Risk Assessment, a Community Perspective

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The deficiencies associated with current risk assessment and negligible risk methodologies used to protect public health and the environment during the current epidemic of environmentally induced diseases serve as the imperative for moving ahead with a program to phase out hazardous pesticides and to implement alternatives. With the release of the National Academy of Sciences June 1993 report, Pesticides in the Diets of Infants and Children, the public once again is reminded of the failure of the U.S. government to adequately protect the population from potentially harmful pesticides. Methods of generating exposure data and testing for pesticide toxicity are found to provide inadequate protection for those who fall outside the averages, including children. The analysis supports the retention and expansion of the prevention-oriented Delaney Clause of the Federal Food, Drug, and Cosmetic Act as an approach that removes pesticides shown to cause serious adverse effects and promotes alternatives.

With the release of the National Academy of Sciences (NAS) June 1993 report, Pesticides in the Diets of Infants and Children, the public once again is reminded of the failure of the U.S. government to adequately protect the population from potentially harmful exposure to pesticides. While the report focuses on inadequate protection of children from pesticides, the central conclusion is applicable across the general population—current methods of generating exposure data and testing for pesticide toxicity do not adequately protect those who fall outside the average. In the case of children, this means that exposure data do not take into account their diet, which is disproportionately composed of particular commodities (1) and virtually ignore the limitations of and the impact of pesticides on developing organ systems (2).

In addition, while the NAS report focuses on food exposure, the authors note that pesticides are not simply a food safety problem (3). Safety concerns must take into account the toxicity of all pesticides in the aggregate, with an evaluation of all routes of exposure.

The NAS report raises serious questions about the government's ability to develop meaningful risk assessment models to calculate with any kind of certainty the real risks that pesticides present. In fact, the report indicates that the U.S. Environmental Protection Agency (U.S. EPA) has very limited ability to ensure the public that there can be adequate public health protection without major changes in the way the agency conducts its program. In testimony outlining an intent to propose pesticide legislation in the 103rd Congress, Clinton Administration officials acknowledge the inadequacies of the current regulatory system and NAS findings of the need to overhaul the regulatory requirements. Administration officials said in congressional testimony, "As acknowledged by the NAS study, full information on consumption habits for infants and children is not up-to-date" (4).

Lynn Goldman, Assistant Administrator for Prevention, Pesticides and Toxic Substances, said, "The report made a variety of recommendations concerning how EPA evaluates pesticide toxicity, residue levels, and food consumption, and how this information is used in risk assessments. The Academy's recommendations, taken as a whole, present a great challenge in terms of higher standards for the quality, quantity, sensitivity, and scope of the data the Agency uses in evaluating risks from pesticides. This is a formidable challenge, but one we are prepared to meet (5)." The NAS report is just one of many reports that raise serious questions about our knowledge of pesticides and their effect on people (6). From these reports, we should draw the conclusion that we currently have insufficient information to safely calculate the real risks of pesticides.

This situation exists against a backdrop of adverse human health and environmental effects that in many cases are reaching crisis proportions.

- The rates of illness and mortality associated with cancer are rising. Devra Lee Davis, formerly with the NAS Board on Toxicology and now a senior scientific advisor to the Secretary of Health at the Department of Health and Human Services (DHHS), said in her Oct. 21, 1993 congressional testimony, "We found that industrial countries' rates of cancer mortality increased from 1968 to 1986 for a number of sites, including melanoma, prostate, non-Hodgkins lymphoma, multiple myeloma, breast, brain and kidney cancer" (7). The NRC found that all forms of cancer except lung and stomach cancer are increasing in people over 54—and that this is not attributable to increased detection capabilities (8).
- Dramatic worldwide declines in male sperm counts have been found over the last 50 years (9).
- There are reproductive failures in wildlife species ranging from alligators in Florida to polar bears in Alaska (10).
- Elevated rates of childhood brain cancer (11) and childhood leukemia (12) are associated with homes where pesticides are used. National Cancer Institute epidemiological data from 1991 showed that the rate of childhood malignancies climbed almost 11% from...
1973 to 1988, and did not appear to be a function of better reporting (13).

Our country needs a national framework for recording and evaluating overall chemical use. We live in an age where toxic substances have become a basic ingredient in our food production system and other aspects of pest management. Instead of regulating these materials out of food, we are debating appropriate ways of rationalizing acceptable levels of toxic materials. This process goes on even when there do exist alternative, nontoxic, or less toxic food production systems that compete in productivity and profitability.

