Food Safety: What Your Mother Didn't Tell You

J. Robert Tomerlin*
Christine F. Chaisson

The arguments that have raged regarding the safety of America's food supply may seem silly, foolish and of little importance. However, these issues are real to the public and the legislators who represent them. If this were not the case, Alar would not have received such media attention and California's Proposition 65 would not exist. Members of the agricultural community, particularly those involved in research and education, need to be familiar with these issues.

People are innately interested in food safety because the issues involved are very close to them: everyone has to eat. In the past, people assumed that the food they ate was not harmful, and was in fact good for them. So, recent indictments of the safety of our food supply have excited the public and prompted them to ask "Is our food safe? Are my children going to be OK if they eat this apple?" The public feels it has a right to a safe food supply and the right to expect that their government is watching to make sure that it is safe. The public doesn't realize that this "right" is a blessing stemming from the advances of agricultural science, including the development of chemicals to control the pests that attack our crops.

The purpose of this paper is to illuminate some of the issues regarding food safety by briefly discussing the current regulatory system, the basic elements of risk assessment, the possible reasons for the confusion that currently exists, and techniques for determining if what you are being told is sensible. Pesticide residues in food will be the general area of food safety discussed in this paper. However, many of the principles may be equally applied to issues regarding animal drugs or microbial contamination.

Current Regulatory System

The regulation of pesticide residues in food is governed by two federal statutes (Figure 1): the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA). Under the provisions of these statutes, the Environmental Protection Agency (EPA) is given the authority to register the use of a pesticide and to establish a tolerance for that use. Under FFDCA, the Food and Drug Administration (FDA) is given the enforcement authority to monitor the food supply for pesticide residues. Likewise, the United States Department of Agriculture (USDA) is given the enforcement authority to monitor meat and poultry for pesticide residues.

*J. R. Tomerlin, Technical Assessment Systems, Inc., 1000 Potomac St, NW, Washington, DC 20007

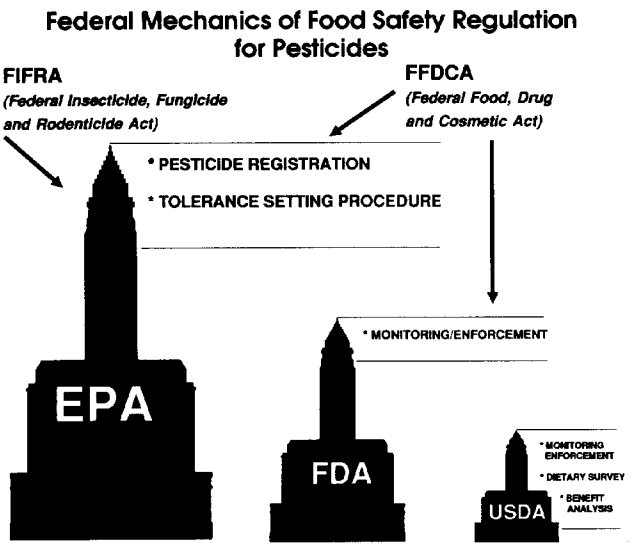
Reciprocal Meat Conference Proceedings, Volume 43, 1990

Establishing Pesticide Tolerances

The EPA reviews pesticide data submitted by companies desiring to register a chemical for use in the United States. Among the data submitted to EPA are the results of field trials which aim to show the maximum amount of pesticide residues remaining on a raw agricultural commodity (RAC) if the pesticide is applied according to the product label. The product label stipulates the maximum rate at which the pesticide may be applied, the maximum number of applications, and the minimum preharvest interval (PHI). The PHI is the time between the last application of the pesticide and harvest. EPA assumes that if field trials are conducted under these label stipulations, the residues on the RAC will be as high as they could possibly be. Pesticide residues may also be present in milk, meat and poultry if the feed consumed by the animals is comprised from treated commodities.

The EPA will then use such residue data to establish a tolerance, which is the maximum amount of the pesticide permitted on the RAC. Tolerances are established on the RAC, e.g., whole oranges, whole bananas, or whole pineapples. The focus of the EPA's review of the residue field trials is to establish the maximum pesticide residue that is expected to occur on the crop if the product label is adhered to. This level, the tolerance, is designed as an enforcement tool to indicate whether or not a pesticide has been applied to the crop in accordance with the product label. Note that the tolerance does not represent the residue concentration one would usually expect to find on treated crops, but rather the

Figure 1



The Federal food safety apparatus.

maximum that can legally occur. In practice, therefore, actual pesticide residues on crops should only rarely be as great as the tolerance. This topic will be addressed in more detail in the "Pesticide Residues" section of this paper.

