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Reprinted from AMERICAN ENTOMOLOGIST
Vol. 39, No. 4, Winter 1993

Communicating Pesticide Risks

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BECAUSE PESTS are identified as species capable of impairing some human activity, the designation of a species as a pest is anthropocentric and is not an intrinsic biological property. Consequently, unlike many scientific specialties, pest management is tied intrinsically to economic and social concerns. This issue of societal involvement in pest management is often identified, but it is infrequently examined in detail. Although as biologists we may be uncomfortable at addressing issues in social science, such issues are crucial to the successes and failures of many pest management programs. We are examining such social issues in an ongoing effort to reexamine and extend pest management theory (e.g., Higley & Wintersteen 1992, Higley et al. 1992, Pedigo & Higley 1992). Nowhere is this effort more needed than with questions on perceptions of pesticide risks.

Public perceptions of pesticide safety increasingly influence pesticide legislation and regulation. Unfortunately, although public concerns about pesticides do, and *should,* contribute to the formation of pesticide legislation and policies, perceived risks that do not mirror actual risks may contribute to irrational—even counter-productive—regulations (Higley et al. 1992).

We believe scientists and the scientific community have an obligation to address technical issues that relate to societal concerns. In the case of pesticide risks, we find current efforts inadequate. Certainly, apathy and antipathy of individual scientists to communicate with the public is one barrier to better risk communication. However, we believe misunderstandings about public perceptions of risk, and a failure to address the key issues of risk perception, are more common and important barriers. Our fear is that the continuing, and possibly growing, gap between scientists and the public regarding pesticides is leading inexorably towards crisis. What can we do to avoid that crisis?

Public Perceptions and Ineffective Responses

Although definitions of risk vary, most recognize risk as the product of the probability of an undesirable event, multiplied by the adverse consequences of the event (Lowrance 1980). Differences in risk perception involve differences in perspectives on both aspects of risk: probability and consequence. Understanding how scientists and the public differ in their approaches to these aspects of risk is essential for improving risk communication.

Public perceptions of risk from pesticides usually are greater than the risks determined from empirical evidence. Although in most cases human-health risks associated with pesticide use are actually very low, the public consistently ranks pesticide use as being very risky (Slovic 1987). Indeed, the public perception of risk posed by most synthetic chemicals is inordinately great (Hart & Turturro 1987, Kraus et al. 1992). In our experience, scientists who work with pesticides and who may have a more complete understanding of the actual risks often dismiss public concerns as irrational, or at best, misinformed. As a consequence, many scientists seem to react defensively to public concerns. Even worse, some scientists in many disciplines seem to regard public fears as so irrational that they do not attempt to explain risks and the risk-assessment process to the lay person. They contend that because the public seems to want a "zero-risk society," trying to educate the lay person about risks is certain to fail (Wilson 1991). By not appropriately addressing citizen concerns, we fear experts are contributing to widening the chasm between the scientific community and the public. This is particularly egregious because the public needs to understand and be involved in pesticide issues to improve the policy-making process (Higley et al. 1992).

In our view, spoken and written responses to public concerns by experts often are inadequate, doing little to seriously address public risk perceptions. A traditional approach for scientists in both the public and private sectors has been to respond to public concerns by comparing highly visible, well-understood risks with less-visible, less-well-understood risks (National Research Council 1989). Some responses have compared the risks from pesticide exposure with the risks presented by everyday activities, such as driving an automobile or riding a bicycle. Other comparisons characterize the risk of getting cancer from consuming pesticides in a normal diet with the risk from consuming naturally produced carcinogens in everyday foods (e.g., American Council on Science and Health 1989). Still others have compared the risks from pesticide exposure with the risks presented by very low probability events, such as the chance of being struck by lightning (e.g., Anonymous).

Although most risk comparison statements by pesticide experts are more accurate than public perception of the risks, research on risk perception has revealed that these responses do not meaningfully inform the public about unfamiliar risks, such as pesticide use (Slovic 1987, National Research Council 1989). Most experts fail to consider the criteria the public actually use to evaluate risks.