At the community level, where pesticide and pest management decisions are made—about such things as schools, parks, and rights-of-way—the question is whether people want to institutionalize a certain level of toxic material or whether they want to phase out the use of toxic and hazardous materials and force a shift to alternative methods of control.

Central to the discussion on community decisions are questions of risk assessment. Community people are told that the chemicals in wide use are tested and found to represent an acceptable or "negligible risk." Generally, people are told that the public is exposed to trivial or trace amounts of chemicals or, for example, that their risk from exposure to a carcinogen is one in a million. What drives these conclusions is a process of decision making commonly referred to as risk assessment. While risk assessment has attached to it a scientific mystique, the methodology brings with it some commonplace assumptions about exposure and toxicity that the NAS report has challenged. In fact, what emerges from any investigation of risk assessment is uncertainty. Much has been written about the uncertainties associated with risk assessment. The NAS report Risk Assessment in the Federal Government: Managing the Process (1983) concluded, [D]ata may be incomplete, and there is often great uncertainty in estimates of the types, probability, and magnitude of health effects associated with a chemical agent, of the economic effects of a proposed regulatory action, and of the extent of current and possible future human exposures. These problems have no immediate solutions, given the many gaps in our understanding of the causal mechanisms of carcinogenesis and other health effects and in our ability to ascertain the nature or extent of the effects associated with specific exposures (14).

The president of the American Chemical Society said, "...risk assessment requires inferences drawn from limited scientific data" (15). A physician working in occupational and environmental medicine, Grace Ziem, writing about multiple chemical sensitivity (MCS), said, "Although initially skeptical that such illness reactions could occur following low-level chemical exposure, I became aware that existing chemical exposure limits were scientifically faulty and that no-effect levels extrapolated from chronic animal studies were often orders of magnitude below current legal exposure limits" (16–19).

Therefore, a number of requirements are central to risk discussions at the community level. These requirements, which should be thought of as principles for community decision making, are:

- To ensure that all pesticides proposed for use are fully tested, with specific focus on vulnerable or sensitive population groups;
- To provide full disclosure of pesticide test data, all pesticide ingredient ratios, pesticide ingredients in all end products, and possible health and environmental effects, as well as to posting and to inform of proposed pesticide use;
- To contribute to the prevention of adverse health and environmental effects; and,
- To reduce and, where possible, eliminate unnecessary use of pesticides. While use reduction decisions must target high-risk chemicals, an overall strategy to reduce pesticide use should not be limited by deficiencies and limitations in our ability to define risk accurately.

Testing of Pesticides for Health and Environmental Effects

An April 1993 report issued by the U.S. General Accounting Office (GAO) offers a very distressing update on the status of U.S. EPA's efforts at reregistration under the 1988 amendments to the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The report issues findings that indicate U.S. EPA's program in two areas: a) failure to meet statutorily imposed deadlines; and, b) a reduction in data requirements as part of an effort to speed up the pesticide reregistration process. (GAO, in its report, cites U.S. EPA concurrence with the facts presented.) (20)

To evaluate U.S. EPA's reregistration efforts, we must review their evaluation in at least three areas of data. GAO has described these areas as follows: a) toxicity data, generally from laboratory studies, to identify possible adverse health effects; b) environmental fate and ecological effects data, which identify the fate of a chemical in the environment after application and its possible effects on nontarget species; c) exposure data, which assess the frequency, extent, and routes of exposure for people, including subpopulations such as children (21).

GAO found the following:

U.S. EPA is Behind Schedule on Reregistrations

According to GAO (22), U.S. EPA continues to fall behind its schedule to reregister the 18 major lawn care pesticides. In the meantime, the pesticides continue to be applied in large amounts without complete knowledge of their safety. Since March 1991, U.S. EPA's scheduled study completion dates for many of the 18 major lawn care pesticides have slipped significantly, some by as much as 4 years. The following factors contributed to delays, according to GAO: the need for higher level studies; repetition of rejected studies; time extensions; and concern about pesticide derivatives. Much of the delay seems to be a function of the registrant failing to adequately perform a study and registrant delays resulting in time extensions. Some delays are generated by U.S. EPA. The same can be said for food use pesticides, most of which are also used in lawn care. According to GAO testimony delivered to Congress in 1992, Enactment of FIFRA '88 was intended to address such concerns [about the safety of many existing tolerances] by accelerating the reregistration of about 23,000 older pesticide products. However, the reregistration task has proven more formidable than anticipated, and the U.S. EPA will not meet the 1997 reregistration time frame established by FIFRA '88. In the interim, previously registered pesticide products may be used on food under their existing registration and tolerances, despite the U.S. EPA's incomplete knowledge of their human health and environmental effects (23).
U.S. EPA Has Changed the Basis of Making Reregistration Decisions from “Fully” Complete to a “Substantially” Complete Database.