Monitoring the Food Supply

The responsibility for testing food for pesticide residues falls upon two organizations. USDA inspects meat and poultry for pesticide residues and the FDA inspects all other food commodities. If pesticide residues greater than the tolerance established by the EPA are found, the presumption is that the pesticide was used in a manner inconsistent with the product label. If such is the case, the food can be excluded from interstate commerce.

In general, FDA and USDA monitor food in RAC form close to the production site. For example, FDA would test apples for pesticide residues at the point of harvest, or at a main distribution point, not at a processing plant making applesauce or at a bakery making apple pies.

Has the Train Derailed?

One can conceive a picture of food safety in which a train is made of the locomotive of science pulling the regulatory policy and public perception cars (Figure 2). Public policy would be promulgated upon sound science. Confidence in the rightness of the regulatory policy would result in the assurance that the food supply was safe.

Unfortunately, it seems that in recent months the train has been derailed (Figure 3). The car of public perception is in the front, pulling the regulatory policy behind it. It sometimes seems that the science upon which a sound food safety policy should be based is not part of the train at all. Food safety policy must be based upon valid principles of science. The ultimate regulatory decisions are made by the consumers in the market-place, but even those decisions must be made rationally and with an eye to the scientific basis of the issues.

In order to understand the proper role of science in food safety, it will be necessary to cover in some detail how the EPA goes about evaluating the potential hazard of a pesticide to public health.

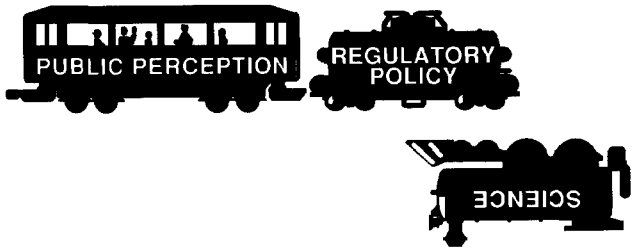
Principles of Pesticide Risk Assessment

We are concerned here with the potential of a pesticide to harm people. Therefore, we will not be concerned with the possible impact using a pesticide has on fish, or birds or non-target plants. Suffice it to say that full evaluation of a pesticide by the EPA includes a battery of environmental and ecological tests. Furthermore, we are restricting our discussion to the question of "Will pesticide residues in food affect human health?" The EPA also evaluates the potential harm to those who use the pesticide. However, we will restrict this discussion to an evaluation of potential health risk associated with exposure to pesticide residues on food that is eaten.

Figure 2

The desired food safety chain.

Figure 3

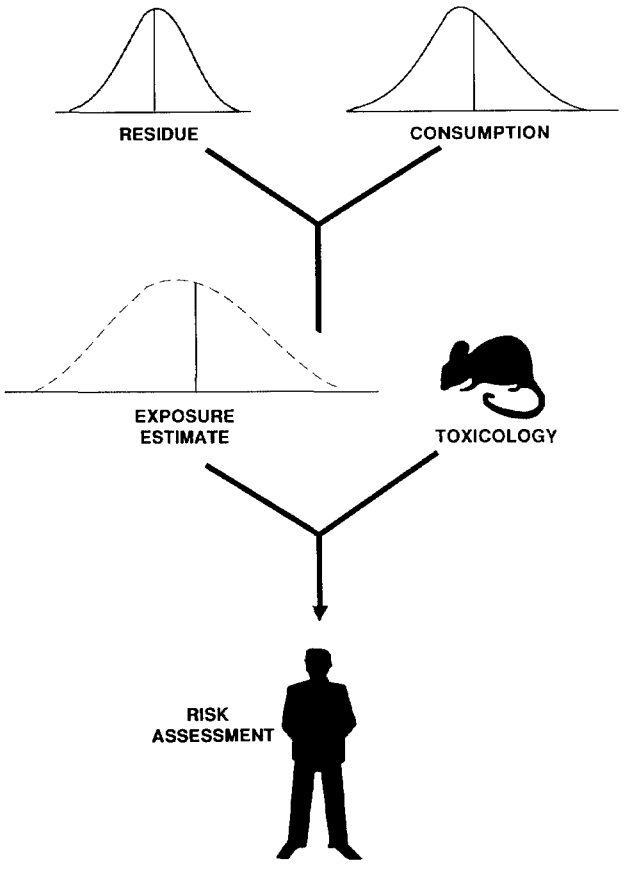


The real food safety chain.