Another area of conflict between intended and achieved goals is in communicating pesticide benefits. Certainly, the benefits of pesticide use must be considered in conjunction with pesticide risks. Where benefits relate directly to questions of risk, for example, accepting one risk (such as pesticides) to avoid a greater risk (such as tick- or mosquito-borne disease), benefits may have a direct bearing on risk perception. More commonly, discussions of benefits seem to focus on economic effects or crop yields which are not as important to the public as health or environmental risks (Slovic 1990). Because assessing those benefits is very much a matter of opinion (in which experts will likely disagree) and because benefits do not directly apply across society, discussions of pesticide benefits seem unlikely to mitigate greatly public concerns about

pesticide risks. Although providing information on benefits of pesticide use is valuable for making more informed decisions on pesticides, discussing pesticide benefits in an effort to allay public concerns about risk ignores public attitudes on risk. The public most likely does not find economic benefit an acceptable justification for medical or environmental risks from pesticides (Slovic 1987, 1990).

We believe there is rationality behind the public's seemingly irrational concerns about pesticides. More than 15 yr of risk-perception research (National Research Council 1989) has identified the legitimate basis for many public attitudes on risk and has provided a framework for better risk communication. Consequently, we believe proactive policies for communicating pesticide risk information to the public can be developed. By using new information about how lay people perceive risk, individuals who work with pesticide technology and are involved with pesticide issues can be more effective risk communicators.

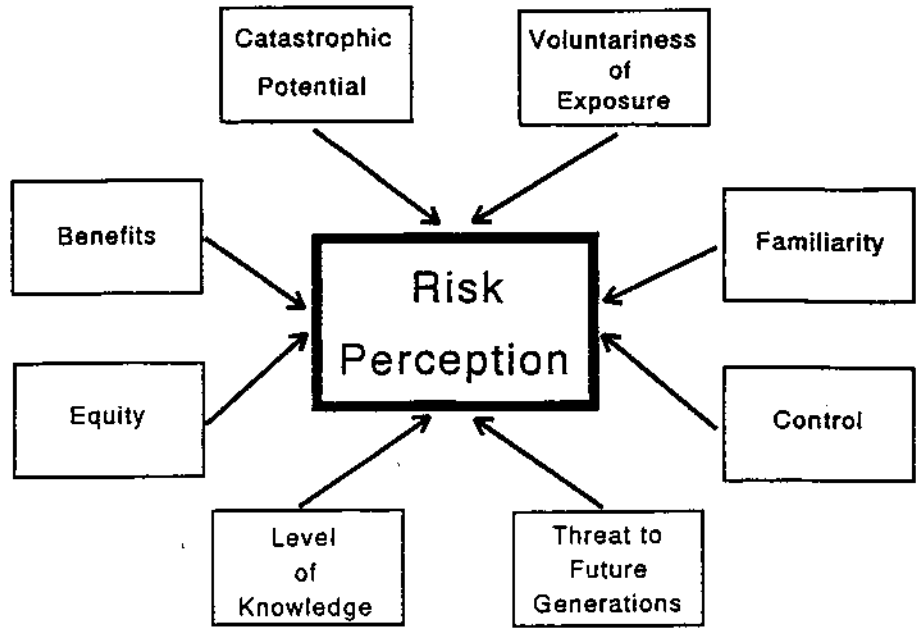

Fig. 1. Factors that influence public perceptions of risk. The factors presented are taken from categories used by Slovic (1987), Covello et al. (1988), and National Research Council (1989).

Risk Perception

Although the risks associated with driving an automobile are more serious, the public perceives pesticide use as being much riskier. Why is this so? Researchers recently have explored the mental processes people use to assess risks from many types of modern technologies and activities. This body of research demonstrates that the lay person uses a different set of criteria than experts for evaluating risk.

Specific factors that have been shown to influence public risk perception include: control, catastrophic potential, dread, familiarity, equity, level of knowledge, voluntariness of exposure, effects on children, effects on future generations, clarity of benefits, media attention, and trust in organizations or institutions (Slovic 1987, Covello et al. 1988, National Research Council 1989). *Control* reflects the ability of the individual or society to control the risk. *Equity* refers to the equal distribution of risks and benefits throughout society. *Catastrophic potential* is the possibility of fatalities or ill effects grouped in time and space. *Dread* reflects the possibility of disturbing delayed effects, such as cancer. (Dread is closely related to catastrophic potential, but the effect does not necessarily need to be grouped in time or space.) *Familiarity* reflects the degree of familiarity lay people have with the risk. *Level of knowledge* is the general understanding lay people have with the process or activity posing the risk. *Effects on future generations* and *effects on children* reflect concerns about possible delayed effects on humans and the environment posed by the risk. *Clarity of benefits* represents the awareness and understanding of the benefits provided by the activity posing the risk.