Because of this change, it appears U.S. EPA has been able to accelerate its time schedule. In the case of 2,4-D, U.S. EPA eliminated the need for a crop residue study to make its reregistration decision, saving 21 months. With Isoclofroam, the registrant made up 24 months in slippage when, “EPA determined that it did not need spray drift studies due in 1995,” according to GAO. “Two other pesticides, Pendimethalin and Glyphosate, improved by 28 and 12 months, respectively, since June 1992, for similar reasons” (24). U.S. EPA says it will be using data on similar pesticides when it drops a data requirement or proceeds with reregistration even though the study has not been received. According to GAO,

One of the 18 pesticides—Glyphosate—is currently in Reregistration Eligibility Document (RED) preparation. Although EPA had earlier rejected a number of the registrant’s environmental fate studies, it determined that the database for Glyphosate was sufficiently complete with the studies. EPA officials told us that they may not require the registrants to repeat the rejected studies (25).

U.S. EPA told GAO that it might make registration decisions without waiting for a 1996 groundwater study on diazinon or a cancer study on an atrazine metabolite.

U.S. EPA Does Not Have Adequate Exposure Data to Make Safety Decisions

In its 1992 testimony, GAO indicated that U.S. EPA did not have reliable data on the quantity of pesticides used on food crops. The statement went even further to say that inadequate knowledge supports risk estimates. According to GAO, “[W]e found that EPA’s estimate of potential human exposure to pesticide residues in food is uncertain because these [USDA Nationwide Food Consumption] surveys are flawed” (26).

Similarly, with nondietary exposure, U.S. EPA has poor exposure data to use for purposes of reregistration because the agency simply assumed that significant exposure was unlikely. “...EPA is working on better testing and assessment guidelines for all types of residential exposure to toxicics,” says GAO (27). It appears unlikely that U.S. EPA will have guidelines developed before fiscal year 1997 and then only if funding becomes available.

Farmworker protection remains inadequate under new worker protection regulations that do not ensure that all workers have full information, training, and medical monitoring provided all other workers protected under the Occupational Safety and Health Act. Our country’s “harvest of shame” must be addressed within the context of registration to ensure the well-being of those who harvest the nation’s food. According to the GAO,

Hired farmworkers are not adequately protected by federal laws, regulations, and programs; therefore, their health and well-being are at risk. Hired farmworkers go into fields sprayed with pesticides, but many have no knowledge of the specific chemicals they are exposed to or the potential health effects. Field sanitation on many small farms may be inadequate, constituting a serious health hazard to hired farmworkers on those farms. Young children . . . may be more susceptible than adults to the harmful effects of pesticides” (28).

Integrity of Test Data is Still an Issue

In 1991 the U.S. EPA Inspector General (IG) reported to the agency inadequate auditing of testing laboratories used by chemical companies that generate studies used for reregistration. In the wake of major pesticide testing scandals involving falsified pesticide health and safety data, U.S. EPA’s Office of the IG has revealed serious gaps in the agency’s good laboratory practices (GLP) inspection program. According to the IG, U.S. EPA might not recognize a bad study when it came across one because, “the Agency does not have standards to determine if a specific GLP deficiency would compromise the validity of a study.” According to the IG, “of the 220,000 studies completed under FIFRA, only 2268 have ever been audited—just under one percent” (K A Kouz, personal communication).

The cost of dependency on pesticides must be calculated more broadly. There is increased general understanding that pesticide use has secondary environmental and economic impacts, which some researchers have totaled at $8 billion annually (29).