Components of a Risk Assessment

There are three basic components (shown in Figure 4) to an assessment of risk from pesticide residues on food: an

Figure 4



Components of a dietary pesticide risk assessment.

estimate of the amount of food that is consumed, an estimate of the magnitude of the pesticide residue on the food, and an estimate of the toxicity of the pesticide.

Food Consumption

Food consumption estimates used in a pesticide risk assessment are based upon data collected in the USDA Nationwide Food Consumption Survey. This survey is conducted approximately every 10 years. The most recent survey, which is used for current pesticide risk assessments, was conducted in 1977-1978. Over 30,000 individuals were questioned as to their food consumption profiles over a 3-day sampling period. Data was collected in all regions of the United States throughout the year, with a final data base of food consumption data of more than 87,000 observations.

People who responded to the survey gave data in terms of what they ate throughout the day: beef stew, chocolate cake, and pizza. However, the EPA establishes pesticide tolerances on raw agricultural commodities, not beef stew, chocolate cake, or pizza. Therefore, the raw data from the USDA survey was broken down into its component parts, and a data base of consumption of raw agricultural commodities was created. In recognition of the fact that processing can affect the chemical's degradation, the data were further broken down into form of the food, for example, baked, fried, raw, canned or frozen.

In addition to data on the foods that were consumed, data were also recorded as to gender, age, and body weight of the respondents, region of residence, and other demographic information for the survey respondents. This additional information means that exposure may be calculated for various population subgroups, for example, for various ethnic groups, children, teenaged males, and pregnant women.

The food consumption data may be viewed in two different ways. For chemicals having a chronic toxic effect, it is generally most appropriate to use mean consumption estimates. Chronic toxicity exists when a chemical causes a toxic effect following a prolonged period of exposure, usually presumed to be a lifetime. Acute toxicity, on the other hand, occurs when a toxic effect is observed following a relatively short period of exposure to the chemical. For some effects, such as teratogenic effects, one short period of exposure may be enough for the effect to be expressed. Individual estimates of food consumption are used for analyses of acute exposure.

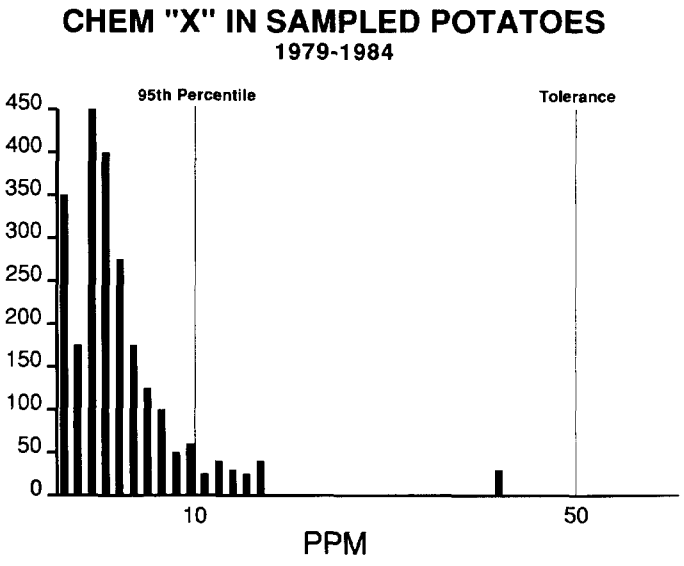
Pesticide Residues

Pesticide residue data may come from several different sources. Residue data are most commonly available from field trials submitted to the EPA as part of the tolerance petition process. From such data, mean residues suitable for estimates of chronic exposure may be calculated. If the chemical being considered is acutely toxic, a different statistic, such as the 95th percentile value, may be used as an estimate of the pesticide residue on the crop. A more severe estimate of the residue is used in the case of acutely toxic chemicals to insure that individuals who eat a lot of a given commodity will not ingest more of the pesticide than what is considered to be safe. Typically, even the 95th percentile value is much lower than the tolerance, because the vast majority of the residue samples are clustered at the low end of the range of residues observed in the study, whereas the tolerance is established in light of possible extreme values (Figure 5).

