicologist examines health effects data. (Massachusetts registers 7,500 to 8,000 products annually, according to staff, about 25 percent fewer than Minnesota.) All new active ingredients undergo such review, as do requests for significant new use patterns. Routine reregistrations are not reviewed.

202 Letter from Stephen Hammond, Director, NYSDEC Division of Solid & Hazardous Materials, to Jerry Harrison, Novartis Crop Protection, Inc., June 5, 1998.

203 Letter from Norman H. Nosenchuck, Director, NYSDEC Division of Solid & Hazardous Materials, to Sonia R. White, BASF Corporation, May 15, 1997.

204 Letter from Norman H. Nosenchuck, Director, NYSDEC Division of Solid & Hazardous Materials, to Michael S. O'Connor, Acetochlor Registration Partnership, April 10, 1997.

205 This section is based on interviews with Susan Reed, Lee Corte-Real, and Steve Antunes-Kenyon of the Massachusetts Department of Food and Agriculture, September 14, 1999.

Pesticide manufacturers are asked to provide summaries of data which have been submitted to the EPA on these issues. If concerns arise, the full studies may be requested. On rare occasions, the staff will request the manufacturer to conduct additional studies. The state collects fees of \$100 per registered product from pesticide manufacturers which are deposited into the General Fund, from which the Legislature makes appropriations for pesticide regulatory activities.

One result of such reviews may be to classify pesticide products as State Restricted Use Pesticides, similar to the federal classification. This is done when it is determined that a product used in accordance with federal label requirements “may cause . . . unreasonable adverse effects on the environment.” As a result, only certified applicators may use such products. Sixteen active ingredients have been so classified.

The state may also classify pesticides as State Limited Use, which means use may be restricted to certain individuals or groups, may require permission from the Department prior to each use, or may be restricted in some other manner. One pesticide so classified is acetochlor, a corn herbicide popular in Minnesota. The federal label warns that the product should not be used where the amount of organic matter in the soil is below three percent or the depth to groundwater is less than 30 feet. The state, concerned that users might apply acetochlor without verifying these conditions, required them to submit documentation that those conditions are indeed met at the application site. Only a handful of pesticides are classified as State Limited Use.

On rare occasions, registration is simply denied. This recently happened to sulfosulfuron, a spring and winter wheat herbicide. The EPA has classified the active ingredient as a likely carcinogen. No spring or winter wheat is raised in Massachusetts, and staff were concerned that once the product was registered the manufacturer would attempt in the future to add new uses, hoping that environmental review could be avoided upon reregistration.

Staff also said that some products are withdrawn by the manufacturer when the staff asks for additional information.

A Modest Review Program Can Have Significant Benefits

The point of reviewing these examples is not that the MDA – which has registered all of the products discussed above without any restrictions – should have necessarily reached the same decisions as New York or Massachusetts did. However, by not even conducting such a review process, the MDA forfeits its opportunity to learn more about potential contamination problems and to take steps to prevent them. The modifications made by other states allow products to be used in a manner which safeguards at-risk resources while at the same time preserving farmers’ access to these products, resulting in a win-win outcome.

While the magnitude of California’s program reflects, in part, its position as the nation’s leading agricultural state, Massachusetts and New York manage to run respectable programs with just a handful of staff positions. (The market value of crop, nursery, and greenhouse sales in Minnesota is four times that of New York and almost 12 times higher than that of Massachusetts.) The different-sized programs in these states give the MDA several models to consider. The examples of New York and Massachusetts show that good results can be achieved from relatively modest expenditures.

MCEA does not believe that citizens in these states care more about their children’s health and the purity of their water resources than Minnesotans do. The MDA needs to create an environmental review process that matches the strength of those values.

204 Letter from Norman H. Nosenchuck, Director, NYSDEC Division of Solid & Hazardous Materials, to Michael S. O’Connor, Acetochlor Registration Partnership, April 10, 1997.

205 This section is based on interviews with Susan Reed, Lee Corte-Real, and Steve Antunes-Kenyon of the Massachusetts Department of Food and Agriculture, September 14, 1999.

Recommendation: Minnesota should assess the environmental and health impacts of new active ingredients as part of the registration process, and, if warranted, impose conditions on use to mitigate potential contamination. Proposed major changes in use patterns and selected products undergoing reregistration and which raise environmental concerns should also be subject to such review.

To keep costs down, Minnesota’s program should be structured along the lines of that in New York State, which takes advantage of technical expertise housed in various state agencies to conduct the review. The Minnesota Department of Natural Resources should have responsibility for analyzing the effects of pesticides on fish and wildlife. The MDH should analyze human health effects. Environmental fate issues, including the potential for groundwater leaching, should be examined by the PCA. Funding for this work should come from MDA’s Pesticide Regulatory Account.

If any of these analyses indicate that the potential concentration of pesticides in groundwater or surface water may cause “unreasonable adverse effects on the environment,” as the Pesticide Control Law states, the MDA should impose use conditions that would prevent such an occurrence. These conditions should be developed jointly by the MDA and the agency that makes the finding, to the satisfaction of the latter that the conditions will sufficiently reduce the identified risk.

MCEA estimates that this recommendation will require an additional 3.5 positions, approximately \$210,000.

MDA Should Request Sufficient Funding to Address Monitoring Gaps, Implement an Effective Common Detection Process, Collect Pesticide Use Data, and Review Environmental Effects During Registration

MCEA’s examination of the MDA’s regulatory actions with respect to pesticides, as documented in this report, has revealed numerous instances where MDA has failed to fulfill its statutory obligations and others where, in MCEA’s estimation, additional action should be taken in order to protect Minnesota’s waters, its wildlife, and its citizens from the risks posed by exposure to pesticides. These activities are in four areas: filling gaps in the monitoring network; implementing a common detection process that functions more closely to what the Act envisioned; collecting and analyzing pesticide use data; and establishing a process to examine the environmental and health effects of pesticides during the state registration process.

The fee on pesticide sales, which funds MDA’s pesticide regulatory activities, hasn’t been increased in 10 years.

Documents prepared by the MDA indicate that it understands the need for additional expenditures to address pesticide contamination. In its 1998-99 budget narrative, the Department stated, “The increasing recognition of the environmental impacts of agricultural activities will cause more resources to be spent on environmental monitoring, compliance and remediation.” The MDA also reminded legislators that “Implementation of programs to address surface and ground water protection from nutrients and pesticides remain [sic] a high priority.”²⁰⁶

206 State of Minnesota, 1998-99 Minnesota Biennial Budget, Environment and Natural Resources, pp. D-273 and D-287.

In the MDA’s Biennial Report to the Legislature for that same biennium, it noted, “Growing concerns regarding commonly accepted agricultural practices are evident as the [Agronomy and Plant Protection] division fields more complaints regarding pesticide and fertilizer use, and ground or surface water contamination.”²⁰⁷

While MDA officials agreed with several of MCEA’s recommendations, they indicated that insufficient funding prevented them from implementing such programs.

The MDA’s Pesticide Regulatory Account, which funds the pesticide regulatory program, has maintained a sizable surplus for the past several years. As shown in Table 5, between Fiscal Years 1997 and 2001, the annual surplus carried by the account ranged from \$2.6 to \$3.5 million. The account’s largest revenue stream comes from a 0.4 percent fee on the gross sales of all pesticides sold in the state, which has provided \$4 to \$5 million annually over the past five years. Other revenues placed in the account include pesticide license fees from dealers and applicators.²⁰⁸

The surplus in the account has declined by 30 percent since Fiscal Year 1999, a trend which is forecasted to continue in the near future. MDA officials cite as a major reason the recent popularity of the low-priced herbicide Roundup (active ingredient: glyphosate) used on soybeans genetically modified to be herbicide-tolerant.²⁰⁹ Sales of glyphosate increased from 1.1 million pounds in 1996 to 6.2 million pounds in 2000, making it by far the largest selling pesticide in the state.

A second major factor reducing the purchasing power of the account is the fact that the level of the fee on pesticide sales has remained unchanged since 1991, while the Consumer Price Index has risen by 31 percent over that period. **Yet, the MDA has never asked the Minnesota Legislature to increase the fee.** In contrast, in the 2001 session, the MDA asked the Legislature to **double** the amount of several fees: fees on wholesale produce dealers, fertilizer tonnage, specialty fertilizer, fluid milk processors, milk procurement, dairy plant review, grade A milk testing, and milk tank inspection. All except the fertilizer fees were

TABLE 5
Pesticide Regulatory Account Earnings and Expenditures
FY 1997 - FY 2003

	Actual FY 1997	Actual FY 1998	Actual FY 1999	Actual FY 2000	Budgeted FY 2001	Estimated FY 2002	Estimated FY 2003
Accumulated Balance Forward	\$2,676,000	\$2,634,000	\$2,864,000	\$4,067,000(a)	\$3,548,000	\$2,833,000	\$2,129,000
Earnings	\$5,071,000	\$5,216,000	\$5,507,000	\$4,772,000	\$4,962,000	\$4,977,000	\$4,952,000
Expenditures	\$4,163,000	\$4,298,000	\$4,466,000	\$4,446,000	\$4,835,000	\$4,951,000	\$5,131,000
Balance Forward	\$2,634,000	\$2,923,000	\$4,067,000	\$3,548,000	\$2,833,000	\$2,129,000	\$1,180,000

(a) Represents Transfer In from 200 Fund: \$4,011, and Prior Year Adjustments: \$25,000

Source: FY 1997-98: State of Minnesota, Minnesota Department of Finance, 2000-2001 Departmental Earnings Report, January 29, 1999.
FY 1999-03: State of Minnesota, Minnesota Department of Finance, 2002-2003 Departmental Earnings Report, January 2001.

207 Minnesota Department of Agriculture, *Biennial Report to the Legislature*, 1998-1999, November 15, 1998.
208 Letter from Michael Schommer, Communications Director, MDA to Bob Eleff, MCEA, April 25, 2001.
209 *Ibid.*

passed by the Legislature and signed by the Governor.²¹⁰ The MDA also asked for and received authority to increase fees to reimburse clean-up costs for pesticide spills.²¹¹ It appears that these issues have a higher priority at the MDA than addressing chronic pesticide contamination.

MCEA also investigated the possibility that the MDA sought to spend more on pesticide regulation but was prohibited by the Legislature from doing so. (Prior to 1999, the Legislature had to approve in advance any expenditures from the account.) The MDA said that the Legislature never took such an action.²¹²

Recommendation: The MDA should request the Minnesota Legislature increase the revenues in the Pesticide Regulatory Account to enable the MDA to fulfill its mandate to protect Minnesota's resources and citizens from pesticide contamination and exposure and to collect data on pesticide use trends as directed by the Legislature.

Potential Sources of Additional Funds for Pesticide Regulatory Activities

MCEA's recommendations in this chapter amount to \$1,001,000 in additional annual costs, and a one-time capital expenditure of \$135,000 for well drilling and monitoring stations. While some of these costs can be paid from the MDA's Pesticide Regulatory Account, additional funds are needed. Several options for increasing revenues are presented in the recommendation below. MCEA believes that the best option is to increase the fee on gross pesticide sales in the state, which has not been increased since 1991, and which clearly no longer raises sufficient revenues to fulfill all of the MDA's statutory obligations to prevent and minimize pesticide contamination. This fee is designed to fund regulatory and administrative tasks necessary to support the safe use of pesticides in the state. MCEA's recommendations are focused on improving the effectiveness of those activities.

Recommendation: The Minnesota Legislature should provide additional funding to enable the MDA and other state agencies to fulfill the statutory requirements of the Minnesota Groundwater Protection Act and Pesticide Control Law and to analyze the environmental and health impacts of pesticides during the state registration process. The Legislature should consider the following sources of revenue:

- Raising the fee on gross pesticide sales paid by pesticide manufacturers, which has not changed since 1991, by an amount sufficient to enable the MDA to carry out all of its statutory responsibilities to prevent and minimize pesticide contamination.
- Increasing fees on pesticide dealer licenses and/or applicator licenses.
- Repealing in whole or in part the exemption of retail pesticide sales from the state sales tax. This exemption amounts to more than \$30 million in lost revenues annually. (Pesticides are not exempt from sales taxes in 15 states, including Iowa, Michigan, and South Dakota.) Each one percent sales tax paid on such sales raises more than \$4 million in revenues.
- Appropriating general funds directly.

210 Minnesota Senate, Office of Fiscal Policy Analysis, *Tracking Document, 2001 Environmental and Agriculture Budget – Details*, pp. 26-27.

211 H.F. 10, 2001 Special Session.

212 Letter from Michael Schommer.

CHAPTER 7

INTEGRATED PEST MANAGEMENT: A COST-EFFECTIVE ALTERNATIVE TO PESTICIDES

What Is Integrated Pest Management?

We can minimize the risks posed by heavy pesticide use – and we can do it without economically harming farmers – by taking advantage of effective alternatives which can be substituted for chemicals. A wealth of evidence based on real-world experience shows that many non-chemical ways of controlling insects and weeds are successfully being used on farms across the country.

These alternative techniques – referred to collectively as Integrated Pest Management (IPM) – are very different from conventional reliance on pesticides. While the pesticides themselves are the result of highly sophisticated chemical research, the concept behind them is a simple one: zap those bugs or weeds. Less consideration is given to the ecological processes that undergird agriculture and how application of the “silver bullet” may affect their ability to support productivity. IPM, in contrast, uses a knowledge of pest biology, genetics, ecology, and population dynamics to **understand** and **anticipate** the interactions among plants, pests, and beneficial organisms. It utilizes this practical information to craft a strategy of **diverse** tactics designed to **prevent** pest infestations and to keep plants healthy so that they can better resist insects, weeds, and disease. IPM techniques can dramatically reduce dependence on pesticides.

IPM involves substituting labor, knowledge, and machinery for pesticides. There is plenty of scope for such substitution to be economical because pesticides represent a significant portion of Minnesota farmers’ total variable costs, from 15 percent for wheat, to 21 percent for sugar beets and 35 percent for soybeans.²¹³

IPM is really a continuum of behaviors, reflecting a shift from treatment with chemicals to prevention of pest infestations. IPM methods include cleaning tillage and harvest equipment to prevent weeds from spreading; rotating crops to reduce the risk of infestation by disrupting weed life cycles; planting cover crops to suppress weeds by successfully competing with them for light, moisture, and nutrients (some cover crops, such as rye, also produce chemicals which suppress the germination and seedling growth of several broadleaf weed species); and using a rotary hoe or inter-row cultivation to dislodge germinating weeds and seeds.²¹⁴ Many studies have shown such practices to be profitable, not only as a result of higher yields, but also through lower production costs resulting from less pesticide and fertilizer use.²¹⁵

With respect to insect pests, introducing new predators or parasites, conserving natural enemies that already exist (for example, by planting cover crops to provide them a food source), and augmenting these natural enemies by releasing artificially reared populations are examples of typical IPM pest prevention and management methods.²¹⁶

213 U.S. Department of Agriculture and Minnesota Department of Agriculture, *Minnesota Agricultural Statistics 2000*, pp. 7-9.