The public uses these characteristics to judge the acceptability of a risk, rather than using empirical risk estimates (Fig. 1). Slovic (1987) stated, "Lay people can assess annual fatalities [from a given factor] if they are asked to (and produce estimates somewhat like the technical estimates). However, their judgments of 'risk' are related more to other hazard characteristics (for example, catastrophic potential, threat to future generations) and, as a result, tend to differ from their own (and experts') estimates of annual fatalities."

Frankly, we find such a view of risk more encompassing and powerful than simple empirical estimates of mortality. In addressing risk, we should consider issues such as catastrophic potential, control, level of knowledge, and effects on future generations. When we consider failures of expert opinion on risk, DDT being an obvious example, it is important to recognize that in defining risk narrowly to include only human health, most experts failed to anticipate the more important risk: environmental toxicity. Similarly, even though human and environmental risk in pesticide use is now considered, the risk of management failures (which has medical and environmental implications) is not addressed adequately (Higley et al. 1992). It is sobering to recognize that the same failure to broaden outlooks of risk still occurs, as the current failure to adequately address selection pressure and resistance management in the deployment of biotechnology (specifically, *Bacillus thuringiensis* toxins) sadly illustrates.

A central challenge in risk communication is to address these features of public perceptions of risk. Of these, control and catastrophic potential are especially important to pesticide risk communication. The concept of control is pertinent, especially as it relates to risks posed by pesticides. We believe control is a key to understanding why reporting risk data in the format of a comparison is largely ineffective. As we mentioned previously, it has been common practice to compare the risk of contracting cancer from eating common foods and beverages to the risk of contracting cancer from consuming pesticides in a normal diet. The public views pesticides in food as riskier to their health because they have no control over the pesticide content of the foods they are consuming. In contrast, people can choose which types of foods they eat, and, therefore, they have a sense of control over this activity. Additionally, people may tolerate the risks from chemicals inherent in food, but they are unwilling to tolerate additional risks from pesticides. People accept the risks from driving an automobile much more readily than the risks from pesticide exposure because they have control over the automobile.

The risks from most, if not all, voluntary activities are accepted much more readily than the risks from involuntary activities largely because of the concept of control. Is it any wonder then that experts who drank pesticides in front of the media had little effect convincing the public that exposure to these chemicals was safe?

Catastrophic potential substantially influences the public's perception of risk. If there is a perception that an activity has the potential to cause a catastrophic event, the public will not readily accept the risk (Slovic 1987). This is an important criterion because catastrophic potential is seldom incorporated into the experts' empirical predictions of risk. This has clearly been demonstrated in the perception of risk from nuclear power. Public fear of nuclear power is largely based on vivid images of thousands or even millions of radiation deaths, massive environmental devastation, and threat to future generations should an accident occur (Slovic et al. 1982). Consequently, the public's perception of risk from nuclear power is tremendously greater than the experts' estimates of risk. Similarly, the disaster at Bhopal, India (although it was an industrial accident) presents a vivid example of the catastrophic potential of pesticides (Shrivastava 1987).

The public also views pesticides as having catastrophic potential and posing a dread risk (Slovic 1987). We believe there are two major reasons for this. First, pesticides are feared because of their carcinogenic potential. Possible harmful delayed effects from pesticide use, such as cancer or teratogenic toxicity, are definite factors in public risk perceptions. Second, the public is greatly concerned about environmental damage caused by pesticide use. It was, after all, Rachel Carson's 1962 book, *Silent Spring,* documenting the ill effects from pesticide use that sparked the environmental movement. Widespread knowledge of the problems with biomagnification and contamination of groundwater by pesticides and their metabolites, coupled with the reality that pesticides are among the most extensively broadcast synthetic chemicals in the environment, makes dread risk a very real concern to the public.