Residue estimates calculated from field trial data, whether means or 95th percentile values, are often higher than what one would expect to find on food as eaten. The major reason for this is that field trials are conducted according to the maximum conditions permitted on the product label. Samples are immediately harvested and taken to a laboratory for analysis. Although some foods, such as apples, oranges or potatoes, may be eaten right after harvest, residues on foods as eaten may be considerably lower than what would be expected from freshly harvested food commodities.

For example, pesticide residues may decrease during storage, so that residues on potatoes immediately after harvest may be higher than residues on the same potatoes after they have been stored for several months. Very few pesticides would ever be used on 100 percent of the crops they are registered on, even in a single year. Therefore, one correction that may be used is to adjust the field trial residue by the percentage of the crop that is treated. Pesticide residues may be mainly on the surface of the crop, so that a peeled orange contains hardly any residues, whereas the whole orange does have pesticide residues. Toxic residues may decrease (or increase) upon heating, so that residues in an apple may be considerably higher than the residues that one would find in a can of prepared apple pie filling. The concept of anticipated residues was developed to account for the fact that pesticide residues vary in magnitude in relation to the degree of processing (washing, peeling, cooking) or proportion of actual use, so that people are not consistently exposed to maximum residues. In fact, it is extremely unlikely that anyone would consistently eat a food that contained high levels of pesticide residues, and even more unlikely that all the foods a person ate would consistently contain high residues levels.

Figure 5



Typical residue data from a field trial.

The residue values used in a risk assessment, then, may come from field trial data, field trial data which have been adjusted for the percentage of the crop that is treated, field trial data that have been adjusted for processing, residue estimates based upon FDA pesticide monitoring data, or residues based upon data collected in specific surveys of produce in grocery stores. It is usually assumed that more refined estimates of pesticide residues result in a more accurate estimate of exposure to be used in the risk assessment.

Exposure Estimate

The estimate of exposure is simply the product of the amount of food consumed and magnitude of the pesticide residue on that food. Estimates of chronic exposure are most commonly calculated from mean consumption data and mean residue data. Estimates of acute exposure are most commonly calculated from individual consumption data and high, such as 95th, percentile residue values. Regardless of the type of exposure estimate, the basic operation is a simple multiplication of food consumption and pesticide residue summed across crop commodities.

Risk Assessment

Once an exposure estimate is calculated from food consumption and residue data, it must be compared to standard of toxicological potency. This comparison forms the basis of the risk assessment, making it useful to know something about how the toxicological potency of a chemical is evaluated. This facet of the risk assessment is termed hazard identification.

The EPA requires that every pesticide that is granted a tolerance be extensively tested for toxic effects. Among the tests are long-term feeding studies in rodents and dogs, teratology studies, mutagenicity studies, oncogenicity studies and reproductive toxicity studies. In each of these required studies, two important dose response statistics are identified. The NOEL is the No Observable Effect Level and represents the highest dose in the study at which no toxic effects were observed. The LEL, or Lowest Effect Level, is the lowest dose in the study at which a toxic effect was observed.

The EPA will review all of the toxicology studies available, and from the battery will select the *lowest* NOEL as the value on which to base their estimate of the amount of the pesticide that is safe for humans to ingest. The EPA will divide the NOEL by at least 10 to account for variation between individuals of the same species, and will divide again by 10 to account for the variation between species, i.e., to account for a study using dogs being used to predict a possible toxic effect in humans. Thus, if a dog study had a NOEL of 0.05 mg of chemical/kg body weight/day (mg/kg/day), a rat study had a NOEL of .07 mg/kg/day, and a reproduction study had a NOEL of 0.02 mg/kg/day, the EPA would usually select the NOEL of 0.02 mg/kg/day as the definitive NOEL for the chemical. After applying the two 10-fold safety factors, the resulting value of 0.0002 mg/kg/day would be used as the reference dose (RfD), meaning that the EPA would determine that people could safely ingest as much as 0.0002 mg of the chemical per kg of body weight each day without suffering any adverse toxic effects.

The procedure described above is appropriate for evaluating exposure to chronically toxic chemicals. The risk assessment procedure for acutely toxic chemicals is essentially the same, except that individual food consumption estimates are used to calcuate the exposure estimate, which is then compared directly to a NOEL from an acute toxicity study.