Defining Acceptable Risk

In the year since the Ninth Circuit Court decision upholding the Delaney Clause of the Federal Food, Drug, and Cosmetic Act (30), the provision has been called outdated and anachronistic by politicians and industry interests. However, the law is based on the scientific understanding that we cannot prove the level at which a cancer-causing substance initiates a cancer effect, although we can determine that a chemical is a carcinogen. This distinction stems from the fact that high dose animal experimentation can tell us that a chemical causes cancer, but it does not tell us the low dose point at which the chemical has no effect. Given that carcinogens have delayed or long-term effects, animal experiments have never been able to replicate the time period and low dose. For all the criticism, the high dose method has yielded impressive results, proving accurate in the vast majority of cases in which chemicals are known through epidemiological studies to cause cancer in humans (31). There is no scientific basis for suggesting that any carcinogenic exposure represents a trivial or negligible risk. The Delaney Clause errs on the side of public health protection, and rightly so.

Those arguing the Delaney Clause’s demise would have it replaced with a negligible risk standard, as proposed by RH Lehman and TJ Billey in H.R. 1627 (32). The negligible risk standard is steeped in risk assessment methods filled with uncertainties and miscalculations as to sensitive population groups, such as children and elderly, average body weight, consumption patterns, and other exposures affecting the total toxic load that any one individual already carries.

Risk Assumptions Belie Reality

The risk assessment strategies proposed to replace Delaney ignore multiple chemical exposures (33). For example, 11 of U.S. EPA’s 32 carcinogenic pesticides are registered for use on apples and 10 for use on grapes. Assessing the risk from a piece of fruit, a plate of food, and three meals a day is beyond the grasp of the proposal. Worse yet, there is no attempt to aggregate the risk of nonfood exposure to the very same pesticides, which are widely used on lawns and in parks and school yards, or the risk to those at highest risk.

Full Disclosure Is Critical

Those who currently use and are exposed to pesticides are being denied information regarding the identity and toxicity of the trade secret inert ingredients. The term inert, by which trade secret pesticide
formulation ingredients are commonly known, is an extremely deceptive misnomer since the great majority of these materials are quite chemically and biologically active. Furthermore, U.S. EPA has consistently failed to give adequate attention to the toxicological review of the at least 1100 trade secret ingredients, openly admitting that it has so little information on 71% (800) of them that it cannot even rate their potential toxicity.

Among the more notable types of materials of concern are those that are registered as active ingredients in other formulations—solvents with considerable biological activity and surfactants that facilitate passage of other chemicals through biological membranes including human skin, insect integument, and plant cell walls.

In general, trade secret ingredients comprise from 25 to 99% of a formulation. This implies that very large quantities of these materials are being dispersed into the environment. Given that many of these secret ingredients are known to have or may have serious toxicological effects, it seems clear that the secret ingredients may be posing as significant a threat to human health and the environment as these are the active ingredients themselves.

Given that secret ingredients comprise large portions of formulations, are biologically active, and may pose serious toxicological and environmental concern, U.S. EPA has a clear responsibility to perform full and adequate assessments of risks posed by these materials, based upon adequate data that must be required of manufacturers. U.S. EPA has shown no indication that it plans to commit any resources to the review of the over 800 secret ingredients of unknown toxicological concern.

Despite large potential exposure and known and unknown potential for serious human health and environmental harm, these materials are allowed trade secret status. People have no opportunity to make informed decisions in purchasing and using pesticidal products since they do not know all the ingredients. Furthermore, federal, state, and local agencies can provide no real assurance to the public that the pesticides in use do not pose a serious risk because they cannot know what materials comprise a significant portion of the formulations.

Preventing the Poisoning in a Time of National Health Crisis
It must be recognized that the negligible risk standard—central to H.R. 1627 and other legislative proposals—is based on extremely imperfect methods of predicting risk, collectively known as risk assessment. It is the inadequacies of these predictive tools that require our critical examination to determine the validity of the concept as a whole.

An evaluation of cancer is instructive in determining the application of risk assessment. One operating premise is that dramatic changes must be taken to prevent avoidable exposure to carcinogenic materials at a time when cancer plagues our nation. Cancer is a killing and disabling disease of epidemic proportions and now strikes one in three persons and kills one in four (34). Scientific consensus contends that cancer is mainly caused by exposure to causative agents in the environment and chemically induced cancer has been well demonstrated. We are exposed to a wide range of carcinogens in our environment, some of which occur naturally, but many are a direct result of an industrialized society.

Attempts at managing risks under a negligible risk policy ignore the fact that the last 3 decades have confirmed the scientific basis of the Delaney Clause and our inability to quantitatively define carcinogenic risk.