Public perception of risk also is molded by many other dimensions that interact in complex ways. Coverage of a risk by the mass media can reinforce existing public risk perceptions (Wilson 1991). Media coverage of risks often reveals to the public the dangerous activities that are so pervasive in today's technological world. The mass media provide visual images of risks, enhance the imaginability of a problem, and concentrate on the human aspects of risks (Hart & Turturro 1987, Valenti 1987). Moreover, the media may remind the public that they have little or no control over certain unfamiliar activities.

The public is unlikely to accept risks from an unfamiliar activity if experts openly disagree over the magnitude of the risk or the meaning of the risk-assessment data. Indeed, research has demonstrated that toxicologists differ among themselves in the assessment of pesticide risks (Krauss et al. 1992). Further, the public knows that experts have advocated the use of pesticides without full knowledge of their potential hazards (e.g., the ubiquitous use of DDT and other chlorinated hydrocarbons and the failure of experts to anticipate the environmental problems that eventually occurred). We believe the public views pesticides as risky, in part, because of a justified lack of confidence in expert opinion. Once the credibility of experts and government institutions has been damaged, it is very difficult to regain public confidence (National Research Council 1989). To complicate matters further, the public realizes that experts can be found to support any position in a risk argument because attitudes about risk are inherently subjective.

Public perception of risk also is influenced by individual and group goals, values, and politics (National Research Council 1989). Some groups may want to see all pesticides banned; other groups may want less government regulation of pesticides. The goals and values expressed by individuals in these diverse groups will influence their risk perceptions. Similarly, members of society do not equally accept the benefits from a technology (National Research Council 1989).

Risk Communication

What can the results from social research offer to risk communication programs? Advances in risk perception research in recent years have sparked substantial interest in risk communication. Indeed, the field of risk communication has grown tremendously since 1987. A paradigm for more effective communication of risks has been promulgated by the National Research Council (1989). Risk communication, as defined by the National Research Council, is an interactive process of risk information and opinion among individuals, groups, and institutions. We believe this definition of risk communication is important because it places more emphasis on interactive exchange among affected parties and less emphasis on traditional unidirectional delivery of risk messages from experts to the public. In the new paradigm, the public has a legitimate role in the risk communication process. The challenge is for experts to adapt to this new paradigm to communicate technical information on risk more effectively.

The Experts. Based on the National Research Council's (1989) definition, risk communication is successful when it "raises the level of understanding of relevant issues or actions for those involved and satisfies them that they are adequately informed within the limits of available knowledge." To this end, we have compiled a list of five recommendations for pesticide experts that we believe will improve the communication of pesticide risks. Our recommendations do not contain specific risk messages that pertain to pesticide concerns; rather, they reflect a general framework for the communication of pesticide risks.

1. *Empathize with and Genuinely Consider Public Concerns.* If the public perceives the risk as real, then experts should treat it seriously, whether or not it is a significant risk. Scientists should not dismiss the criteria lay people use to judge the tolerability of a pesticide as irrational. This is especially true for criteria such as control, catastrophic potential, and effect on future generations, which often receive insufficient attention from experts. Beyond empathy, it is important for experts to try to step outside their potentially narrow disciplines to consider broader issues that may be raised as part of public concerns.

2. *Interact with and Inform the Public.* We believe scientists in both the public and private sector have an ethical obligation to communicate with the public on those issues requiring scientific expertise and society's need for information. Clearly, the need for pesticides and the risks from their use is such an issue. Ideally, such communication should be informational rather than persuasive, although correcting misinformation and misconceptions should be a priority. (See National Research Council [1989] for an extensive discussion of persuasion and the role of experts.) One key mistake is to try to change public opinion about the seriousness of a risk. This often is attempted with messages comparing the risk from a well-known risk to the risk from a less well-known risk. Similarly, pesticide risks are sometimes minimized in the context of discussing pesticide benefits.

Research has demonstrated that trivializing the size of a risk is ineffective and even counterproductive (National Research Council 1989).

Part of this effort to communicate with the public must focus on issues other than risk. In particular, it is essential that the public understands fundamental concepts regarding pesticides, because misunderstandings in these concepts greatly contribute to differences between public and scientific views (Fisher 1991, Krauss et al. 1992). For pesticides, key points include the recognition that toxicity is a function of dose, that source of a chemical (natural or synthetic) has no bearing on its toxicity, that risk is a function of both toxicity and exposure, and that pesticides have environmental half-lives; that is, they break down in the environment.