Assessing Cancer Risk

Evaluating exposure to a carcinogenic chemical is done differently, however. The starting point of a carcinogenic risk assessment is an exposure estimate calculated as described for a chronically toxic pesticide. The evaluation of the toxic potential is different from the RfD approach already described.

In cancer studies, experimental animals are fed vast quantities of the chemical, typically 10,000 to 100,000 times the amount a human would ever ingest, and the tumors are counted. The resulting data are then subjected to theoretical probability models to express the probability that a tumor would result if humans were exposed to levels of the chemical thousands of times lower than the doses actually used in the animal studies.

These studies are replete with uncertainty. Scientists are not certain that they tested the chemical in the proper test animal, that they have observed the critical tissues, or that they understand the underlying mechanisms that result in the tumors. They also must extrapolate the probability that the chemical might cause cancer in humans from studies in which animals are given the chemical in amounts thousands of times greater than a human would be expected to encounter in a whole lifetime of exposure. Consequently, a conservative, protective assumption is made: that any exposure in humans, no matter how small, could result in tumors. Furthermore, they also assume that the mathematical models used to extrapolate from rodents to man and from high dose to low dose correctly predict the "odds" that the chemical will cause cancer in humans.

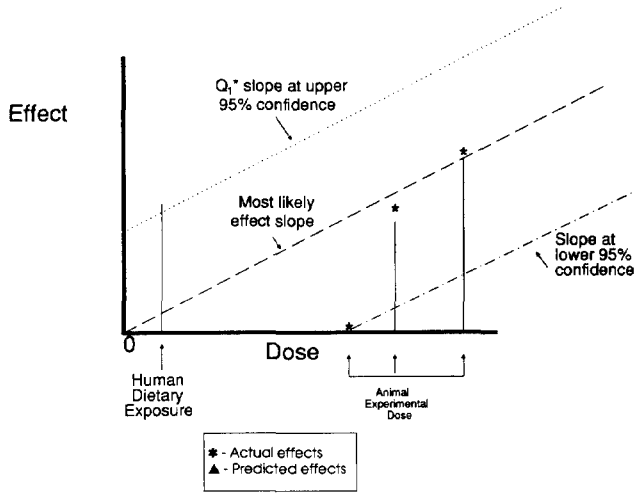
To allow for these uncertainties, the "answer" will be expressed with a 95% confidence that the "odds" are not underestimated. From animal data, usually based upon three dose levels, the most likely dose-effect relationship is calculated. Then, another slope, called the Q1* (known as the Q-star), is calculated. The Q1* is typically the upper 95 percent confidence interval, which is interpreted to mean that there is a 95% confidence that the "answer" is never underestimated (see Figure 6).

The Q* is then multiplied by the exposure estimate to yield an estimate of the probability of additional cancers occurring in the human population being considered following a lifetime of exposure at the level calculated in the chronic exposure analysis. For example, if the Q* for a chemical was calculated as 0.0045 $(mg/kg/day)^{-1}$ and the exposure estimate was 0.00055 mg/kg/day, the resulting product would estimate the probability of additional cases of cancer in the population following a lifetime of exposure. In this example, this probability would be 2.5×10^{-6}, meaning that the use of the chemical would result in an additional 2.5 cases of cancer for every million people in the population who are exposed to 0.00055 mg/kg/day of the chemical over their lifetimes.

Figure 6

Cancer Risk Assessment

- Assume all exposure causes some effect
- Assume the mathematical model profile at high doses mimic expression at low doses
- Be "conservative", so estimate probability at 95% confidence level



Components of a cancer risk assessment.

A significant problem with this quantitative approach to risk assessment is that usually all that is reported is the final number. All the assumptions that underpin the assessment, all the interpretations of the data, all the explanatory information is stripped from the number and the message that is received is "Using this chemical is going to cause 2.7 out of every million people to get cancer. What if my kid is one of them?"

With this general background to the science and art of risk assessment, we are now ready to consider some of the recent confusion regarding the safety of the American food supply.

Reasons for the Confusion

Clearly, the whole process of exposure analysis and risk assessment is relatively complicated and is not something that the average person is familiar with. However, even though the average person may not be familiar with these principles of risk assessment, he or she does feel, strongly, a personal responsibility to buy healthy food, food that is safe. Most people aren't chemists, most people aren't nutritionists and most people aren't toxicologists. Even if most people were versed in the sciences of chemistry, nutrition and toxicology, they still wouldn't have access to the thousands of pages of data pertinent to a risk assessment for a pesticide.