The Delaney Principle Is Still the Best Scientific Standard for Cancer Control
Cancer mechanisms are not completely understood, but all scientifically acceptable theories preclude measuring or predicting a safe level of exposure to any carcinogen below which no individual or population group will develop cancer. Recognition of this forms the basis of the Delaney Clause standard of no additional cancer or "no induction of cancer."

As a substitute for the Delaney Clause, H.R. 1627 proposes to establish a negligible risk standard, tied to an acceptable incidence of cancer. Ratification of this new standard, already adopted by the U.S. EPA in an interpretive rule in October 1988 (53 FR 411050) and successfully challenged in court, undermines long-term public health and safety.

Negligible Risk Is Too Crude a Measure
A negligible risk formulation relies on risk assessment modeling, a crude tool containing numerous uncertainties that make it inadequate for predicting potential hazards to people ingesting carcinogens. Depending on the assumptions and models used, calculated risks can vary by orders of magnitude. Risk assessment cannot accurately yield thresholds for cancer effects in humans. At best, it can give us indications of relative risks.

It has become accepted practice to use animal cancer bioassays in which animals are exposed at doses that approximate the animal's maximum tolerated dose. This is done to maximize the likelihood of a positive effect, using experimental animal group sizes that are manageable logistically and economically. Central to predicting the toxic effects of a substance is the process of generating a graphical dose-response curve. The shape of such a curve may vary from chemical to chemical, and even for a single chemical it is not likely to be linear over its entire range. However, scientists plotting tumor incidence against dose of the putative carcinogen are plotting data points relevant to the high end of the curve where doses are large. In fact, the validity of extrapolation down to low doses is not easily verifiable and may not accurately predict the shape of the curve at that end of the scale.

The One-Hit model used by U.S. EPA, widely considered our most conservative model, assumes that tumor yield graphed against dose will be linear in the low-dose range (based on mathematical proof). However, a review indicates that it is less conservative as popularly assumed (35). Using data from 1212 bioassays on 308 chemicals tested by the National Toxicology Program, it was found that in small percentage of cases the mathematically generated curve may deviate significantly from the actual animal bioassay results. This occurs more frequently than expected by chance, resulting in significant underestimation of risk by what is characterized as an extremely conservative technique.

Limitations Exist in Estimating Carcinogen Potency
An essential element in cancer risk calculation, carcinogenic potency, is derived by calculating the slope of the curve graphed by plotting tumor yield against dose in animal bioassays. These slopes, which U.S. EPA calls Q*-values, may be derived from a series of carcinogenicity bioassays and averaged to get an overall potency figure. The artificiality of this process is especially troublesome when experimental data do not correspond well to linear dose–response models, for example, with many Class C (possible human) carcinogens. Also, potency is alterable by a host of external factors. As Maugh (36) stated in a 1987 review,
Significant differences in the observed potency of carcinogens in laboratory animals can be obtained, for example, by exposing the animals to chemical agents that stimulate or depress drug-metabolizing enzyme systems; by modification of the animals’ diet; by changing the hormonal balance of the animals; and by stressing the animals in various ways, such as by increasing the number in a cage.

Most important, the influence of multiple chemical exposures is an important issue that current mathematical models are too crude to assess, yet it is a reality of human exposure.

**Limitations Exist in Estimating Exposure**

Exposure calculations are combined with carcinogenic potency values to obtain a cancer risk estimate. Just as artificial as carcinogenic potency estimates, exposure estimates can be derived in several ways, depending on the quality of the pesticide residue database. Dietary exposure estimates tend to generalize risk over an average situation or population, away from the consideration of particular situations and individual sensitivities. This oversimplification is dangerous, since the simple inclusion of exposure figures for sensitive subpopulations within the overall average exposure calculation does not in fact address the particular hazard that a subpopulation might face. Rather, it obliterates it from conscious consideration. As stated by Hattis (37), “Should the analyst take pains to uncover and disclose the distribution of the risk among the population? A 10⁻⁶ risk of death from a specific hazard for an aggregated group might translate into 10⁻² for a particularly at-risk subset. Holodren cites possible differences in the distribution of risk between rich and poor, the medically susceptible and the population as a whole, and between those who have a voice in the acceptance of risk and those who do not” (38).