214 Richard T. Proost et. al., *Protecting Wisconsin's resources through integrated weed management*, University of Wisconsin-Extension, n.d., pp. 18-20, 32-34.

215 Northwest Area Foundation, *Which Row to Hoe?*, 1993.

216 Natural Resources Defense Council, *Fields of change: a new crop of American farmers finds alternatives to pesticides*, 1998, p. 4.

There are many formal definitions of IPM. Minnesota Statutes define IPM as “use of a combination of approaches, incorporating the judicious application of ecological principles, management techniques, cultural and biological controls, and chemical methods, to keep pests below levels where they do economic damage.”²¹⁷ This defines IPM merely as a grab-bag of several management techniques, without a goal or principle upon which producers can make decisions.

A website maintained by the Consortium for International Crop Protection and the Integrated Plant Protection Center lists 57 definitions appearing in the literature since 1970.²¹⁸ Several of these incorporate environmentally protective decision-making guides, such as operating “with the least possible hazard to people, property, and the environment.”²¹⁹ One definition succinctly states: “IPM is a system that controls pests and contributes to long-term sustainability by combining judicious use of biological, cultural, physical and chemical control tools in a way that minimizes the risks of pesticides to human health and the environment.”²²⁰

Some concrete examples of IPM methods may make the concept clearer:

- Research at the University of Wisconsin found that corn herbicide applied in bands (on crop rows only, rather than broadcast) at 50 percent of the label rate, combined with timely cultivation or rotary hoeing, resulted in no significant differences in weed levels and yields when compared with conventional applications. This reduced the amount of herbicide used by 75 percent.²²¹
- An example of an IPM technique for potatoes is the planting of 12- to 15-foot borders of other crops around potato plots in order to attract aphids, carriers of Potato Virus Y, which migrate to the edges of fields where the contrast between green plants and dark soil is greatest. The virus was reduced by 27 percent in the first year these borders were used, and by 60 percent in the second year.²²²
- Recent research from the U.S. Department of Agriculture recommended that farmers take steps to encourage the growth of soil microbes called deleterious rhizobacteria (DRB), which keep weed seeds from germinating, and produce toxins and excessive concentrations of plant growth hormones that weaken and rupture weed root cells, while not harming crop plant growth. “[T]he highest numbers of weed-suppressing DRB,” the research concluded, “came from fields where crops were rotated, chemicals and tillage were minimal, and organic materials like compost were added. DRB fared best in a corn-soybean-wheat-cover crop rotation.”²²³

Minnesota has several fine IPM programs, but they lack concrete goals, a long-range strategic plan, and a governing body to coordinate them and determine priorities.

A project in the Midwest that has been successful in moving farmers along the IPM continuum has been conducted by the World Wildlife Fund in conjunction with the Wisconsin Potato and Vegetable Growers Association. Growers have planted disease resistant potatoes, practiced rotation, switched to less toxic pesticides, and carefully monitored fields and weather conditions in order to spray only when necessary. The results so far are encouraging.

In the project’s first two years, growers achieved a 20 percent reduction in toxicity units across all herbicides, insecticides, and fungicides applied, while potato farmers nationally posted a 16 percent increase.²²⁴

The ecological benefits of IPM adoption are obvious: less hazard to human health; fewer toxic risks to wildlife; improved water quality; less disruption of existing biological controls; a lower risk of developing pesticide resistance; less chance of promoting secondary pests; and a greater likelihood of long-term suppression of pests.

As a report prepared for the MDA in 1996 concluded, “Minimizing pesticide use is the most important strategy in reducing contamination of water resources.”²²⁵

217 Minn. Stat. § 17.114, subd. 2(b).

218 <www.ipcc.orst.edu/IPMdefinitions/home/html?>

219 A. R. Leslie (ed.), *Integrated pest management for turf and ornamentals* (London: Lewis Publishers), 1990, Preface.

220 A.A. Sorensen, *IPM in partnership with nature*, Center for Agriculture in the Environment, American Farmland Trust, 1994.

221 J. Doll et. al., *Reduced Herbicide Rates: Aspects to Consider*, Nutrient and Pest Management Program, University of Wisconsin-Madison, September 1992.

222 Christina D. DiFonzo, David W. Ragsdale and Edward B. Radcliffe, "Integrated Management of PLRV and PVY in Seed Potato, with Emphasis on the Red River Valley of Minnesota and North Dakota," *Radcliffe's IPM World Textbook*, <<http://ipmworld.umn.edu>>.

223 "Cropping Systems Influence Biological Weed Control," ARS News Service press release, Agricultural Research Service, U.S. Department of Agriculture, June 27, 2000.

224 <www.worldwildlife.org/toxics/progareas/ap/altern_5.htm>.

225 *Pesticides in Minnesota Water Resources* . . . , p. 44.

Minnesota Undertakes IPM Efforts in Several Areas

Minnesota has many IPM programs, but they are scattered among different agencies, and lack a formal body to coordinate, prioritize, and focus them. While the University of Minnesota, the University of Minnesota Extension Service, and the MDA often cooperate on an ad hoc basis on individual projects, overall coordination is missing. There is no state IPM plan which lays out the state's policies and priorities, nor an integrated structure whose components can be assigned responsibility for carrying out certain parts of the plan. A consequence of Minnesota's fragmented IPM infrastructure is the absence of a sense that IPM is the preferred pest management strategy to be pursued by all elements of agriculture.

In 1994, the Legislature stated that the "department of agriculture is the lead state agency on . . . integrated pest management."²²⁶ While the MDA has developed some fine IPM programs, in MCEA's estimation it has not played a leadership role, as evidenced by its noncommittal statement in the Plan that it does not "promote or discourage differing philosophies on pest management. . . ."²²⁷ The significant budget cuts proposed for IPM programs by the MDA in its 2002-03 biennial budget, described below, also lead one to question the MDA's commitment to programs promoting the transition to a more sustainable agriculture, even though funding was eventually fully restored by the Legislature.

This chapter examines Minnesota's IPM programs, reviews key features of programs in other states, and makes recommendations on how Minnesota's IPM infrastructure can be strengthened in the areas of organization, planning, and program delivery, in order to be more effective in hastening the transition to a less chemical-intensive agriculture.

Among Minnesota's many IPM activities are the following:

Research/Demonstration Grants

MDA's Sustainable Agriculture Grant Program: About 19 projects, which can last up to three years, are funded annually, with a maximum award of \$25,000. The average award per project has declined from \$12,900 in 1995 to \$8,800 in 2000. Of 145 grant projects funded between 1990 and 2000, 17 were IPM-related. Three of these concerned corn and one concerned soybeans; the rest were for fruits and vegetables.

Other MDA Grants: The 2000-2001 biennium was the first in which the MDA benefitted from a \$300,000 appropriation from the legislature for IPM. The bulk of those funds support research and demonstration grants for IPM projects conducted at the University and the state's system of agricultural Research and Outreach Centers. The five current projects are all on fruits and vegetables.

The MDA proposed cuts of \$270,000 in these two grant programs for the 2002-2003 biennium.

Agricultural Utilization Research Institute Grants: Funded by up to \$200,000 annually (in part from the fee on gross sales of pesticides), the Institute's Pesticide Reduction Options program aims to reduce pesticide use. In 1999, six projects were funded; four were added in 2000. One project is on corn, the rest are on fruits and vegetables. The average award in 2000 was approximately \$35,500.

Minnesota Pesticide Impact Assessment Project: This small federally-funded program has underwritten IPM research and conducted surveys of aerial pesticide spraying.

²²⁶ Minn. Stat. § 17.114, subd. 1.
²²⁷ *PMP*, October 1998, p. 3.

Information Delivery

University of Minnesota and Extension Service

- Research and Outreach Centers: Six centers are maintained by the Minnesota Extension Service. Those in Waseca, Lamberton and Crookston have substantive IPM programs. Two IPM Specialists (at Lamberton and Crookston) are supported with a portion of \$210,000 that Minnesota receives in federal IPM funds.
- More than half a dozen University of Minnesota faculty members hold joint appointments with the Extension Service, conduct research, and serve as resources for IPM inquiries. For example, one is responsible for insects and one for weeds in each of three crop areas: corn and soybeans, fruits and vegetables, and small grains.
- There is an agricultural Extension county educator in each Minnesota county, although not necessarily one with expertise in crops.
- University of Minnesota Entomology Department faculty maintain two on-line IPM resources: *VegEdge: Vegetable IPM Resource for the Midwest* (www.vegedge.umn.edu) and Radcliffe's IPM World Textbook (<http://ipmworld.umn.edu>).
- Extension personnel teach short courses and organize conferences, workshops, tours, and field days on IPM topics for agricultural professionals.

MCEA has identified a number of gaps in the IPM delivery system at the University of Minnesota and Minnesota Extension:

- There are currently only three regional IPM specialists, at Crookston, Lamberton, and Waseca. In other regions of the state such expertise is unavailable. The need to quickly respond to changing conditions, such as emerging pest and weed infestations, reinforces the idea that a larger number of such experts covering smaller areas – with similar cropping systems, weather patterns, and pest pressures – will be able to do a better job.
 - Not every county has an Extension educator with a specialty in crops, and crop consultants often bypass them as a result. This places additional burdens on other county, regional, and statewide Extension personnel.
 - There are few attempts to quantify the economic benefits of IPM adoption, either to individual farmers or with respect to the state as a whole.
 - Given the significant grant resources devoted to research and demonstration of IPM techniques, little attention has been paid to how the results of these projects are disseminated, and how the likelihood of their adoption can be increased. Typically, the projects are carried out in a single location, raising the question of how they can be adapted to areas with different soils, weather patterns, etc. These considerations can raise formidable barriers to adoption.
 - There are no funded positions in the University of Minnesota's Department of Plant Pathology for research faculty specializing in diseases of corn or stored grain.
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Minnesota Department of Agriculture

- **Apple and Strawberry IPM Projects:** For the past four years the MDA has monitored pests in a dozen or more orchards, sharing data on pest pressure, and communicating information on IPM strategies to the state's 120 apple growers through a weekly newsletter. A similar program is operating with the state's 55 strawberry growers.
- **Biological Control Program:** This program's function is to research and implement non-chemical pest controls, such as beneficial insects and parasites that attack both insects and weeds.

Approximately \$300,000 in general funds supports a competitive grant program that funds six to seven research projects per biennium conducted by University of Minnesota scientists.

A \$350,000 biennial appropriation from the general fund supports research, field testing, insect rearing and release, and pest surveys. In the summer of 2000, 16 employees conducted surveys in every county in the state, results of which are posted on the MDA's website so controls can be targeted to those areas.

The MDA proposed cuts of \$120,000 in this program for the next biennium.

- **IPM Coordinator:** A single position at MDA supported by approximately \$65,000 annually in general funds promotes IPM on state-managed lands and in schools, and serves as an information resource for urban and agricultural IPM activities.

Other State IPM Programs Offer Ideas

MCEA also examined IPM programs in three states that have reputations for innovation and effectiveness: New York, Texas, and Michigan.

New York²²⁸

In contrast to Minnesota, the most notable feature of New York's IPM program is its highly integrated and focused nature, both in terms of its activities and the organizational structure devised to accomplish them.

New York's IPM structure integrates Extension and University educators, commodity groups, crop consultants, the state agriculture department, and growers to govern the program.

The program's overall priority is to promote the transition of New York agriculture away from pesticides targeted for restriction or elimination by the federal Food Quality Protection Act and those whose use results in groundwater and surface water contamination. Grant proposals are evaluated in light of this priority.

To achieve this goal, New York has produced a Strategic Long-Range IPM Plan which targets specific crops and pests for pesticide reduction. Crops are ranked on a numerical scale that reflects their economic value, the amount of pesticides used, the environmental impacts of use, and the number of pests associated with the crop.

228 The information in this section was taken from New York's IPM website: <www.nysaes.cornell.edu/ipmnet/ny/>.

The premise of the Plan describes the factors motivating the development of an effective IPM program:²²⁹

The IPM plan is built upon the premise that agriculture will face continuing efficacy, environmental, and health-related issues because of the industry's reliance upon synthetic pesticides. Included in this premise is the realization that pesticide registrations are being curtailed or withdrawn, that pesticide residues are present in groundwater and in food, that public pressure to reduce . . . contamination will increase, that rising numbers of pests have developed resistance to chemical materials, and that conflicts between growers and communities over environmental issues will grow.

The organizational structure that develops and carries out the Plan brings together IPM professionals from various institutions and infuses them with a common purpose. The Plan itself is developed with input from five commodity-based Working Groups made up of Cornell University research and extension faculty and staff, growers, and crop consultants. The IPM program staff, housed at Cornell, consists of a director and assistant director, four coordinators, and five Extension educators. Policies and directives to guide the program are provided by an operating committee which includes the IPM director, chairs of the Working Groups, and the directors of extension, experiment station research, the state department of agriculture's IPM program, and Cornell's Pest Management Education Program.

One factor that is important to successful adoption of IPM methods by growers in New York was revealed by the results of a survey of more than 1,000 field corn and alfalfa growers. It found that growers must have confidence in the efficacy of IPM techniques and their ability to implement them before they will consider adoption. IPM programs play a critical role in raising farmers' confidence levels. Of those with no ties to Cornell's IPM education programs, only 15 percent adopted IPM methods. Growers with formal ties to the program adopted IPM at more than twice that rate, 35 percent. Growers who also participated in a year-long intensive IPM course conducted on their own farm had the highest adoption rate, 46 percent.

New York's IPM Program points to the following among its successes in reducing pesticide use:

- A survey of strawberry growers conducted in 1998 found that of growers who attended IPM educational programs, 39 percent used no fungicides during the growing season and 61 percent applied no fungicides after the fruit was formed.
- The adoption of guidelines developed by the IPM program by two food processing companies that control over 90 percent of sweet corn acres in the state lowered the number of insecticide sprays by 55 to 65 percent, reducing the amount applied by over 100 tons, and producing net savings to growers of \$500,000 per year.