Undoubtedly, public ignorance or misinformation on these elementary concepts about pesticides greatly contributes to problems in risk communication. We believe educational efforts on these basic issues can be successful and are crucial for improving risk communication. For example, in our interactions with undergraduates and other lay people, we find the concept of biomagnification is well understood, probably as a result of educational efforts about the environmental effect of DDT. However, we find that many people assume all pesticides demonstrate biomagnification and are unaware of the nonpersistence of most modern pesticides. These observations suggest that educational efforts about pesticides can be successful, but they also illustrate that continued education is necessary to avoid misconceptions about current situations.

Besides educational efforts on noncontroversial points of fact, we believe there is a place for discussions by experts on less straightforward issues, such as the applicability of animal models in toxicity testing or what constitutes proof of carcinogenicity. With such issues that involve conflicts within the scientific community, every effort must be made to present a balanced presentation and to emphasize the criteria scientists use to determine truth in scientific debates. Less technical issues, such as pesticide benefits or alternatives to pesticides, also merit presentation, but again in as neutral a context as possible. Although we believe the public has not been adequately informed about the importance of pesticides in many contexts, such as in curative management of pest outbreaks, discussions of such pesticide benefits cannot be used as an argument for mitigating pesticide risks without alienating our audience.

We regard these education efforts as among the most important activities experts could undertake to improve risk communication. Certainly, undergraduate teaching and extension activities are two forums for such educational actions, although both will need to seek broader audiences. However, the obligation to respond to the public's need for information also must rest with other scientists who work in areas associated with pesticides. Throughout discussions, scientists must conscientiously discriminate between established fact and expert opinion. Moreover, acknowledging the fallibility of scientists and other experts need not undermine expert credibility, although many scientists seem unwilling to make such acknowledgments.

3. Respond Promptly and with Complete Openness. Immediate and thorough responses to public concerns and to the media are paramount to establishing a greater degree of credibility, respect, and trust. If there are uncertainties and expert disagreements about the magnitude of a pesticide risk, then this information should be reported. Further, incomplete knowledge about pesticide toxicity to both humans and ecosystems also should be revealed in an objective manner. More fundamentally, experts often fail to provide open communication when they ignore the distinction between scientific fact and scientific opinion or when they do not acknowledge their own potential interests (for example, in funding or research prestige) in supporting a given position.

4. Respond with Simplicity and Clarity. Simple, nontechnical statements about pesticide risks, risk assessment, and risk regulation should be the rule, not the exception when experts are queried. The general public typically does not understand scientific terminology as it relates to technological risk (National Research Council 1989, Fisher 1991). In our opinion, most toxicological and statistical terms currently used in relating pesticide risks to the public are inadequate for their intended purpose. Therefore, experts should design risk messages that accurately convey the magnitude of risk presented by a pesticide, while at the same time provide messages understandable to lay people (Fisher 1991). This is not an easy task. Details may have to be sacrificed to convey a clear statement, which can itself contribute to public mistrust and misunderstanding (National Research Council 1989).

5. Relate to the Public that Experts are Determined to Control, Limit, and Understand Medical and Environmental Risks Associated with Pesticide Use. On a philosophical level, it is important that scientists, particularly applied scientists, recognize their true constituency is society in general, not a subset of society such as agriculture. This view may be at odds with traditional viewpoints of agricultural scientists (Perkins 1982), but it is essential for engaging in a meaningful dialogue with the public. Scientists must be able to truthfully relate that experts are devoted to solving pesticide-related problems and are not intentionally creating new risks. Informing the public about pesticide regulation policies and procedures may help alleviate justifiable fears about society's ability to control these risks. Experts also should define and discuss approaches to using pesticides, particularly integrated pest management, and how they relate to managing and reducing risks.

Experts and the Media. The public typically gets information about the risks posed by pesticides from the mass media. We briefly discussed how the media are a factor in risk perception. Because of the importance of the mass media in risk perception, we believe it is essential that experts are effective sources for the media. Unfortunately, many experts shun the media, fearing they will be misquoted or a reporter will exaggerate the risk or event (Valenti 1987). Moreover, scientists often indict the media for propagandizing and sensationalizing risk-related issues. Similarly, many reporters believe that scientists do not respect them and may consider most experts poor sources (Valenti 1987). This is particularly unfortunate because experts need the media to inform the public better about risks posed by pesticides, and the media need clear, meaningful statements from experts for well-balanced stories on risk.