In the past, the general public placed its trust in the government to read the thousands of pages of data and to pronounce the food supply "Safe." The public, informed by the media and the efforts of various consumer and environmental groups, realizes that a scientist can never state that something is absolutely safe. All the data that enter into a risk assessment are estimates. All the data are subject to the error and uncertainty associated with data. Scientists, on the other hand, have generally not explained their craft very well, leaving the public confused, frustrated and angry. A schism results because the public wants a safe food supply, and what a scientist sees as insignificant risk may be a frightening, substantial risk to the public. Without a firm grasp of the scientific principles and issues underlying the risk assessment process, the public falls back on its only basis of making a decision: outrage.

Risk and Rage Factors

The public reaction to food safety issues is moderated by several subtle factors which we call Rage Factors (Figure 7). In general, the more familiar a person is with a given situation, the less threatened they will feel. America used to be an agrarian nation, but this is no longer the case. Many people are unfamiliar with agriculture and don't understand the importance the prudent use of pesticides has in producing food. This lack of familiarity with the basics of food production may lead to rage if, after being coached in the health problems pesticides "cause," they learn that pesticides are used on the food eaten by them or their loved ones.

The degree of rage is determined to some extent by whether or not the risk is viewed as voluntary. People may read reports about the link between fatal automobile accidents and unbuckled seat belts, but they may still choose not to use seat belts. They have weighed the evidence themselves and decided that the inconvenience of wearing a seat

Figure 7

RAGE FACTORS

- **Familiarity with situation**
- **Voluntary nature of situation**
- **Subpopulation affected and victim identified**
- **"Dreadedness"**
- **Trust in authority having control**
- **Equity in risk/benefit**
- **Reversibility**

Evaluating risk with rage factors.

belt outweighs the potential benefit. In short, they have decided to take the risk. However, if they feel that someone may be putting pesticides on their food and they don't have any way of deciding whether or not that's something they want, they may feel outraged at being forced to take the risk of being sickened by pesticides.

The rage people feel regarding the potential health risks is also partially dependent upon their view of who the victim is. If people feel that Agribusiness is playing loose with the health of their children, they will react with rage.

The willingness of people to accept the health risk of using pesticides is somewhat related to how much they dread the risk. Americans dread cancer. People view cancer as a horrible disease and do not want to be forced to risk getting cancer from pesticides on the food they eat. Frequently, the social goal regarding cancer is zero risk.

The rage people feel about having to take a risk also increases as their confidence in authority decreases. After the "60 Minutes" presentation on Alar and apples, people felt that the government was letting them down and was not protecting them and their loved ones. Such a lack of confidence may be replaced by rage, particularly if the public also feels that those in authority are somehow culpable and are deliberately forcing them to take unnecessary risks.

Rage will also increase if the public feels that there is a lack of equity in who takes the risks and who reaps the benefits. With pesticides in food, many people feel that they must risk their health so that Agribusiness can reap the benefits. They may not see the reality of a bountiful, inexpensive food supply as a direct benefit to them.

People will also feel more or less outraged about health risks related to their food supply, depending on the extent to which they perceive the risk as reversible. If people believe that a one-time exposure to pesticide residues in their food is going to give them cancer, they will most likely find the risk unacceptable.

There are probably other factors which contribute to people's rage regarding the health risk associated with pesticide residues in food. The few we have mentioned, however, should be enough to demonstrate how people may decide whether or not they are willing to accept pesticide residues on their food. The section on risk assessment briefly discussed the rationale behind a scientific risk assessment. The general public, however, has neither the training nor the resources to conduct a scientific risk assessment. Furthermore, they have lost confidence in the ability of the government to correctly evaluate risk associated with pesticide residues, so they rely on their feelings of rage to decide whether or not to accept the risk.

Assessing the Risk Assessment

The last topic we need to consider is that of who makes the risk assessment and how does one evaluate the validity of what they say. In other words, how does one assess the assessment?

We all encounter risk assessments from the media, from government, from special interest groups, from friends and from relatives. Sometimes, you may need to rehearse the basic principles of risk assessment we've discussed to determine if the risk assessor seems to be adhering to those principles. More often, however, much can be learned from a relatively simple analysis of what the assessor says. The basic questions to ask are shown in Figures 8 and 9.