Texas²³⁰

The key feature of the Texas IPM program is its grassroots nature. Twenty-six Pesticide Management Units have been established throughout the state, encompassing from one to six counties. Each unit has a steering committee consisting of a member of a commodity group, a grower, and an IPM Extension Agent employed by Texas A&M University. The extension agent in each unit serves as a key liaison between growers and university faculty to insure that growers' needs are addressed by faculty research programs.

229 New York State IPM Program, *IPM Strategic Long-Range Plan*, p. 45.

230 Texas Pest Management Association website, <www.tpma.org>; interview with TPMA Executive Director Mike Wallace, October 2000.

Growers are attracted to the program because they see that it directly serves their local needs. Having IPM experts on site, “eyeball to eyeball with the farmer,” helps give growers the confidence to adopt IPM methods.

In Texas, a private grassroots organization comprised of 2,500 growers and 12 commodity associations spearheads IPM.

The unique aspect of the Texas program is that the centerpiece of the delivery system is a private grassroots organization run by an association of growers. The Texas Pest Management Association (TPMA) is made up of more than 2,500 growers and 12 commodity associations. Its sole purpose is to expand the use of IPM techniques in the state, in partnership with the Texas Agricultural Extension Service and the Texas Department of Agriculture. TPMA raises

funds from growers by means of membership dues and service fees for crop monitoring and scouting, as well as non-IPM services.

TPMA Executive Director Mike Wallace attributes the positive attitude towards IPM among all groups involved in Texas agriculture to the personal charisma of Texas A&M University researcher Dr. Perry Adkisson, winner of the 1997 World Food Prize for his IPM work. He founded the Extension IPM program in the 1970s, and did an excellent job convincing growers, the Texas Department of Agriculture, and crop consultants that embracing IPM was in their best interest.

Texas also makes a point of calculating the economic benefits of IPM adoption which helps both to garner funding support and to make adopting IPM measures more attractive to farmers. For example, 94 percent of cotton farmers surveyed in two northeast Texas counties reduced their pesticide use and increased net profits by \$15 to \$20 per acre. Similarly, an analysis of the state’s pecan IPM program found that use of fungicides and insecticides were reduced by about one-third, while yields increased, producing annual benefits of over \$6 million.²³¹

Michigan²³²

The way in which Michigan’s Extension Service is organized to deliver IPM information and services serves to integrate and coordinate these functions. Individual Area of Expertise (AOE) teams exist for field crops, fruits, vegetables, landscape nurseries, and Christmas trees. The 10- to 20-member teams comprise all University, Extension, and Agricultural Experiment Station personnel who work in those areas.

Each AOE team develops its own plan for program delivery and staff development. Stakeholder involvement in project selection, direction, and evaluation is an important element of this customer-focused style of organization.

To foster coordination, a conference call of all team members, including those in the field, is held once a week during the growing season, with the discussion being summarized in an on-line newsletter. The teams meet face-to-face three to four times a year for two-day sessions, at which team leaders – one on campus, one in the field – are selected. Once a year the team meets formally with growers and commodity groups to listen to their concerns, and may establish workgroups to address specific needs.

According to Department of Entomology and Extension faculty member Christina diFonzo, this structure has several advantages over one like Minnesota’s Extension Service. Advice to growers is likely to be more consistent; new Extension personnel have ready access to mentors and can reach a level of expertise more quickly; and county agents covering multiple counties have an easier time of pooling their resources and planning joint programs. She said that both Purdue University and Ohio State University are considering adopting a similar organizational structure.

231 Texas Agricultural Extension Service, *IPM Progress Through Partnerships*, August 1999, pp. 18, 25.

232 Arlen Leholm et. al, "Area of Expertise Teams: The Michigan Approach to Applied Research and Extension," *Journal of Extension*, vol. 37, no. 3 (June 1999), available online at <<http://joe.org/joe/1999june/a3.html>>; interview with Christina DiFonzo, Michigan State University Department of Entomology and Extension faculty member, November 2000.

Ways To Strengthen Minnesota's IPM Programs: Organization, Planning, and Service Delivery

Minnesota's IPM Organizational Structure Should Be Integrated

Compared with other state IPM programs, Minnesota's is very fragmented, lacking coordination of many scattered programs. A more integrated structure is needed to insure that programs and policies are consistent and that responsibilities for achieving program goals are clearly defined.

MCEA believes that New York's example, in particular, offers a structure which contributes to success: a relatively small program staff housed at Cornell University; commodity-based working groups integrating faculty, growers, and crop consultants working on similar commodities; and a policymaking and coordinating committee made up of representatives of university and extension faculty, the state department of agriculture, and other important sectors to guide the program.

Recommendation: The Minnesota Legislature should create a task force containing representatives from Minnesota Extension, researchers at the University of Minnesota, the Research and Outreach Centers, the MDA, commodity groups, crop consultants, and producers to devise an operating structure to better integrate, prioritize, and focus the state's IPM programs, based on the New York model. The task force should report to the Legislature how this may be accomplished and estimated costs.

Minnesota Needs a Long-Range Strategic IPM Plan to Set Goals and Priorities

Minnesota's IPM programs are operating without a map, making it harder for them to reach their goal. For example, many of the projects funded through IPM demonstration grant programs have been aimed at fruits or vegetables, which represent a tiny proportion of the state's total pesticide use in comparison with crops like corn, soybeans, and wheat. A long-range plan which establishes priorities, details statewide goals, and describes ways of achieving them can do much to focus efforts and reduce duplication.

Recommendation: Minnesota's new organizational structure should produce a Strategic Long-Range IPM Plan that sets priorities to govern IPM programs in the state and establishes goals against which results can be measured.

- More attention should be placed on developing IPM methods for field crops like corn, soybeans, and wheat, where adoption could result in large reductions in pesticide use and risk statewide.
- Priorities should be developed for pesticides targeted for use reduction, based, at least in part, on the environmental and health risks they pose.
- Grant programs should issue Requests for Proposals that reflect these priorities and proposals should be evaluated accordingly, to insure that the state's most pressing needs are being addressed.

MCEA has two recommendations to help establish additional priorities for the plan.

First, it is important to insure that efforts are targeted to have the most positive effects on IPM adoption. In 1989, the Legislature charged the MDA with several responsibilities with respect to IPM, one of which was “identification of barriers to [IPM] adoption.”²³³ A survey of Minnesota farmers is needed to better understand the barriers inhibiting the adoption of IPM techniques – financial, informational, etc. – and ways to overcome them. The results should be used to help to determine funding priorities and shape programs to increase their effectiveness.

Recommendation: Minnesota should conduct a statistically valid survey of farmers to determine what they view as the major barriers inhibiting them from adopting IPM techniques, and what might be the most successful strategies to overcoming those barriers. The survey should have input from the MDA, the University of Minnesota, and the Minnesota Extension Service. The results should be used to determine funding levels and priorities and to shape the state’s IPM programs and approach.

A second factor which should help establish priorities for Minnesota’s IPM program is the calculation of environmental and health risks posed by specific pesticides. Ideally, the program would seek substitutes or non-chemical pest management methods for chemicals posing the greatest risks. What is needed is a tool which can help make comparisons of risk among many pesticides.

Models exist which combine toxicity “scores” reflecting pesticide risks to several types of organisms into a single index. For example, a model developed by Charles Benbrook combines indices measuring acute and chronic mammalian toxicity; toxicity to birds, fish, and aquatic invertebrates; impacts on bees, beneficial arthropods, and soil microorganisms; and the likelihood of triggering resistance. Depending on the weights given to these components, indices can be computed which focus on human health or environmental toxicity. Further refinements can be made, such as an adjustment for exposure that reflects the likelihood of a pesticide leaching to groundwater that takes into effect the chemical’s solubility and the type of soils in the area in which it is applied.²³⁴

Multiplying these indices by the amount of each pesticide used produces a “use-weighted toxicity index” for each chemical, allowing comparison among them. In addition, these indices can be summed across all pesticides applied to measure total risk in a particular geographical area or for the state as a whole. Over time, the changes in these indices show whether the aggregate risk posed by pesticide use is increasing or decreasing, and can serve as an automatic report card on the penetration rate and effectiveness of programs promoting alternative means of pest management.

Recommendation: Minnesota’s IPM program should use a toxicity model that measures the environmental and health risks posed by individual agricultural pesticides to help prioritize pesticides for replacement by IPM techniques or substitution with less harmful chemicals. This tool should also be used to assess the penetration rate of IPM methods by measuring the change in total risk over time.

²³³ Minn. Stat. § 17.114, subd. 4(b).

²³⁴ Charles Benbrook, “A Methodology for Adjusting Pesticide Use Data For The Toxicity of Active Ingredients,” World Wildlife Fund-Wisconsin Potato and Vegetable Growers Association Potato IPM Project, <www.pmac.net>.

Delivery of IPM Services Is Key

The gaps in the delivery system must be addressed so that it can effectively carry out the goals of the Strategic Plan.

Recommendation: The Minnesota Legislature should appropriate additional funds to expand the state's IPM infrastructure in the following areas:

- An agricultural economist should be added to the Minnesota Extension Service staff to calculate the economic benefits to individual farmers and to the state of the adoption of various IPM measures.
- Positions in the University of Minnesota's Department of Plant Pathology should be funded for research faculty specializing in diseases of corn and stored grain.

Recommendation: In order to give its IPM service delivery greater focus, the Minnesota Extension Service should examine the Michigan Extension Service's Area of Expertise team approach and consider adopting it in Minnesota.

Sources of Additional Funds to Improve Minnesota's IPM Programs

Recommendation: The Minnesota Legislature should consider the following options in directing additional funding to reorganize and expand IPM programs in the state:

- Raising the fee on gross pesticide sales paid by pesticide manufacturers, which has not been increased since 1991.
- Increasing fees on pesticide dealer licenses and/or applicator licenses.
- Repealing the exemption of retail pesticide sales from state sales tax, in whole or in part. This exemption amounts to more than \$30 million in lost revenues annually. (Pesticides are not exempt from sales taxes in 15 states, including Iowa, Michigan and South Dakota.) Each one percent sales tax paid on such sales raises more than \$4 million in revenues.
- Appropriating general funds directly.

MDA Has Ignored Legislative Reporting Requirements With Respect to IPM

MDA has routinely failed to provide the Legislature with required reports on ways to extend and improve IPM programs.

Beginning in 1990, the Legislature required the MDA to report to the Environmental Quality Board and the Legislature in every even-numbered year on its activities with respect to both sustainable agriculture and IPM. Among the required elements of the report:

- “the status of soil and water resources utilized by production agriculture . . . and the amount of non-renewable resources used by Minnesota farmers.”²³⁵
- “suggestions for changes in existing programs or policies or enactment of new programs or policies that will . . . maintain soil and water quality . . . , or lessen dependence upon non-renewable resources.”²³⁶
- “procedures for factoring integrated pest management into state laws, rules, and uses of pesticides; and identification of barriers to adoption.”²³⁷

The report issued in 1994 treats these issues cursorily; IPM is barely mentioned at all. No report was issued in 1996, 1998, or 2000.

Recommendation: The MDA should conduct the analysis and produce the reports mandated by the Legislature in a timely fashion.

235 Minn. Stat. § 17.114, subd. 3(b)(1).

236 Minn. Stat. § 17.114, subd. 3(b)(5).

237 Minn. Stat. § 17.114, subd. 4(c).

APPENDIX A

PESTICIDES SOLD IN MINNESOTA FOR AGRICULTURAL CROPS: 1998

HERBICIDES	TOTAL POUNDS	CROPS
2, 4-D	1,235,947	corn, small grains, spring wheat, soybeans
ACETOCHLOR	3,051,010	corn
ACIFLUORFEN	66,151	soybeans
ALACHLOR	1,104,165	corn, dry beans, soybeans
AMETRYN	800	corn, dry beans, potatoes
ASULAM	199,966	alfalfa, flax
ATRAZINE	3,322,613	corn
BENEFIN	1,508	alfalfa
BENSULIDE	5,760	carrots, onions
BENTAZON	802,531	corn, dry beans, soybeans
BROMOXYNIL	153,972	corn, flax, small grains, spring wheat
CHLORIMURON-ETHYL	2,978	soybeans
CHLORPROPHAM	3,413	alfalfa, carrots, onions
CHLORSULFURON	300	wheat, barley, oats
CLETHODIM	46,244	dry beans, soybeans, sugar beets
CLOMAZONE	242,250	soybeans
CLOPYRALID	256,517	corn, small grains, spring wheat
CLORANSULAM	253	soybeans
CYANAZINE	454,749	corn
DESMEDIPHAM	241,353	sugar beets
DICAMBA	1,901,686	corn, small grains, spring wheat
DICHLOBENIL	720	apples, stone fruits
DICLOFOP	102,861	small grains, spring wheat
DIFENZOQUAT	21,240	small grains, spring wheat
DIMETHENAMID	2,100,008	corn, dry beans, soybeans
DIQUAT	24,060	potatoes
DIURON	16,311	alfalfa, wheat
EPTC	1,452,224	onions, dry beans, sugar beets
ETHALFLURALIN	174,702	dry beans, soybeans
FENOXAPROP-ETHYL	108,641	small grains, spring wheat, soybeans
FLUAZIFOP-BUTYL	86,827	soybeans
FLUFENACET	17,014	soybeans
FLUMETSULAM	78,321	corn, soybeans
FLUMICLORAC	277	corn, soybeans
FOMESAFEN	162,259	soybeans
GLUFOSINATE-AMMONIUM	103,166	corn, soybeans
GLYPHOSATE	2,555,434	corn, spring wheat, soybeans, sugar beets
HALOSULFURON	4,667	corn
HEXAZINONE	1,474	alfalfa
IMAZAMOX	68,178	soybeans