Valenti (1987) suggested that scientists need a better understanding of the media process and reporters need a better understanding of the scientific process. Contrary to what many experts believe, Valenti argues that the media generally are not biased and do not readily change the public's perceptions of risk. Valenti stated, "Mass media reinforce the existing attitudes of the audience; they are not a force for change." However, she also stated, "...it is also acknowledged that mass media can be used to guide an audience toward a new attitude that is rooted essentially in what they (the audience or message receivers) have already accepted, what they already believe." This argument alone should convince experts to view the media as a valuable resource for

communicating with the public the risks posed by pesticide use.

Valenti (1987) indicated that the common goal of scientists and the mass media "is to have a more informed public able to make more informed decisions." To that end, ways to improve the communication between scientists and the mass media have been recommended. Some suggestions for scientists include clearly defining scientific terms, providing complete information, accommodating the deadlines and other constraints placed on reporters, and organizing and participating in forums that bring scientists and reporters together (Valenti 1987, National Research Council 1989).

Proactive Approaches

It is important to recognize that society does not consist of a homogeneous public with identical goals and values (National Research Council 1989). Therefore, determining what specific segments of the public think about risks and benefits from pesticide use and the information they need from experts will help shape better communication efforts. Specific messages directed toward groups, such as growers, farm workers, pesticide applicators, environmentalists, children, educators, and medical health professionals, will greatly improve communications. Unfortunately, surveys have not been conducted to assess the views and needs of different groups extensively.

Recent work in risk communication has stressed the importance of setting realistic goals for communication activities (National Research Council 1989, Fisher 1991). We believe goal-setting fits well with the proactive response strategies discussed above. Pesticide experts should deliberately plan risk-communication activities and establish specific goals.

Organizations and experts should be able to address individual concerns on a day-to-day basis, as well as widespread concerns during crisis situations, such as the Alar incident or the 1980–1982 Mediterranean fruit fly control crisis (Jackson & Lee 1985). Indeed, failure of risk communication was itself a major cause of the Mediterranean fruit fly crisis (Jackson & Lee 1985) and is a potentially crucial factor in almost any entomological crisis. Responses to concerns over pesticide risk should be reliable, informative, thorough, and prompt. Such responses demand proactive preparation. We believe organizations should develop risk-communication procedures to anticipate and better manage crisis situations. For example, recommendations for risk communication have been developed for gypsy moth outbreaks in west-coast cities (Czerwinski & Isman 1986).

Educational efforts directed toward providing fundamental information on biological and chemical concepts associated with pesticides is a critical undertaking. In this effort, the cooperative extension service clearly needs to play a central role, particularly in reaching nontraditional audiences. Also, new types of extension appointments, such as extension toxicologists, may be valuable. Other educational opportunities with school children, undergraduates, and adult continuing-education students should be promoted. Ultimately, the problem of popular literacy regarding pesticide fundamentals is but one aspect of scientific literacy. We believe scientists and scientific organizations must make improving public understanding of science and the scientific process a priority.

Where appropriate, documents such as public information pamphlets should provide nontechnical discussions of the nature and magnitude of pesticide risks to human health and the environment, of risk-assessment and regulatory procedures, and of how the organization (private or public) intends to manage pesticide risks and avoid creating new risks. It is essential that such documents represent sincere efforts to provide impartial information on pesticide risks and their management. The National Research Council (1989) also recommends that organizations produce a long-form document that describes elements of risk and risk management in more detail. This document would be available to anyone wanting more information than conversations or short pamphlets can provide.

Risk documents should not only be available to concerned citizens, but they should also be sent unsolicited to individuals and groups that the public may access to answer pesticide-related questions. Medical professionals, extension personnel, environmental activists, political officials, and others should also be involved in the risk-communication process, and pesticide experts should view them as allies working toward a common goal—a better informed public.