In addition to the problems mentioned above, risk assessments are limited to the effects of exposure to a single toxic agent. They do not consider ‘plate-of-food’ risks and thereby underestimate the additive risk from ingesting multiple carcinogens.

**Negligible Risk Standard Is Unacceptable to the Public**

People have made it clear that they do not want to eat, carcinogenic pesticides. Growers and consumers agree that the food supply must be safe. The negligible risk standard of safety is not an adequate predictor of safety. The public does not want to be lulled into a false sense of security. For these reasons, we support the establishment of a standard by which society prohibits the purposeful introduction of cancer-causing agents into the food supply and rejects the unproven assumption that these poisons are necessary to a food production system yielding affordable food prices.

**Reduce Pesticide Dependency**

There are a number of systems in place pertaining to pest control for farms, structures, and landscapes. In agriculture, there are a number of sustainable agricultural systems that reduce pesticide dependency (39). Organic agriculture has shown itself to be profitable and productive. Soybean growers in Practical Farmers of Iowa have replaced the cancer-causing herbicide alachlor with tillage systems and planting techniques to shade out weeds. They eliminated one of the 32 carcinogenic pesticides announced by U.S. EPA while maintaining productivity and profitability—at yields higher than the state average and an average savings of at least $11 an acre (40). In schools, parks, along rights-of-way, and in forestry, alternatives to pesticides have proved successful. The Government Services Administration, in its pest control program for 30 million square feet of federal office building space, has reduced pesticide use by 98% through the use of integrated pest management (41).

Our pest management systems must be reoriented toward pest prevention by designing out vulnerabilities and stress in the agricultural environment and practices in the urban environment that invite pest problems. Until we are able to do this, we will maintain our current crisis orientation toward pest management with an exaggerated need for pesticide use and pressure to accept higher and higher risks because of escalating pest problems (42).

**Conclusion**

We have an opportunity to change the regulation of pesticides and still meet the food production and nutritional needs of the public and the productivity and profitability needs of those who grow and market food commodities. The National Coalition Against the Misuse of Pesticides (NCAMP) has proposed a federal pest management act, which takes a holistic look at pest management and the social and health costs of pesticide dependency. It is an approach quite different from FIFRA and H.R. 1627. It is the purpose of the federal pest management act to provide for the protection of public health and the environment from unsafe or inappropriate pest management practices. It is founded on the notion that the environment and natural resources of the country are a heritage which is held in trust for the benefit of succeeding generations and that the public health is a paramount concern, not subject or subordinate to economic considerations. The approach is founded on the belief that a just and effective regulatory scheme cannot be devised, established, or administered without public understanding and involvement.

In keeping with the purpose, the act has the following goals:

- To adopt and implement a national and international policy for the promotion of integrated pest management and sustainable natural resource management;
- To recognize that pesticides are toxic substances and that they must be regulated as part of a cradle-to-grave toxicant control policy;
- To govern pest management practices by a regulatory scheme that embodies open decision making and public participation at every stage and at all levels;
- To govern pest management practices by a regulatory scheme that is health-based and designed to protect all susceptible populations; and
- To ensure that environmental quality must not be degraded and shall be protected by the promotion of safe pest management practices and by elimination of dependency on chemical pest management and agricultural methods.

Legislation now before Congress, including H.R. 1627, embraces the business-as-usual approach to pesticide law and asks us to take a narrow look at pesticide use, while lowering standards of protection by calling the risks negligible. Rather than bring the public into the decision-making process, H.R. 1627 in particular would disempower people and state governments by preempting the authority of states to adopt more protective standards than the federal government.

Pesticide policy reform must move us ahead, not backward because of an unfounded fear that we cannot achieve our pest management and productivity goals. It is difficult to find a person who does not
want to achieve the goal of public health and environmental protection while meeting needs for food production. The question is whether we, as a nation, can afford to maintain a course of dependency on highly toxic pesticides with policies that tinker with flawed risk assessment calculations. We may feel good about what we have accomplished in the short run, but we will have failed our children, future generations, and the sustainability of our planet.

The emphasis must now shift to a massive reorientation away from pesticides, with regulatory and user incentives for the adoption of alternatives, disincentives, and penalties for those who maintain pesticide dependency, and research, technical, and financial support to facilitate the transition to nonchemical pest management systems. We can no longer simply talk about substituting toxic chemicals with chemicals of lower toxicity. We must talk about replacing toxic materials with pest management approaches that are not reliant on poisons.

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