HERBICIDES	TOTAL POUNDS	CROPS
IMAZAPYR	3,082	corn
IMAZAQUIN	2,645	soybeans
IMAZETHABENZ	67,500	small grains, spring wheat
IMAZETHAPYR	387,523	corn, dry beans, soybeans
ISOXABEN	457	fruits
LACTOFEN	17,934	soybeans
LINURON	19,340	corn, soybeans
MCPA	653,101	small grains, spring wheat
MCPB	9,600	green peas
METOLACHLOR	1,935,327	corn, dry beans, soybeans
METRIBUZIN	69,908	soybeans
METSULFURON-METHYL	577	small grains, spring wheat
NAPROPAMIDE	7,090	apples, tomatoes
NAPTALAM	1,440	squash
NICOSULFURON	87,736	corn
NORFLURAZON	1,258	soybeans
ORYZALIN	5,144	fruit trees, apples
OXYFLUORFEN	2,697	soybeans
PARAQUAT	28,018	corn, dry beans, spring wheat, soybeans, sugar beets
PENDIMETHALIN	2,063,195	corn, dry beans, soybeans
PHENMEDIPHAM	36,519	sugar beets
PRIMISULFURON	7,753	corn
PROPACHLOR	61,500	corn
PROPANIL	5,954	small grains, spring wheat
PROSULFURON	207	small grains, spring wheat
PYRAZON	21	sugar beets
PYRIDATE	3,911	corn
QUIZALOFOP-ETHYL	41,167	dry beans, soybeans
RIMSULFURON	3,489	corn
SETHOXYDIM	155,661	dry beans, flax, soybeans, sugar beets, corn
SIMAZINE	16,630	apples
SULFENTRAZONE	2,201	soybeans
SULFOSATE	2,783	soybeans
TERBACIL	192	alfalfa
THIFENSULFURON	3,660	small grains, spring wheat, soybeans
TRIALATE	78,690	small grains, spring wheat
TRIASULFURON	16	small grains, spring wheat
TRIBENURON	4,881	small grains, spring wheat
TRIFLURALIN	1,336,960	dry beans, flax, small grains, spring wheat, soybeans, sugar beets
TRIFLUSULFURON METHYL	4,249	sugar beets
Total Pounds	27,302,560	

INSECTICIDES	TOTAL POUNDS	CROPS
ABAMECTIN	11	potatoes
ACEPHATE	12,215	beans
AZINPHOS-METHYL	12,954	potatoes
CARBARYL	80,355	spring wheat, sugar beets, corn
CARBOFURAN	67,186	potatoes, corn
CHLORETHOXYFOS	3,345	potatoes, sugar beets, corn
CHLORPYRIFOS	219,204	potatoes, corn, spring wheat
CYCLOATE	116,305	sugar beets
CYFLUTHRIN	1,153	corn
DIAZINON	9,515	green peas, corn
DIFLUBENZURON	40	soybeans
DIMETHOATE	94,864	spring wheat, green peas
DISULFOTON	782	potatoes, vegetables
ENDOSULFAN	44,088	potatoes
FENPROPATHRIN	72	vegetables, field crops
FENVALERATE	6,820	potatoes, soybeans, tomatoes
FIPRONIL	8,944	corn
FONOFOS	364	corn
FOSETYL-AL	8,448	apples, onions
IMIDACLOPRID	4,869	potatoes
LAMBDA-CYHALOTHRIN	7,857	corn
LINDANE	101,720	soybeans, sugar beets, alfalfa, barley
MALATHION	53,030	alfalfa, corn
METHAMIDOPHOS	12,536	potatoes
METHIOCARB	144	potatoes
METHOMYL	4,757	green peas, corn
METHOXYCHLOR	336	soybeans, green peas, wheat
METHYL PARATHION	19,480	spring wheat, sugar beets
OXAMYL	5,278	vegetables, fruits
PERMETHRIN	61,455	corn
PHORATE	76,404	potatoes
PHOSMET	9,464	green peas
PYRETHRIN	32	most food crops
PYRIDABEN	85	fruit trees, vegetables
TEBUPIRIMPHOS	5,148	corn
TEFLUTHRIN	36,795	corn
TERBUFOS	464,162	sugar beets, corn
Total Pounds	1,550,218	

FUNGICIDES	TOTAL POUNDS	CROPS
AZOXYSTROBIN	7,636	potatoes
BENOMYL	23,832	potatoes, sugar beets, soybeans
CAPTAN	29,253	apples
CARBOXIN	12,379	spring wheat, barley, oats
CHLOROTHALONIL	237,353	potatoes, tomatoes
COPPER SULFATE	91	apples, potatoes, tomatoes
COPPER HYDROXIDE	33,112	potatoes
COPPER OXYCHLORIDE	479	potatoes, tomatoes
CYMOXANIL	10,294	potatoes
DAZOMET	5,396	vegetables
DIFENOCONAZOLE	2,213	wheat, sugar beets
DIMETHOMORPH	138	potatoes, tomatoes
DODINE	393	apples, stone fruits
ETRIDIAZOLE	47	barley, corn, soybeans, sugar beets, wheat
FLUDIOXONIL	35,546	potatoes, green peas
FLUTOLANIL	2,491	potatoes
IMAZALIL	57	small grains
IPRODIONE	1,800	potatoes, stone fruits
MANCOZEB	261,119	potatoes, spring wheat
MANEB	202,842	potatoes
METALAXYL	12,498	potatoes
METIRAM	32,880	potatoes
MYCLOBUTANIL	162	apples
PCNB	3,926	potatoes
PROPICONAZOLE	21,454	corn
PROPIONIC ACID	32,895	grains
SODIUM DIACETATE	25,939	alfalfa, hay
TEBUCONAZOLE	30,295	stone fruits
THIABENDAZOLE	1,356	potatoes, apples
THIOPHANATE METHYL	31,198	fruits, vegetables
THIRAM	7,692	apples, onions, tomatoes
TRIADIMEFON	94	cereals, vegetables
TRIFLUMIZOLE	420	apples
TRIPHENYLTIN (FENTIN HYDROXIDE)	1,170,627	potatoes
VINCLOZOLIN	2,966	apples, onions
ZIRAM	840	apples
Total Pounds	2,241,708	

Other	Total Pounds	Crops
CHLORMEQUAT	679	vegetables
ENDOTHALL	9,000	sugar beets
ETHEPHON	60	apples, rye, tomaotes, wheat
HEXYTHIAZOX	61	apples
MALEIC HYDRAZIDE	802	potatoes, onions
METALDEHYDE	383	vegetables
METAM SODIUM	766,935	potatoes, small grains
NITRAPYRIN	146,207	corn, wheat
PARAQUAT	28,018	corn, dry beans, spring wheat, soybeans, sugar beets
SODIUM CHLORATE	65,628	dry beans, potatoes
STREPTOMYCIN	570	stone fruits, tomatoes
SULFURIC ACID	1,620,237	potatoes
Total Pounds	2,638,579	
Grand Total Pounds	33,733,065	

APPENDIX B

EVIDENCE OF PESTICIDES IN MINNESOTA SURFACE WATERS AND GROUNDWATER

Pesticides Are Present in Minnesota's Surface Waters

Scores of studies conducted by both state and federal agencies throughout Minnesota's agricultural areas over the past 15 years have found that many rivers and streams are contaminated with pesticides. In its most recent Common Detection Data Report, published in May 2001, the MDA summarized pesticide detections at surface water sites across the state from 1992 through 2000. Atrazine was detected in 82 percent of the baseflow samples and 77 percent of the stormwater samples. Comparable figures for metolachlor were 41 and 61 percent; for acetochlor, 25 and 55 percent; and for 2,4-D, 14 and 38 percent.¹

Listed below are data on pesticide detections in surface waters in different regions throughout the state.

East Central Minnesota

Stream samples for pesticides analysis were collected by several federal and state agencies between 1988 and 1993 in a 19,500 square mile area within an arc formed by Brainerd to the north, Willmar to the west, and Mankato to the south, and extending to Minnesota's eastern border.

The Minnesota Pollution Control Agency (PCA) took samples from 14 sites in 1988-93, including the Rum, Crow, Snake, Sunrise, Kettle and Mississippi Rivers. It found atrazine at 13 sites (in 35 to 90 percent of the samples taken), metolachlor at nine sites (detection in 10 to 65 percent of samples), cyanazine at 9 sites (10 to 80 percent of samples), and alachlor at eight sites (10 to 40 percent of samples). Although concentrations were generally below 1 part per billion (ppb), the study noted that these levels "probably do not represent maximum concentrations for these months because samples were not collected near streamflow peaks."²

The U.S. Geological Survey (USGS) sampled five sites on the Mississippi, Minnesota, and St. Croix Rivers in 1991-92, and detected 14 pesticides. Atrazine and one of its breakdown products, deethylatrazine, were found in every sample taken, as were cyanazine, a cyanazine degradate, and prometon.³

1 Minnesota Department of Agriculture, Monitoring and Assessment Unit, *2001 Common Detection Data Report*, May 25, 2001, p. 16.

2 James D. Fallon et. al., *Water-Quality Assessment of Part of the Upper Mississippi River Basin, Minnesota and Wisconsin – Pesticides in Streams, Streambed Sediment, and Ground Water, 1974-94*, U.S. Geological Survey Water-Resources Investigations Report 97-4141, 1997, pp. 14-15.

3 *Ibid.*, Table 5, pp. 43-45.

After reviewing these and several other similar studies, the USGS concluded:⁴

In streams, trace concentrations of pesticides are ubiquitous – herbicides were detected at every site sampled except the Kettle River. Herbicides were detected most often in streams draining row-crop agricultural areas; the Minnesota and Cannon Rivers had the most detections, followed by the Sauk, Straight, and Crow Rivers. Concentrations of atrazine, metolachlor, and cyanazine were greatest in July, although these herbicides and others are detectable most of the year at very low (ppt) [parts per trillion] concentrations.

- A 1997 USGS study of 13 streams in the Twin Cities metropolitan area detected pesticides in all streams, a total of 17 compounds and five breakdown products. (The percentage of detections was not reported.) The sum of all pesticide concentrations ranged from .03 to .15 ppb. The highest concentrations were found at Rice Creek, followed by Riley Creek, Minnehaha Creek and Ford Brook.⁵
- The MDA took grab samples from 20 stations in the Mississippi River basin between 1991 and 1993. Atrazine was detected at 70 percent of the stations and in 48 percent of the samples; alachlor was detected at 20 percent of the stations and in 21 percent of the samples; cyanazine was detected at 20 percent of the stations and in 13 percent of the samples; and metolachlor was detected at 20 percent of the stations and 11 percent of the samples.⁶
- The PCA found pesticides in 75 percent of the samples it took from the Sauk River near St. Cloud in 1998. Atrazine and two of its degradates were detected most often, followed by two metolachlor degradates, two acetochlor degradates, one alachlor degradate, and cyanazine and one of its degradates.⁷
- While the concentrations of these detections were at very low levels, a study of stormwater in the Lake Harriet watershed in the early 1990s detected atrazine at concentrations exceeding the U.S. Environmental Protection Agency's (EPA's) safe drinking water limits.⁸

4 *Ibid.*, p. 31.

5 Philip J. Talmage et. al., *Water Quality, Physical Habitat, and Fish-Community Composition in Streams in the Twin Cities Metropolitan Area, Minnesota 1997-98*, Water-Resources Investigations Report 99-4247, 1999, p. 6.

6 *Recommendations from the Common Detection Advisory Committee to the Commissioner of Agriculture on the status of pesticides in Minnesota's water resources*, December 1998, Appendix C. Hereafter referred to as CDAC Report.

7 Minnesota Pollution Control Agency, *Ground Water Monitoring and Assessment Program, Effects of Land Use on Ground Water Quality, St. Cloud Area, Minnesota - 1998 Results*, March 1999, pp. 62-63.

8 P.J. Wotzka et. al., "Pesticide concentrations and fluxes in an urban watershed," in *American Water Resources Association National Symposium on Water Quality*, 1994, pp. 135-145, quoted in James D. Fallon et. al., Table 4.

Southeastern Minnesota

- The USGS monitored the Mississippi River near Hastings in 1998 and detected 14 pesticides and degradates, all but one of which were below 1 ppb.⁹
- The MDA maintains six automated surface sampling sites in the southeastern part of the state. Table 2 shows the range and average percentage of detections of four pesticides at each of these sites in both surface runoff (after storm events) and baseflow (dry periods).¹⁰ It is clear that these pesticides are detected regularly in these waters. Atrazine was detected most often in both runoff and baseflow. The low percentage of detections of alachlor in baseflow is most likely related to its ability to degrade quickly.

Although concentrations were also reported, MDA staff warned against examining trends on data sets with fewer than ten years of data, due to the extreme variability of these readings.

TABLE B-1
Average Percentage Detections of Pesticides at MDA Automated Surface Water Sampling Sites in Southeastern Minnesota, 1992-1997

	Atrazine	Acetochlor	Alachlor	Metolachlor
Middle Fork Whitewater	97/93	28/10	27/5	64/21
South Br. Whitewater	86/71	80/13	43/9	63/32
East Fork Blue Earth	80/67	71/35	45/21	73/44
Bevins Creek	92/72	57/16	38/13	47/33
Sand Creek	84/86	40/5	28/5	69/32
Jordan (MN River)	72/90	50/59	35/5	95/100

Source: Recommendations from the Common Detection Advisory Committee to the Commissioner of Agriculture on the status of pesticides in Minnesota's water resources, December 1998, Appendix C.

⁹ W.A. Battaglin et. al., *Concentration of Selected Sulfonyurea, Sulfonamide, and Imidazolinone Herbicides, Other Pesticides, and Nutrients in 71 Streams, 5 Reservoir Outflows, and 25 Wells in the Midwestern United States, 1998*, U.S. Geological Survey Water-Resources Investigations Report 00-4225, 2001, Tables 6, 11, 12, 15, and 16.

¹⁰ CDAC Report, App. C.

South Central Minnesota

- The MDA took grab samples at 14 sites in the Minnesota River basin from 1991 through 1993. Atrazine was detected at 86 percent of the stations and in 53 percent of the samples; alachlor was detected at 57 percent of the stations and in 30 percent of the samples; cyanazine was detected at 86 percent of the stations and in 50 percent of the samples; and metolachlor was detected at 79 percent of the stations and in 48 percent of the samples.¹¹
- USGS sampling in 1998 of the Cottonwood, Little Cobb, and Minnesota Rivers detected 19, 16, and 21 pesticides and degradates, respectively. Although most detections were below 1 ppb, summed alachlor and alachlor degradate concentrations on the Little Cobb River exceeded the federal drinking water standard of 2 ppb.¹²
- Atrazine and deethylatrazine are detected year-round in the Minnesota River. In 1991, it was estimated that 2.0 tons of atrazine, 2.9 tons of alachlor, and 6.4 tons of cyanazine passed a sampling point at Mankato.¹³ In fact, when the USGS studied the ecological health of the Upper Mississippi basin, it noted the significant contribution of Minnesota's agricultural areas to the load of pesticides in the river:¹⁴

These chemicals enter tributary streams in both contaminated surface runoff and groundwater. The tributary streams act as point sources of agricultural chemicals to the main stem Mississippi River. The Minnesota and Des Moines rivers, for example, are the primary contributors of the herbicides alachlor, cyanazine and metolachlor to the entire Mississippi River main stem.