In this light and in consideration of the general guidelines we have recommended, we suggest that the following four specific actions be taken to improve risk communication:

1. Survey different societal groups to determine their views about pesticide risks and benefits. Morgan et al. (1992) provide a detailed methodology for developing surveys and risk communications. It is crucial that experts do not rely on their intuitions for information about how lay people think about risk. Indeed, recent research has found poor correlation between expert judgments of the unacceptability of risk comparison statements and lay judgments of unacceptable comparisons (Roth et al. 1990). Therefore, experts should not assume they know their audience's general knowledge and perception of risk, so an empirical approach (in the form of surveys and questionnaires) most likely is required.

2. Develop educational programs on the basic properties of pesticides and their management. Additionally, tailor educational programs to interested public groups, based on results from surveys. Directing programs to nonagricultural audiences, such as environmental groups, homeowner associations, or civic groups, should be emphasized. An important part of any program would include pamphlets that address pesticide-related information. Ideally, risk documents should be prepared after the audience's views and perceptions are determined, particularly in developing documents relative to specific risks (such as groundwater contamination) or specific pesticides. However, it may be necessary to prepare risk documents before intensive assessments of clientele views can be conducted (although basic pesticide information need not depend on survey results).

3. Serve as a resource (not an advocate) for public information on issues. Experts should always be available to answer questions from the public and from the media. Because the information reported needs to be reliable, thorough, and of consistent quality, it may be necessary for organizations to appoint one individual as a liaison. However, all experts should be prepared to serve as a resource.

4. Evaluate all programs and actions on a regular basis. This will lead to fine-tuning (and possibly major revisions) of existing programs.

We realize that there are key differences between public and private sector experts regarding priorities, viewpoints, and clientele. However, these differences should not preclude cooperative arrangements between both types of experts to improve pesticide risk communication. Indeed, individuals in both groups should work together to stimulate the implementation of better communication programs. This could be accomplished through the creation of a center for communication of pesticide risks.

Caveats and Conclusions

Although the recommendations presented in this article do not incorporate all possible strategies for pesticide-risk communication, they do provide a frame-work for proactive responses. The new risk-communication paradigm and our recommendations most likely have utility for other pest management technologies, such as biological control, biotechnology, and plant resistance. Moreover, pest-related crisis situations, such as significant pest outbreaks and unintentional introductions (especially of medically important pests) may be managed more effectively using the new communication framework.

Redirecting risk communications to reflect recent research findings better will not by itself produce a new era of public understanding and acceptability of risks posed by pesticides. Indeed, a lay person's perception of risk is resistant to change (Slovic et al. 1982). Moreover, the National Research Council (1989) stated, "...people do not all share common interests and values, so better understanding may not lead to consensus about controversial issues...." As we discussed, public perceptions of risk and acceptance of technological hazards are governed by complex, interacting factors. These factors still are not well understood by researchers. A tremendous amount of risk-perception and risk-communication research needs to be undertaken as it relates to pesticides. Even if poor risk comparisons are no longer used in communications and the recommendations we suggest are more widely implemented, we believe the public still will be slow to alter its attitudes about pesticide risks. However, we believe the status quo of pesticide-risk communication is not acceptable, especially given recent developments in risk-perception and risk-communication research.

Slovic (1987) eloquently stated, "Lay people sometimes lack certain information about hazards. However, their basic conceptualization of risk is much richer than that of the experts and reflects legitimate concerns that are typically omitted from expert risk assessments.... Each side must respect the insights and intelligence of the other." By understanding and respecting the concerns of the public, we, as experts, can develop more effective and proactive pesticide-risk-communication strategies. Improved risk communications will lead to improved public trust and respect of experts and the scientific process. More importantly, improved risk communications will lead to a more scientifically literate public able to contribute meaningfully to pesticide legislation and policies.

Acknowledgments

We thank F. Baxendale, J. Foster, S. Kamble, B. Siegfried (Department of Entomology, University of Nebraska), B. Fischhoff (Department of Social and Decision Sciences, Carnegie Mellon University), and M. Zeiss (Department of Entomology, Iowa State University) for reviewing the manuscript. This is article 10243 of the journal series of the Nebraska Agricultural Research Division, University of Nebraska–Lincoln. This work was supported by University of Nebraska Agricultural Experiment Station Projects 17-053 and 17-055.

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