West Central Minnesota

- The U.S. Fish and Wildlife Service sampled 30 private and public wetlands in an intensively farmed area in west central Minnesota and found concentrations of triazines,¹⁵ alachlor, and 2,4-D in every sample taken in every wetland during each of the four months studied. Concentrations of alachlor in four wetlands in one area exceeded EPA drinking water standards. The report concluded, "[W]idespread, low-level herbicide deposition is occurring in the Prairie Pothole Region of Minnesota. . .," adding that these areas "may be receiving herbicides at concentrations which can adversely impact their flora and fauna."¹⁶

Southwestern Minnesota

- USGS monitoring of the Des Moines and Rock Rivers in 1998 detected 16 and 14 pesticides and degradates, respectively. Except for metolachlor degradates, all concentrations were below 1 ppb.¹⁷

Northwestern Minnesota

- Between 1993 and 1995, the USGS sampled 11 rivers in the Red River Valley in Minnesota and North Dakota, an area about 100 miles wide and extending about 250 miles south from the Canadian border. The eight Minnesota rivers included the Red River of the North, Bois de Sioux, Wild Rice, Snake, Roseau, Otter Tail, Red Lake, and White Earth.

11 *Ibid.*

12 Battaglin et. al.

13 S.P. Schottler, S.J. Eisenreich, and P.D. Capel, "Atrazine, Alachlor, and Cyanazine in a Large Agricultural River System," *Environmental Science and Technology*, vol. 28, no. 6 (1994), Table 1, p. 1088.

14 U.S. Geological Survey, *Ecological Status and Trends of the Upper Mississippi River System, 1998: A Report of the Long Term Resource Monitoring Program*, April 1999, p. 7-15.

15 A group of chemically-related pesticides including atrazine, cyanazine, metribuzin, and others.

16 Keren L. Ensor and Stanley L. Smith, *Herbicide Concentrations in Wetlands in West Central Minnesota, 1992*, U.S. Fish and Wildlife Service, Twin Cities Field Office, June 1994, pp. 10, 13.

17 Battaglin et. al.

Tests were run for 81 pesticides and seven breakdown products; 42 pesticides and two breakdown products were detected. Eleven of the pesticides were detected in more than 20 percent of the samples: atrazine (92 percent), deethylatrazine (66 percent), metolachlor (61 percent), cyanazine (57 percent), triallate (47 percent), EPTC (35 percent), simazine (33 percent), trifluralin (28 percent), prometon (27 percent), alachlor (21 percent), and bentazon (20 percent). Median concentrations were below 1 ppb.¹⁸

- In a separate sampling conducted as part of its National Water-Quality Assessment Program, the USGS monitored two sites in the Red River Valley between 1992 and 1995. In the Wild Rice River near Twin Valley, atrazine was detected in 47 percent of the samples taken, while triallate was detected in 24 percent, cyanazine in 19 percent, and trifluralin in 11 percent. In the Snake River above Alvarado, atrazine was found in 33 percent of the samples; triallate, 31 percent; metolachlor, 19 percent; cyanazine, 17 percent; EPTC, 13 percent; and the insecticide carbofuran, 10 percent.¹⁹

These studies clearly indicate that a group of up to a dozen pesticides are routinely found in surface waters in low concentrations in all agricultural regions of the state.

Pesticides Are Present in Minnesota's Groundwater

As with surface water, a large number of studies of Minnesota groundwater resources underlying agricultural areas of the state have routinely detected the presence of pesticides.

The MDA's Monitoring Network

The MDA maintained a network of over 420 groundwater monitoring wells in the central and southern portions of Minnesota from 1985 until 1996. Almost half of these wells were located in the central sand plain, an area encompassing portions of 16 counties and extending west and northwest of the Twin Cities and which is known to be sensitive to groundwater contamination. Wells were also located in the geologically sensitive southeastern karst regions, and in south central and southwestern Minnesota.

The most important fact about this network is that it was not developed by the MDA to specifically address the detection of pesticides in groundwater. The vast majority of these wells were installed by other government agencies, such as the USGS and the Minnesota Department of Natural Resources (DNR), for other purposes, prior to the inception of the MDA's monitoring program. MDA utilized these wells because it was less costly than building its own network, but a price was paid in terms of the quality of the data obtained.

Some of these wells were DNR observation wells, known as piezometers, which are used to determine water elevation; others were domestic drinking water wells. Both of these types of wells, and others in the network, are likely to have been drilled well below the water table. This is true of piezometers because their function is to measure the level of the water table as it fluctuates over time. Domestic wells are drilled deeper than the water table in order to insure that enough water can be obtained even when the water level drops in low rainfall years.

In contrast, wells built to detect pesticides should take their samples right at the water table, according to MDA staff. This is optimal for two reasons. First, pesticides that leach will reach the top of an aquifer first, so that is where they are more likely to be found. Second, the MDA is interested in evaluating how

¹⁸ L.H. Tornes, M.E. Brigham, and D.L. Lorenz, *Nutrients, Suspended Sediment, and Pesticides in Streams in the Red River of the North Basin, Minnesota, North Dakota and South Dakota, 1993-95*, U.S. Geological Survey Water-Resources Investigations Report 97-4053, 1997, Table 16, pp. 65-66.

¹⁹ Steven J. Larson, Robert J. Gilliom, and Paul D. Capel, *Pesticides in Streams of the United States – Initial Results from the National Water-Quality Assessment Program*, U.S. Geological Survey Water-Resources Investigations Report 98-4222, 1999, Table 5, p. 40.

changes in farm practices – using fewer or different pesticides, for example – affect the underlying groundwater. The quickest turnaround for such information is to sample from the first water to reach the water table.

Clearly, this network did not provide the best characterization of the aquifers sampled. Its accuracy as a measure of the extent of pesticide contamination in these areas is also open to question. In 1996, the MDA decided to abandon these wells and to develop a new network that would reflect the reasoning above and better serve its needs. Data was provided from 80 wells in 2000.

The reader may note that the proportion of pesticide detections in the groundwater studies reported below is generally smaller than was the case with surface waters. The major reason for this discrepancy is the extensive system of ditches and tile draining used in rural Minnesota. Ditches and drains short-circuit the groundwater system by diverting soil water and shallow groundwater directly to streams. This elevates the concentration of pesticides in surface water and minimizes seepage into the ground, reducing the concentration levels in groundwater.²⁰

Multi-Area Studies

- Given the imperfections of the MDA's old monitoring network in the southeastern and central parts of Minnesota, we would expect to see relatively low numbers of detections. Between 1986 and 1994, atrazine was detected in between 20 and 41 percent of the wells sampled (averaging 30 percent). The other pesticides tested for – alachlor, cyanazine, metolachlor, and metribuzin – were detected, on average, in between one and three percent of the wells.²¹ These figures did not change in 1995-96, the last time samples were taken from this network.²²
- A 1985-87 study by the Minnesota Department of Health (MDH) and the MDA took one-time samples from 157 private drinking wells located in the more hydrogeologically sensitive areas of the state: the southeastern karst regions, the sand and gravel aquifers in central and west central Minnesota, and the southwest. Seventy-seven (49 percent) had detectable levels of atrazine, alachlor was found in eight wells (5 percent), and eight other pesticides were detected in a smaller number of wells. Atrazine was also found in 42 of 214 (20 percent) public drinking water wells sampled.²³
- A MDH study sampled 66 public and private wells in those same sensitive areas of the state three times in 1990. Atrazine was found in 41 of the wells (62 percent), and three of its breakdown products were detected in 59, 26, and 21 percent of wells, respectively. Alachlor was detected in nine percent of the wells. Fonofos, one of five insecticides tested for, was detected in about three percent of the wells. The study also found that "atrazine and deethylatrazine were found to persist during spring, summer and fall in approximately 70 percent of the wells in which they were detected."²⁴

20 *Ibid.*, p. 17.

21 Minnesota Department of Agriculture, *Water Quality Monitoring Program, Common Detection Data Report: November 1985 through September 1994*, June 1996.

22 *CDAC Report*, October 1996, Appendix B.

23 Minnesota Department of Health and Minnesota Department of Agriculture, *Minnesota Pesticide Monitoring Surveys Interim Report*, presented at Pesticides and Groundwater: A Health Concern for the Midwest, held in St. Paul, Minnesota on October 16, 1986, Tables 4 and 6.

24 Minnesota Department of Health, *Pesticides and Their Breakdown Products in Minnesota Groundwater*, July 1993, pp. viii, 4.

East Central Minnesota

- An improved reporting format for MDA's monitoring network in 1995-96 indicated that the highest percentage of detections were in sand plain wells. Atrazine was detected in 41 percent of the wells in that area; alachlor in 7 percent. All the detections of metribuzin and metolachlor in the state, and nine of ten detections of cyanazine, were recorded in sand plain wells.²⁵
- The MDA established its new monitoring network in the central sand plains in 1999. Calendar year 2000 results indicate a higher incidence of detections than was found at the MDA's old network.²⁶

As in most other groundwater sampling results, detections of atrazine and its breakdown products were frequent, found in 76 percent of the wells. Detections of the corn herbicide metolachlor were more frequent also, at 19 percent, compared with less than two percent in the old network. Metribuzin and its breakdown products were detected in 28 percent of the wells.

- A USGS study in a 75-square mile agricultural area of Sherburne County found that 86 percent of the samples contained at least one of the 13 pesticides detected. Atrazine was found in 76 percent of the samples, and one of its degradates, deethylatrazine, was found in 79 percent. Metolachlor was detected in 41 percent of the samples; both metribuzin and bentazon were detected in 21 percent.²⁷
- A PCA study in Cottage Grove in 1999 sampled 78 private wells and detected herbicides in 68 percent of them. This study illustrates the importance of testing for breakdown products, especially those of parent compounds such as alachlor, which degrade rapidly. Alachlor itself was only detected twice, but two of its breakdown products were detected 40 and 27 times, respectively. Similarly, two metolachlor degradates had 29 and 27 detections, respectively, compared with just two for the parent compound. Atrazine was detected 25 times, but one of its degradates was detected 27 times. Testing only for parent compounds, as the MDA did in its old network, and still continues to do for some pesticides, gives an inaccurate impression of the extent of contamination. The study also noted that, if the concentrations of alachlor and its degradates are summed, the drinking water standard was exceeded in five samples.²⁸
- The PCA detected herbicides in 64 percent of the samples it took from groundwater wells in agricultural areas near St. Cloud in 1998. Among the 101 detections, 30 were of atrazine degradates, 22 of metolachlor degradates, 19 of alachlor degradates, and 12 of acetochlor degradates.²⁹ The results from 1999 testing were similar. The PCA reported that "Degradates accounted for over 96 percent of the total herbicide mass. . . ." ³⁰

25 CDAC Report, October 1996, Appendix B.

26 2001 Common Detection Data Report, p. 8.

27 James F. Ruhl et. al., *Water-Quality Assessment of Part of the Upper Mississippi River Basin, Minnesota and Wisconsin – Ground-Water Quality in an Agricultural Area of Sherburne County, Minnesota, 1998*, Water-Resources Investigations Report 00-4107, 2000, p. 22.

28 Minnesota Pollution Control Agency, *Ground Water Monitoring and Assessment Program, Ground Water Quality in Cottage Grove, Minnesota*, June 2000, pp. 35-36.

29 Minnesota Pollution Control Agency, *Ground Water Monitoring and Assessment Program, Effects of Land Use on Ground Water Quality, St. Cloud Area, Minnesota - 1998 Results*, March 1999, pp. 62-63.

30 Minnesota Pollution Control Agency, *Ground Water Monitoring and Assessment Program, Effects of Land Use on Ground Water Quality, St. Cloud Area, Minnesota - 1999 Results*, July 2000, p. 30.

Northwestern Minnesota

- The USGS studied surficial aquifers in the Red River Valley in 1991-95. In the Moraine located in the eastern part of the study area, pesticides were detected in 52 percent of the wells. Seven pesticides were detected, with atrazine and one of its degradates found most often. In the Lake Plain, along Minnesota's western border and extending into North Dakota, pesticides were detected in 12 percent of the wells. Five pesticides were detected, including atrazine and one of its degradates, simazine and bentazon. All concentrations were below 1 ppb.³¹
- A USGS study in a small area near Otter Tail in the Red River Valley found that 76 percent of all shallow ground water in the Otter Tail outwash aquifer contained detectable pesticides. Of 18 herbicides and four insecticides commonly used in the area, eight herbicides and two degradates were detected. Atrazine and one of its degradates were detected in 66 and 62 percent of all samples, respectively, metolachlor in 14 percent, and metribuzin in 10 percent. All concentrations were below 1 ppb, except for one detection of atrazine at 2.4 ppb, close to the drinking water standard of 3 ppb.³²

Again, it is clear from this review that contamination of groundwater by pesticides is widespread throughout the agricultural regions of Minnesota.

31 Timothy K. Cowdery, *Ground-Water Quality in the Red River of the North Basin, Minnesota and North Dakota, 1991-95*, U.S. Geological Survey Water-Resources Investigative Report 98-4175, 1998, p. 8.

32 Timothy K. Cowdery, *Shallow Ground-Water Quality Beneath Cropland in the Red River of the North Basin, Minnesota and North Dakota, 1993-95*, U.S. Geological Survey Water Resources Investigations Report 97-4001, 1997, pp. 1, 21, 23.

APPENDIX C

PESTICIDES SOLD IN MINNESOTA THAT ARE ACUTELY TOXIC TO WILDLIFE

CHEMICAL	1998 POUNDS SOLD	MAMMALS	FISH	AQUATIC INVERTEBRATES	BEES	BIRDS
2,4-D	1,235,947	X	X	X		
ACEPHATE	12,215	X				
ACETOCHLOR	3,051,010		X			
ALACHLOR	1,104,165		X			
AZINPHOS-METHYL	12,954	X	X	X	X	
BENOMYL	23,832		X			
BENSULIDE	5,760				X	
BROMOXYNIL	153,972		X			
CAPTAN	29,253		X			
CARBARYL	80,355	X			X	
CARBOFURAN	67,186	X	X	X		X
CARBOXIN	12,379		X			
CHLOROTHALONIL	237,353		X	X		
CHLORPYRIFOS	219,204		X	X	X	X
DIAZINON	9,515		X	X	X	X
DIMETHOATE	94,864				X	X
DISULFOTON	782	X	X	X		
DIURON	16,311		X	X		
ENDOSULFAN	44,088	X	X	X		X
FENVALERATE	6,820		X	X	X	
FLUAZIFOP-BUTYL	86,827		X			
FONOFOS	364	X	X	X		X
IMIDACLOPRID	4,869		X			
LAMBDA-CYHALOTHRIN	7,857		X		X	
LINDANE	101,720		X	X	X	
MALATHION	53,030		X	X	X	
MANCOZEB	261,119		X			
MANEB	202,842		X	X		
METHAMIDOPHOS	12,536	X	X	X		X
METHOMYL	4,757	X	X	X		X
METHOXYCHLOR	336		X	X		
METHYL PARATHION	19,480	X				X
MYCLOBUTANIL	162			X		
OXAMYL	5,278	X	X		X	X
PARAQUAT	28,018	X				
PENDIMETHALIN	2,063,195		X	X		
PERMETHRIN	61,455		X	X	X	
PHORATE	76,404	X	X	X		X
PYRETHRIN	32		X			
SIMAZINE	16,630	X	X			
TERBUFOS	464,162	X	X	X		X
TRIALATE	78,690		X	X		
TRIFLURALIN	1,336,960		X	X		
ZIRAM	840		X			
TOTAL POUNDS	11,305,527	2,081,157	11,064,672	6,306,772	658,813	1,017,838

Note: Criteria for "highly toxic" assessment:

Fish and Aquatic Invertebrates: Acute LC50<1,000 mg/L

Birds: Acute Oral LD50<50mg/kg

Mammals: Acute Oral LD50<50mg/kg

Bees: Acute LD50<1.2mg/L

Sources: Pesticide Action Network, Disrupting the Balance: Ecological Impacts of Pesticides in California, 1999, Appendix I. EXTOWNET, Extension Toxicology Network, <http://www.ace.orst.edu/info/extownet/ghindex.html>

APPENDIX D

HUMAN HEALTH EFFECTS ASSOCIATED WITH PESTICIDES SOLD IN MINNESOTA

Active Ingredient	1998 Pounds Sold	Known, Probable Carcinogens	Possible Carcinogens	Reproductive Toxins	Endocrine Disruptors	High Acute Toxicity	Nerve Toxins
2,4-D	1,235,947		X		X		
ACEPHATE	12,215		X				X
ACETOCHLOR	3,051,010	X					
ACIFLUORFEN	66,151	X					
ALACHLOR	1,104,165	X			X	X	
ASULAM	199,966		X				
ATRAZINE	3,322,613				X		
AZINPHOS-METHYL	12,954					X	X
BENOMYL	23,832		X	X	X		
BENSULIDE	5,760						X
BROMOXYNIL	153,972		X	X			
CAPTAN	29,253	X					
CARBARYL	80,355		X		X		X
CARBOFURAN	67,186					X	X
CHLORETHOXYFOS	3,345					X	X
CHLOROTHALONIL	237,353	X					
CHLORPYRIFOS	219,204				X		X
CHLORSULFURON	300			X			
CYANAZINE	454,749		X	X	X		
CYCLOATE	116,305			X			X
CYFLUTHRIN	1,153				X		
DIAZINON	9,515						X
DICAMBA	1,901,686		X				
DICLOFOP-METHYL	102,861	X					
DIFENOCONAZOLE	2,213		X				
DIMETHENAMID	2,100,008		X				
DIMETHOATE	94,864		X				X
DISULFOTON	782					X	X
DIURON	16,311	X					
ENDOSULFAN	44,088				X	X	
EPTC	1,452,224			X			X
ETHALFLURALIN	174,702		X				
FENOXAPROP-ETHYL	108,641			X			
FENPROPATHRIN	72				X		
FENVALERATE	6,820				X		
FIPRONIL	8,944		X				
FLUAZIFOP-BUTYL	86,827			X			
FOMESAFEN	162,259		X			X	
FONOFOS	364					X	X
FOSETYL-AL	8,448					X	
HEXYTHIAZOX	61		X				
IMAZALIL	57	X					
IPRODIONE	1,800	X					
ISOXABEN	457		X				
LACTOFEN	17,934	X					
LAMBDA-CHLOHATHRIN	7,857				X		
LINDANE	101,720	X			X		

Active Ingredient	1998 Pounds Sold	Known, Probable Carcinogens	Possible Carcinogens	Reproductive Toxins	Endocrine Disruptors	High Acute Toxicity	Nerve Toxins
LINURON	19,340		X	X			
MALATHION	53,030				X		X
MANCOZEB	261,119	X			X		
MANEB	202,842	X			X		
MCPA	653,101		X			X	
MCPB	9,600		X				
METAM SODIUM	766,935	X		X			
METHAMIDOPHOS	12,536					X	X
METHOMYL	4,757				X	X	X
METHOXYCHLOR	336				X		
METHYL PARATHION	19,480				X	X	X
METIRAM	32,880	X		X	X		
METOLACHLOR	1,935,327		X		X		
METRIBUZIN	69,908				X		
MSMA	1,485	X					
MYCLOBUTANIL	162			X			
NITRAPYRIN	146,207	X		X			
ORYZALIN	5,144		X				
OXADIAZON	390		X	X			
OXYFLUORFEN	2,697		X				
OXAMYL	5,278					X	X
PARAQUAT	28,018					X	
PCNB	3,926				X		
PENDIMETHALIN	2,063,195		X				
PERMETHRIN	61,455		X		X		
PHORATE	76,404					X	X
PHOSMET	9,464						X
PROPACHLOR	61,500	X					
PROPICONAZOLE	21,454		X				
PROPIONIC ACID	32,895					X	
PYRETHRIN	32	X					
QUIZALOFOP-ETHYL	41,167			X			
SIMAZINE	16,630		X		X		
TEBUCONAZOLE	30,295		X				
TEFLUTHRIN	36,795				X	X	
TERBACIL	192			X			
TERBUFOS	464,162					X	X
THIOPHANATE METHYL	31,198	X		X			
TRIADIMEFON	94		X	X			
TRIALATE	78,690		X				
TRIBENURON METHYL	4,881		X				
TRIFLURALIN	1,336,960		X		X		
TRIFLUSULFURON METHYL	4,249		X				
TRIPHENYL TIN (FENTIN HYDROXIDE)	1,170,627	X			X		
VINCLOZOLIN	2,966		X	X	X		
ZIRAM	840	X			X		
Total Pounds	26,589,942	7,402,279	12,852,695	3,438,380	11,812,453	2,737,018	2,720,185

All listings compiled from S. Orme and S. Kegley, PAN Pesticide Database, Pesticide Action Network, North America, 2000 (www.pesticideinfo.org), based on the following sources:

Carcinogens: USEPA, Office of Pesticide Programs, "Office of Pesticide Programs List of Chemicals Evaluated for Carcinogenic Potential," August 30, 2000; International Agency for Research on Cancer, Lists of IARC Evaluations, August 9, 2000.

Reproductive Toxins: State of California, Environmental Protection Agency, Office of Environmental Health Hazard Assessment, "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity."

Endocrine Disruptors: State of Illinois, Environmental Protection Agency, *Endocrine Disruptors Strategy*, February 1997. L.H. Keith, *Environmental Endocrine Disruptors: A Handbook of Property Data* (New York: Wiley Interscience), 1997. C.M. Benbrook, *Growing Doubt: A Primer on Pesticides Identified as Endocrine Disruptors and/or Reproductive Toxicants* (Washington: National Campaign for Pesticide Policy Reform), September 1996.

Acute Toxicity: World Health Organization and EPA rankings.

Nerve Toxins: California Department of Pesticide Regulation's list of Cholinesterase-inhibiting pesticides listed in *Summary of Pesticide Use Report Data*, 1998, Table 5A, November 1999.

APPENDIX E

REVIEW OF EPIDEMIOLOGICAL STUDIES EXAMINING THE LINK BETWEEN PESTICIDE EXPOSURE AND VARIOUS HEALTH EFFECTS

Spontaneous Abortions and Stillbirths

Those most susceptible to the health risks of pesticides are children, from conception through adolescence. The fact that many pesticides have been identified as reproductive toxicants and endocrine disruptors places pregnant women and the developing fetus in an especially risky position.

A 1998 article by Arbuckle et. al. reviewed 67 studies examining whether pesticide exposure increased fetal deaths through stillbirths and spontaneous abortions.¹ Table C-1 summarizes its findings.

TABLE E-1
Summary of Review* of Studies Examining the Correlation Between Pesticide Exposure and Fetal Death

Result	No. of studies**
Data insufficient to measure effect	11
Positive effect, but data insufficient to determine significance	8
No effect	10
Positive effect, but not significant	11
Positive effect, significant	20

* See footnote 1.

** Seven studies of Vietnam veterans exposed to Agent Orange are not included in table.

Note: Studies were placed in "positive" category if any correlation was positive.

Nineteen studies provided incomplete statistical information, barring any interpretation of results. Ten of the remaining 41 studies found that exposure to pesticides did not increase the risk of fetal death.

Eleven studies found an elevated risk due to exposure, but the risk was not statistically significant, meaning that there was a greater than five percent chance that the increase in risk was due to a factor

¹ T. Arbuckle and L. E. Sever, "Pesticide exposure and fetal death: a review of the epidemiologic literature," *Critical Reviews in Toxicology*, vol. 28, no. 3 (1998), pp. 229-270.

other than pesticide exposure. Finally, 20 studies, about half of those with sufficient statistical data, indicated that exposure increased the risk of fetal death, and that this relationship was statistically significant. The authors, however, urge caution with respect to what they deem methodological weaknesses of many of these studies.

One study the authors cited as “well-conducted” found a statistically significant ratio of observed to expected (O/E) fetal deaths of 2.40 among mothers working in agriculture at the time of conception when the death occurred between 16 and 28 weeks of conception, and 5.55 when it occurred after 28 weeks. The correlation with the father’s agricultural occupation was not significant.²

In one of the studies reviewed which was based on a large data set – the National Natality and Fetal Mortality Surveys – Savitz et. al. found a significant correlation with stillbirths among mothers exposed to pesticides at work (OR = 1.6, 95% CI = 1.5 - 3.8) and in the home (OR = 1.5, 95% CI = 1.3 - 1.7) (The OR is the Odds Ratio, which measures the increase in risk associated with exposure, e.g., an OR of 1.6 signifies a 60 percent risk increase compared with an unexposed group. The 95% CI (confidence interval) signifies that there is a 95 percent chance that the true OR is within the indicated range.)

Another of the reviewed studies found that California women working in agriculture who were exposed during the first trimester of pregnancy had an elevated risk of stillbirth that increased with the duration of exposure. Those exposed during one month showed an increase in risk of about 40 percent (OR = 1.4, 95% CI = 1.1 - 1.7), while those exposed during all three months almost tripled their risk (OR = 2.7, 95% CI = 1.5 - 4.8). Exposure only during the second trimester repeated this pattern at slightly lower ORs.³

Other studies have found that maternal occupational exposure to pesticides had no effect on the risk of birth defects. A study of more than 300 Argentinean women who grew flowers and ornamental plants found no statistically significant effect on spontaneous abortions in either group.⁴ A study of 314 aerial pesticide sprayers found no effect on spontaneous abortions or stillbirths.⁵

Paternal occupational exposure has been studied as well. In Savitz’s study cited above, such exposure was found to be significant, but less strong than maternal exposures. In a later review article, although he found that four of nine studies were positive and significant, Savitz characterized their results as “weak” because of poor quality.⁶ A 1997 study by Savitz found that wives of agricultural workers exposed to the pesticide carbaryl experienced miscarriages at a rate almost twice as high as those in an unexposed group (OR = 1.9, 95% CI = 1.1 - 3.1)⁷

In a 1999 study conducted among Canadian farmers, Arbuckle et. al. found paternal occupational exposure to phenoxy herbicides (such as 2,4-D) during the three months prior to conception significantly raised the risk of spontaneous abortion by 150 percent (OR = 2.5, 95% CI = 1.0 - 6.4) during the first trimester of pregnancy. Such exposure was not significant with respect to later-term abortions, nor was exposure between conception and the end of the first trimester found to be significant.⁸

Birth Defects

A 1998 article⁹ by Garcia reviewed some three dozen studies testing for a connection between parental occupational exposure to pesticides and congenital malformations in their offspring. In many of these studies, low sample size was an important factor weakening the strength of a potential positive connection. Of the 30 studies in which the number of exposed cases was less than 30, 10 found no connection

2 A.D. McDonald et. al., "Fetal death and work in pregnancy," *British Journal of Industrial Medicine*, vol. 45 (1988), pp. 148-157.

3 Lisa M. Pastore et. al., "Risk of stillbirth from occupational and residential exposures," *Occupational Environmental Medicine*, vol. 54, no. 7 (July 1997), pp. 511-518.

4 E.L. Matos et. al., "Pesticides in intensive agriculture: effects on working conditions and workers' health," *PAHO Bulletin*, vol. 21, no. 4 (1987), pp. 405-416.

5 C.C. Roan et. al., "Spontaneous abortions, stillbirths, and birth defects in families of agricultural pilots," *Archives of Environmental Health*, vol. 39, no. 1 (January-February 1984), pp. 56-60.

6 D.A. Savitz et. al., "Review of epidemiologic studies of paternal occupation and spontaneous abortions," *American Journal of Industrial Medicine*, vol. 25, no. 3 (1994), pp. 361-383.

7 D.A. Savitz, "Male pesticide exposure and pregnancy outcome," *American Journal of Epidemiology*, vol. 146, no. 12 (December 15, 1997), pp. 1025-1036.

8 T. Arbuckle et. al., "Exposure to phenoxy herbicides and the risk of spontaneous abortion," *Epidemiology*, vol. 10, no. 6 (November 1999), pp. 752-760.

9 Ana M. Garcia, "Occupational exposure to pesticides and congenital malformations: a review of mechanisms, methods, and results," *American Journal of Industrial Medicine*, vol. 33, no. 3 (March 1998), pp. 232-240.

between agricultural employment and birth defects. Twenty studies did find a positive correlation: five showed an increased risk from 1 to 19 percent; in 15 studies, it was 20 percent or more. However, in only two of these 20 studies were these positive correlations statistically significant at the 95 percent level.

Five studies with larger sample sizes also had positive and statistically significant correlations, with ORs ranging between 1.34 and 2.52. Garcia cited two of them for methodological limitations: either subjects were placed in the "exposed" group solely on the basis of job titles, which could result in misclassification, or the birth defect was assessed through parental interviews, rather than medical records.

One of the remaining three large sample studies showing statistically significant positive correlations was conducted in Minnesota by University of Minnesota professor Vincent Garry.¹⁰ It found that pesticide applicators had children with more birth defects than did non-applicators. The defects were of three types: circulatory/respiratory (OR = 1.69, 95% CI = 1.04 -2.76), musculoskeletal/integumental (OR = 2.52, 95% CI = 1.58 - 4.01), and urogenital (OR = 1.69, 95% CI = 1.06 - 2.64).

A more recent study done by Garcia in Spain found that women employed in agriculture during the month preceding conception or during the first trimester of pregnancy had a statistically significant three-fold increase in risk for giving birth to an infant with one or more birth defects compared with unexposed women (95% CI = 1.11 - 9.01).¹¹

A 1994 study found that maternal exposure was not associated with elevated risks for isolated limb reduction defects.¹² A similar lack of effect was found with respect to mothers whose exposure while pregnant was estimated to be greater than 30 percent of the threshold limit value (a health standard), but less than the threshold itself.¹³ Children of pilots spraying pesticides by plane were found to have fewer birth defects than a control group.¹⁴

Garry's study also suggested that risks may extend beyond those in agricultural occupations to the general population. In regions of the state where chlorophenoxy herbicides and/or fungicides were heavily used, infants in the general population conceived in the spring, when pesticide applications are at their peak, showed a significant increase in birth defects compared with infants conceived in other seasons when pesticide applications are fewer (OR = 1.36, 95% CI = 1.10 - 1.69).¹⁵

In a study of California mothers living in counties of high agricultural productivity or high pesticide use, they were found to have a 70 percent greater risk of giving birth to children with limb reduction defects than mothers living in other areas (95% CI = 1.1 - 2.7).¹⁶

Childhood Cancer

Possible carcinogenic effects from pesticide exposure have long been a concern. EPA's 1999 evaluation lists 79 pesticides identified as known or probable carcinogens, and 87 pesticides classified as possible carcinogens.¹⁷ Cancer has become the second leading killer of children, after accidents, with some 8,000 new cases diagnosed annually.¹⁸

10 Vincent F. Garry et. al., "Pesticide appliers, biocides, and birth defects in rural Minnesota," *Environmental Health Perspectives*, vol. 104, no. 4 (April 1996), pp. 394-399. The other two large sample studies are M. Restrepo et. al., "Prevalence of adverse reproductive outcomes in a population occupationally exposed to pesticides in Colombia," *Scandinavian Journal of Work and Environmental Health*, vol. 16 (1990), pp. 232-238; and T. Nurminen et. al., "Agricultural work during pregnancy and selected structural malformations in Finland," *Epidemiology*, vol. 6 (1995), pp. 23-90.

11 Ana M. Garcia et. al., "Parental agricultural work and selected congenital malformation," *American Journal of Epidemiology*, vol. 149, no. 1 (January 1999), pp. 64-74.

12 S. Lin et. al., "Potential parental exposure to pesticides and limb reduction defects," *Scandinavian Journal of Work and Environmental Health*, vol. 20, no. 3 (June 1994), pp. 166-179.

13 A.D. McDonald et. al., "Congenital defects and work in pregnancy," *British Journal of Industrial Medicine*, vol. 45, no. 9 (1988), pp. 581-588.

14 Roan et. al.

15 Garry et. al., "Pesticide appliers"

16 D.A. Schwartz and J.P. LoGerfo, "Congenital limb reduction defects in the agricultural setting," *American Journal of Public Health*, vol. 78, no. 6 (June 1988), pp. 654-658.

17 U.S. EPA, Office of Pesticide Programs, "Office of Pesticide Programs List of Chemicals Evaluated for Carcinogenic Potential," August 25, 1999.

18 L.L. Robison, "General principles of the epidemiology of childhood cancer," in P.A. Pizzo and D.G. Poplach (eds.), *Principles and Practices of Pediatric Oncology* (Philadelphia: Lippincott-Raven), 1997, pp. 1-10.

A 1998 review article by Zahm and Ward examined more than 60 studies measuring potential links between pesticide exposure and various forms of childhood cancer.¹⁹ Summary results are shown in Table C-2. The largest number of studies finding positive and significant correlations associated pesticide exposure with leukemia and brain cancer.

TABLE E-2
Summary of Review* of Studies Examining Pesticide Exposure and Childhood Cancer

	Insufficient data	No Effect	Positive, not significant	Positive, significant
Leukemia	2	3	7	6
Brain cancer	1	3	5	9
Non-Hodgkin's lymphoma	1	1	3	2
Neuroblastoma (adrenal)	0	3	2	1
Wilms' tumor (kidney)	1	2	0	3
Ewing's sarcoma (bone)	0	0	2	2

* See footnote 19.
 Note: Studies were placed in "positive" category if any correlation was positive.

Most of the positive and significant correlations in these studies were with pesticide use rather than parental occupational exposure.²⁰

Leukemia

As with many of these studies, small samples were the norm: only two of the 18 leukemia studies reviewed contained more than 40 cases of cancer. One of the larger studies reviewed was from the Children's Cancer Study Group, which is comprised of institutions which treat 90 percent of childhood cancer cases in the U.S. This larger sample size allows it to design studies with considerable statistical power. The study of children whose fathers were occupationally exposed to pesticides for at least three years found they had a 2.7 times higher risk of contracting leukemia compared with a control group (95% CI = 1.0 - 7.0).²¹

Other occupational exposure studies reviewed by Zahm and Ward did not show a correlation. A study of parental occupation in agriculture in Finland showed no effect on either childhood leukemia (156 cases) or brain tumors.²² Occupational exposure to neither parent (3 maternal, 32 to 36 paternal cases) had an effect on leukemia rates in another study.²³

Four of the six studies with significant correlations were linked with pesticide use rather than occupational exposure. For example, both in-home and garden use of pesticides by either parent was found to

19 S.H. Zahm and M.H. Ward, "Pesticides and childhood cancer," *Environmental Health Perspectives*, vol. 106, Supp. 3, (June 1998), pp. 893-908.
 20 These results are in accord with an earlier review article by Daniels which examined 31 studies published between 1970 and 1996. Five studies found positive correlations between paternal occupation in agriculture and childhood brain cancer, but only one was statistically significant. Of ten studies in which leukemia was the endpoint of concern, five found no correlation with occupational exposure; of the five studies with a positive correlation, one was statistically significant. J.L. Daniels et. al., "Pesticides and childhood cancers," *Environmental Health Perspectives*, vol. 105 (1997), pp. 1068-1077
 21 J. Buckley et. al., "Occupational exposures of parents of children with acute nonlymphocytic leukemia: a report from the children's cancer study group," *Cancer Research*, vol. 49, no. 14 (July 15, 1989), pp. 4030-4037.
 22 K. Hemminki et. al., "Childhood cancer and parental occupation in Finland," *Journal of Epidemiology and Community Health*, vol. 35, no. 1 (March 1981), pp. 11-15. Correlation of maternal occupation with all childhood cancers, however, was positive and significant.
 23 H.A. Van Stensel-Moll, "Childhood leukemia and parental occupation: a register-based case-control study," *American Journal of Epidemiology*, vol. 121 (1985), pp. 216-224.

significantly increase the risk of developing leukemia (19 cases, OR = 3.8, 95% CI not reported).²⁴ Use of pest strips during the last trimester of pregnancy more than tripled the risk of childhood leukemia (21 cases, OR = 3.06, 95% CI = 1.6 - 5.7), though yard treatments had only a weak positive and non-significant effect, and home extermination no effect.

Brain Cancer

Brain cancer among children increased by 40 percent between 1973 and 1994 to become the second most common form of cancer among children.²⁵ One of the studies Zahm and Ward reviewed found children of Norwegian agricultural production workers had a 71 percent greater risk of developing brain tumors (95% CI = 1.11 - 2.63) and a 3.37 times greater risk of developing a certain type of neuroepithelial tumor (95% CI = 1.63 - 6.94) than those in a control group.²⁶

But five of the nine studies showing significant correlations were with pesticide use rather than occupational exposure. The use of pest strips, but not extermination in the home or yard treatment, was found to have a significant effect on brain cancer rates in one study (OR = 1.8, 95% CI = 1.2 - 2.9).²⁷ Similarly, the use of spray and foggers (17 cases), and flea and tick treatments (76 cases) significantly increased the risk of brain cancer in a 1997 study, which also found a significant effect if the home had not been evacuated following pesticide treatment (OR = 1.6, 95% CI = 1.0 - 2.1).²⁸

However, a report from the Children's Cancer Study Group found no effect of household use of pesticides on the development of brain cancer.²⁹

Non-Hodgkin's Lymphoma

Although five of the seven studies reviewed by Zahm and Ward found a positive association between pesticide exposure and NHL, only two were statistically significant, and all contained fewer than a dozen cancer cases. A recent study from the Children's Cancer Study Group data noted that lymphomas are the third most common tumor of childhood; 60 percent of these are non-Hodgkin's lymphoma. The study showed positive and significant associations between NHL and maternal pesticide use (26 cases, OR = 2.98, 95% CI = 1.44 - 6.16) and the child's exposure to pesticides (OR = 2.35, 95% CI = 1.37 - 4.63). No effect was found for use of insecticides in the home; positive but non-significant effects were found for parental occupational exposure and maternal use of garden sprays.³⁰

Other childhood cancers

Zahm and Ward found little evidence of an association between pesticide exposure and neuroblastoma (cancer originating in the adrenal gland). Again, small sample sizes were the norm. Two of the three studies with positive significant correlations with Ewing's sarcoma (bone cancer) contained only seven cancer cases.

24 R.A. Lowengart et al., "Childhood leukemia and parents' occupational and home exposures," *Journal of the National Cancer Institute*, vol. 79, (1987), pp. 39-46.

25 John H. Cushman, "Cancer rates for children climb yearly," *New York Times*, reprinted in *St. Paul Pioneer Press*, September 29, 1997.

26 P. Kristensen et al., "Cancer in offspring of parents engaged in agricultural activities in Norway: incidence and risk factors in the farm environment," *International Journal of Cancer*, vol. 65, no. 1 (January 3, 1996), pp. 39-50.

27 J.K. Leiss and D.A. Savitz, "Home pest use and childhood cancer: a case-control study," *American Journal of Public Health*, vol. 85 (1995), pp. 249-252.

28 J.M. Pagoda and S. Preston-Martin, "Household pests and risk of pediatric brain tumors," *Environmental Health Perspectives*, vol. 105, no. 11 (1997), pp. 1214-1220.

29 G.R. Bunin et al., "Risk factors for astrocytic glioma and primitive neuroectodermal tumor of the brain in young children: a report from the Children's Cancer Group," *Cancer Epidemiology, Biomarkers, and Prevention*, vol. 3 (1994), pp. 197-204.

30 J.D. Buckley et al., "Pesticide exposures in children with non-Hodgkin lymphoma," *Cancer*, vol. 89, no. 11 (December 1, 2000), pp. 2315-2321.

Adult Cancer

Compared with the general population, farmers, the group most exposed to pesticides, show excess rates of death from some forms of cancer but not others. Farmers die less often than the general population from all forms of cancer, collectively, and from cancer of the lung, bladder, liver, colon, esophagus, kidney, and rectum. They exhibit excess rates of death with respect to leukemia, non-Hodgkin's lymphoma, multiple myeloma, and cancer of the skin, prostate, lip, brain, and stomach.³¹ Studies have tested for a connection between some of those latter forms of cancer and pesticide exposure.

Non-Hodgkin's lymphoma (NHL)

A 1991 review of pesticides and NHL found 12 of 19 case-control studies with positive correlations, eight of which were significant. Of the 21 cohort studies examined, 11 found a positive association, three were significant.³² A 1997 article, reviewing studies published after 1992, found six of seven case-control studies to be positive, four of which were significant, and three of seven cohort studies to be positive, all of which were significant.³³

One study found a positive association (OR = 5.5, 95% CI = 2.7 - 11) arising from occupational exposure to phenoxy herbicides, such as 2,4-D.³⁴ A study of Swedish farmers who applied fungicides found that they had a 60 percent greater risk of developing NHL than those in an unexposed group (95% CI = 1.1 - 13).³⁵ Nebraska farmers who applied the herbicide 2,4-D and fungicides were found to have an 80 percent higher risk of NHL than a control group (95% CI = 1.1 - 3.0).³⁶ A University of Minnesota study found that pesticide applicators had a statistically significant number of breaks in two key chromosomes that also occur in people with NHL.³⁷

Conversely, a cohort study of 205,000 Finnish farmers found an O/E ratio of 0.92 for NHL,³⁸ while a similar study in Sweden found a ratio of 0.99.³⁹

Leukemia

A 1998 review article which examined 11 studies found three in which pesticide exposure had no effect on the risk of developing leukemia, four which were positive but not significant, and four which were both positive and significant.⁴⁰

A study of Illinois farmers found a positive association (51 cases, OR = 1.51, CI = 1.01 - 2.25) when the statistics were controlled for age and tobacco use.⁴¹ Danish male farmers showed no increased risk for leukemia (145 cases), but female farmers showed a positive significant effect (O/E = 2.22), though there were only eight observations.⁴²

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- 31 A. Blair et. al., "Clues to cancer etiology from studies of farmers," *Scandinavian Journal of Work and Environmental Health*, vol. 18 (1992), pp. 209-215.
- 32 S.H. Zahm and A. Blair, "Pesticides and non-Hodgkin's lymphoma," *Cancer Research*, vol. 52 (Supp) (October 1, 1992), pp. 5485s-5488s. Because of the relative rarity of many of these cancers, cohort studies – which look for such cases within a particular group of individuals – are less likely to find significant effects.
- 33 J. Dich, "Pesticides and cancer," *Cancer Causes and Control*, vol. 8, no. 3 (May 1997), pp. 420-443.
- 34 L. Hardell et. al., "Exposure to phenoxyacetic acids, chlorophenols, or organic solvents in relation to histopathology, stage, and anatomical localization of non-Hodgkin's lymphoma," *Cancer Research*, vol. 54, no. 9 (May 1, 1994), pp. 2386-2389.
- 35 Lennert Hardell and Michael Eriksson, "A case-control study of non-Hodgkin lymphoma and exposures to pesticides," *Cancer*, vol. 85, no. 6 (March 15, 1999), pp. 1353-1360.
- 36 Sheila Hoar Zahm et. al., "A case-control study of non-Hodgkin's lymphoma and the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) in eastern Nebraska," *Epidemiology*, vol. 1, no. 5 (September 1990), pp. 349-356.
- 37 Vincent F. Garry et. al., "Pesticide applicators with mixed pesticide exposures: G-banded analysis and possible relationship to non-Hodgkin's lymphoma," *Cancer Epidemiology, Biomarkers and Prevention*, vol. 5, no. 1 (January 1996), pp. 11-16.
- 38 E. Pukkala et. al., "Cancer incidence among Finnish farmers," *Cancer Causes and Control*, vol. 8 (1997), pp. 25-33.
- 39 K. Wiklund and J. Dich, "Cancer risks among male farmers in Sweden," *European Journal of Cancer Prevention*, vol. 4, no. 1 (February 1995), pp. 81-90.
- 40 Hajo Zeeb and Maria Blettner, "Adult leukemia: what is the role of currently known risk factors?" *Radiation and Environmental Biophysics*, vol. 36, no. 4 (February 1998), pp. 217-228.
- 41 J.E. Keller and H.L. Howe, "Case-control studies of cancer in Illinois farmers using data from the Illinois state cancer registry and the U.S. Census of Agriculture," *European Journal of Cancer*, vol. 30A, no. 4 (April 1994), pp. 469-473.
- 42 G. Ronco et. al., "Cancer risk among Danish and Italian farmers," *British Journal of Industrial Medicine*, vol. 49, no. 4 (April 1992), pp. 220-225.

Brain cancer

A 1995 article examining brain cancer in farmers and agricultural workers reviewed nine case-control studies, finding two with no effect from exposure, five with a positive but not significant effect, and two with a positive and significant effect. Of nine cohort studies (of which all but two had fewer than 12 cases), three showed no effect, four were positive but not significant, and two were positive and significant.⁴³

A study based on the Missouri cancer registry found crop farmers had an increased risk of brain cancer (22 cases, OR = 1.5, 1.0 - 2.4).⁴⁴ Italian farmers who used insecticides and fungicides doubled their risk compared to a control group (37 cases, OR = 2.0, 95% CI = 1.22 - 3.23), though a positive association with herbicide use was not significant.⁴⁵

Other occupational studies examining mortality from brain cancer found no increased risk among farmers, although the number of observations was quite small. For example, an east Texas study had 14 observations,⁴⁶ while a study of those working in "agriculture, forestry, and fisheries" in New Jersey and Louisiana had just 13 cancer cases.⁴⁷

Prostate

A study which pooled the results from 24 previous studies of farming and prostate cancer reported that nine studies found no increased risks, with ORs ranging from 0.71 - 0.96, and 15 studies found a positive association, with ORs between 1.06 and 5.0. The pooled data showed an OR of 1.12 (95% CI = 1.01 - 1.24).⁴⁸

A similar positive but weak association (O/E = 1.07, 95% CI = 1.02 - 1.08) was found in a study of Swedish farmers.⁴⁹ Another Swedish study, consisting of almost 4,000 prostate cancer cases, found the ratio of observed to expected incidence to be less than 1.0.⁵⁰

Other studies have found a stronger association. A study of over 33,000 pesticide applicators in Florida found a ratio of observed/expected prostate cancer cases to be 1.91 (95% CI = 1.72 - 3.13), with 353 observations. The ratio increased slightly as the length of employment increased. Private applicators (farmers) had a slightly higher ratio of 1.97.⁵¹ When mortality rates from this same data set were examined, farmers had an O/E ratio of 2.56 (95% CI = 1.96 - 3.29).⁵²

A study of Canadian prairie farmers found that those who sprayed more than 250 acres with herbicides in 1970 had more than twice as high a mortality rate from prostate cancer as those in a control group (OR= 2.23, 95% CI = 1.30 - 3.84).⁵³ This study tried to insure exposure occurred by asking farmers if they hired others or engaged commercial firms to apply pesticides.

43 Nicolaas I. Bohnen et. al., "Brain tumor and exposure to pesticides in humans: a review of the epidemiologic data," *Journal of Neurological Science*, vol. 132, no. 2 (October 1995), pp. 110-121.

44 R.C. Brownson et. al., "An analysis of occupational risks for brain cancer," *American Journal of Public Health*, vol. 80 (1990), pp. 169-172.

45 M. Musicco et. al., "A case-control study of brain gliomas and occupational exposure to chemical carcinogens: the risk to farmers," *American Journal of Epidemiology*, vol. 128, no. 4 (October 1988), pp. 778-785.

46 M.A. Sprees et. al., "Occupational exposure and brain cancer mortality: a preliminary study of east Texas residents," *American Journal of Industrial Medicine*, vol. 13, no. 6 (1988), pp. 629-638.

47 T.L. Thomas et. al., "Occupational risk factors for brain tumors, a case-referent death-certificate analysis," *Scandinavian Journal of Work and Environmental Health*, vol. 12, no. 2 (April 1986), pp. 121-127.

48 Jane E. Keller-Byrne, "Meta-analysis of prostate cancer and farming," *American Journal of Industrial Medicine*, vol. 31, no. 5 (May 1997), pp. 580-586.

49 S. Sharma-Wagner et. al., "Occupation and prostate cancer risk in Sweden," *Journal of Occupational and Environmental Medicine*, vol. 42, no. 5 (May 2000), pp. 517-524.

50 Wiklund and Dich.

51 Lora E. Fleming et. al., "Cancer incidence in a cohort of licensed pesticide applicators in Florida," *Journal of Occupational and Environmental Medicine*, vol. 41, no. 4 (April 1999), pp. 279-288.

52 Lora E. Fleming et. al., "Mortality in a cohort of licensed pesticide applicators in Florida," *Occupational and Environmental Medicine*, vol. 56, no. 1 (January 1999), pp. 14-21.

53 Howard Morrison et. al., "Farming and prostate cancer mortality," *American Journal of Epidemiology*, vol. 137, no. 3 (February 1, 1993), pp. 270-280

54 A. Donna et. al., "Ovarian mesothelial tumors and herbicides: A case-control study," *Carcinogenesis*, vol. 5 (1984), pp. 941-942.

55 Michele A. Kettles et. al., "Triazine herbicide exposure and breast cancer incidence: an ecologic study of Kentucky counties," *Environmental Health Perspectives*, vol. 105, no. 11 (November 1997), pp. 1222-1227.

Other forms of cancer

Women may also be at risk. In one study, female agricultural workers exposed to herbicides had an increased risk of developing ovarian cancer 4.4 times higher than nonexposed women (95% CI = 1.90 - 16.07).⁵⁴ A study done in Kentucky found that a high reading on a composite index measuring the amount of pesticide contamination in local groundwater and surface waters, the acres of corn planted, and county pesticide use correlated with breast cancer incidence (OR = 1.20, 95% CI = 1.13 - 1.28).⁵⁵

Parkinson's Disease

Some studies have reported a link between pesticide exposure and Parkinson's disease. A review of 20 such studies found eight which showed no correlation, and 12 which found a positive and statistically significant correlation, with ORs ranging between 2.23 and 7.0.⁵⁶

A study of 144 Parkinson's patients and 464 controls found that farmers who had contact with herbicides had a 4.1 times higher risk of developing the disease than a control group (95% CI = 1.37 - 12.24). The comparable figure for those who had contact with insecticides was 3.55 (95% CI = 1.75 - 7.18).⁵⁷

Another study, of 260 Parkinson's patients and 260 controls, found an increased risk of 3.06 among agricultural workers with exposure to herbicides (95% CI = 1.34 - 7.00). The risk increased with the length of time the subject worked in field crop agriculture. Those with 20 years of experience had a risk of 2.5, (95% CR = 1.07 - 5.87) while those who farmed for 30 years had a risk of 3.84 (95% CI = 1.16 - 12.70).⁵⁸

A weak and insignificant association was found between pesticide exposure and Parkinson's disease in a study of 150 Parkinson's patients, though the definition of exposure ("some time in their life") was vague.⁵⁹ A study of 224 Australian Parkinson's patients and 310 controls also found a weak and insignificant association. It was impossible to tell whether exposures were occupational or related to home or garden use.⁶⁰

Impaired Neural Development

Investigating the more subtle neurological and developmental effects of pesticides that may interfere with development calls for new types of analysis to assess them. One such study has been conducted on four- to five-year old children in rural Mexico. Children with identical genetic, cultural and social backgrounds were given a battery of tests. Those who lived in areas where pesticides were applied regularly had less physical stamina, poorer gross and fine hand-to-eye coordination, and poorer short-term memory and drawing ability than their counterparts living in areas with little pesticide application.⁶¹

A study of vineyard workers in France examined the relationship between long-term exposure to pesticides (mean exposure duration: 22 years), mostly fungicides, and scores on nine different neuropsychological tests. Workers who were exposed through pesticide mixing or spraying, and those who were indirectly exposed through coming into contact with treated plants had a higher risk of scoring low on these tests than did groups who were not occupationally exposed. (ORs ranged from 1.4 to 3.57, and were significant for seven of the nine tests at the 95 percent level.) Those functions most impaired involved information selection (selective attention) and information processing (working memory), as well as associative memory, verbal fluency, and abstraction.⁶²

54 A. Donna et. al., "Ovarian mesothelial tumors and herbicides: A case-control study," *Carcinogenesis*, vol. 5 (1984), pp. 941-942.

55 Michele A. Kettles et. al., "Triazine herbicide exposure and breast cancer incidence: an ecologic study of Kentucky counties," *Environmental Health Perspectives*, vol. 105, no. 11 (November 1997), pp. 1222-1227.

56 D.G. Le Couteur et. al., "Pesticides and Parkinson's disease," *Biomedicine and Pharmacotherapy*, vol. 53, no. 3 (April 1999), pp. 122-130.

57 J.M. Gorell et. al., "The risk of Parkinson's disease with exposure to pesticides, farming, well water and rural living," *Neurology*, vol. 50, no. 5 (May 1998), pp. 1346-1350.

58 Karen M. Senchuck et. al., "Parkinson's disease and exposure to agricultural work and pesticide chemicals," *Neurology*, vol. 42, no. 7 (July 1992), pp. 1328-1335.

59 W. Koller et. al., "Environmental risk factors in Parkinson's disease," *Neurology*, vol. 40, no. 8 (August 1990), pp. 1218-1221.

60 Sally J. McCann et. al., "The epidemiology of Parkinson's disease in an Australian population," *Neuroepidemiology*, vol. 17 (1998), pp. 310-317.

61 Elizabeth A. Guillette et. al., "An anthropological approach to the evaluation of preschool children exposed to pesticides in Mexico," *Environmental Health Perspectives*, vol. 106, no. 6 (June 1998), pp. 347-353.

62 I. Baldi et. al., "Neuropsychologic effects of long-term exposure to pesticides: results from the French Phytoneer study," *Environmental Health Perspectives*, vol. 109, no. 8 (August 2001), pp. 839-844.

APPENDIX F

PESTICIDE USE REPORTING PROGRAMS IN NINE STATES

Currently, nine states require some measure of reporting of actual pesticide use by applicators.¹ These programs are described briefly below.

California

The most detailed and far-reaching reporting program in the nation, California's use reporting law went into effect in 1990. All agricultural pesticide use, including applications to parks, golf courses, cemeteries, rangeland, pastures, and along roadside and railroad rights-of-way, must be reported monthly. The reports must include the date and location of the application (section, township, range, and assigned site identification number), the kind and amount of pesticides used, the crop type and the operator. Reporting requirements for structural operators, professional gardeners, and other nonagricultural applicators continue under a different law.

An annual summary of the data, aggregating annual use by crop, chemical, and county is published. The Department intends to post the raw database on the Internet, but will withhold names and addresses of applicators and sites.

Oregon

California's program was the model for Oregon's pesticide use reporting law, signed by the Governor on September 1, 1999. It requires use reporting at least annually in all major sectors: agriculture, forestry, industrial, urban commercial and urban homeowner. Information must also be collected on household and other urban pesticide uses. The Oregon Department of Agriculture is to publish an annual report summarizing the use data on a watershed basis.²

Massachusetts

Massachusetts' use reporting law will collect pesticide use data from the same sectors as Oregon's law beginning in 2002.³

¹ In the past two years, pesticide use reporting bills were defeated in Alaska and Texas.

² Enrolled House Bill 3602 (HB 3602-B).

³ Ch. 85 of the Acts of 2000.

Wisconsin

As a result of legislation signed in October 1999, the Wisconsin Department of Agriculture, Trade and Consumer Protection developed a proposal for a pesticide sales and use reporting system and submitted it to the Wisconsin Legislature. If this plan is approved, the Legislature will allocate \$150,000 to administer a pilot program to test the system. The proposal includes use reporting for all commercial sectors and agricultural users, and the use of surveys to collect data on household use.

New York

In 1996, the New York Legislature passed a law requiring all commercial pesticide applicators to submit the following information to the state for each pesticide application made during the year: pesticide used, date applied, and location of application (including 5-digit zip code). In addition, pesticide manufacturers are required to report annual sales of restricted use pesticides by product. Dealers licensed to sell restricted use pesticides must annually report sales of all pesticides – restricted and non-restricted use – made to private applicators for agricultural crop production.⁴

New Hampshire

New Hampshire has the distinction of having the oldest pesticide use reporting law in the country, passed in 1966. It ties reporting to the issuance of commercial and private pesticide applicator licenses and permits. Data to be reported include applicator name, application location, pesticide used, amount of active ingredient and total product amount used, crop or site treated, and number of acres treated. In practice, applicators often turn in partially aggregated data, so the number of applications is not known. Locations of commercial applications are also difficult to determine.⁵

New Jersey

New Jersey conducts mandatory surveys of all private and commercial certified applicators on a triennial basis, surveying one market segment – agriculture, golf courses, and lawn care – each year. Private applicators who do not use restricted use pesticides are not required to be certified, and are not surveyed. The information collected includes: pesticide used, percentage of active ingredient, amount applied, acres treated, crop, and application method.⁶

The response to these surveys is consistently above 90 percent. The state reports data on pounds of each active ingredient used statewide, total pesticide use by crop, and total pounds of active ingredient applied per county.⁷

Arizona

All commercial agricultural pesticide applicators are required to report the following information to the Arizona Department of Agriculture on a weekly basis: pesticide used, date and location of application (range, township, section), crop, acres treated, target pest, wind direction, and velocity.⁸

4 New York State Consolidated Laws, Title 12, Sec. 33-1201 *et. seq.*

5 Audrey Thier, "A Review of Pesticide Use Reporting Policies," Prepared for the Pew Charitable Trust, April 1997, pp. 27-28.

6 New Jersey Administrative Code 7:30-1 *et. seq.*

7 State of New Jersey, Department of Environmental Protection, Pesticide Control Program, "Agricultural Pesticide Use in New Jersey: 1997 Survey," February 1999, and "New Jersey 1996 Golf Course Pesticide Use Survey," September 1997.

8 Thier, pp. 30-31.

Connecticut

Connecticut's use reporting program is tied to license renewal. Commercial applicators are required to report aggregate summary data each year to the state's Department of Environmental Protection, while private applicators must report detailed use records (date and place of application, etc.). The data are not compiled or analyzed by the Department.⁹

⁹ Thier, pp. 31-32.