For example, what are the apparent motives of the assessors? Do the assessors seem to be objective, or is the conclusion of the assessment important to them? Consider whether or not the assessment seems to look at the full spectrum of facts, or only the segment supporting the assessment. Consider the reputation of the assessors. Have they been involved in the field, or are they novices?

It is also important to notice if the assessors rely on value words. For example, they may state that "*Only* 0.1% of the food in this country is ever tested for pesticide residues." The

Figure 8

Finding the "Real" Message
Tips for the Listener

- **Author's motives**
  What are the author's motives?
- **Value words**
  What is the tone?
- **Selective statistics**
  Is the entire database considered?
- **Point-of-view conclusions**
  Whose point-of-view do the conclusions support?

Hints for evaluating a risk assessment.

Figure 9

Finding the "Real" Message
Tips for the Listener

- **Future facts**
  Does the author exploit the unknown?
- **Fact lineup**
  Does the author "lead" the listener?
- **Body count**
  Are "event odds" expressed as certainties?
- **Castle building**
  Are assumptions based upon fact?

More hints for evaluating a risk assessment.

use of the word "only" leads the listener to believe that 0.1% couldn't possibly be enough, when in fact it would be impossible for 1 out of every 1000 apples, oranges, pork chops, grapes, etc. to be tested for residues. You may not know how much of the country's food should be tested, but you have been told that an amount beyond the capacity of the country to test is inadequate. Also be cautious of such words as "contaminated" and "tainted,"

Do the assessors appear to select the statistics in the risk assessment? Be particularly wary of percentages or percentiles. For example, an assessor could ask "Did you know that 50% of the bananas monitored last year contained residues of Chemical X?" This sounds terrible, unless you happen to know that only two bananas were tested. Now, the fact that only two bananas were tested may be a cause of concern, but the statement that 50% of the bananas tested contained residues (were *contaminated*!) is unwarranted. Also beware of assessors who seem to edit the available data to make their points. This is frequently how residue data based upon FDA monitoring activities are used. The FDA conducts two types of pesticide residue monitoring. The first type is routine monitoring which selects lots of food at random to be analyzed for pesticide residues. The second type is compliance monitoring, in which FDA has reason to believe that a particular pesticide has been misused. Consequently, FDA may monitor more intensively in areas where misuse is thought to have occurred. One would expect a greater preponderance of high residues in such a data base and a risk assessment based on such oversampling would be biased.

It is also helpful to consider the point of view of the assessors. Does your knowledge of the assessors lead you to believe that they may over-interpret the data to prove a point? Have their data and their conclusions been reviewed by objective parties? If you were to examine the same data they did, would you draw the same conclusions?

Beware of assessors who rely on future facts to nudge you to their viewpoint. The use of future facts is nothing more than a dodge designed to throw listeners off balance by making them think that there is even more to the risk assessment than is being revealed, "and if you knew it all, you'd really be concerned!" Don't fall for this trick.

Another trick to beware is the lining up of facts with an abrupt halt so that listeners jump to conclusions. For example, consider the following sequence. "X has not been adequately tested to see if it causes cancer. Farmers spray X on orange trees. I wouldn't want my children to drink orange juice that had been sprayed with X." If the argument stops here, listeners will automatically complete the thought "X causes cancer in children," even though that was never explicitly stated.

We've previously discussed the problems of relying on a simple number in risk assessment, but this is the basis of another spurious method of risk assessment known as the body count. This is done by multiplying the probability of extra cancers, which is based upon the *upper* 95th confidence band, by the population size and concluding that the use of chemical X will cause cancer in a certain number of people. This is not a proper use of this probability expression, but in their minds, the listeners will automatically ask if they're one of the victims.

The final thing to look for in evaluating a risk assessment is building castles from false assumptions. Spurious assessments prey on the underlying assumptions the audience may hold regarding pesticides. For example, the assessors may use the belief that there really is no good reason to use pesticides, or that only man-made chemicals in food are toxic, or that pesticides are only made by man. Some assessors will use such unstated assumptions to lead the listeners to the desired conclusion or response.

Conclusion

The process of evaluating the health risks incurred by the population is complicated, using data from food consumption surveys, pesticide residue trails and toxicology studies. The data used in pesticide risk assessments are variable and subject to the normal laws of statistical probability, meaning that one can never know with certainty the extent to which a population may be exposed to a pesticide and the toxic effect that exposure may cause to the population.

However, the public's confidence in the regulatory system has eroded, and that erosion has resulted in a demand that the food supply be "certified" to be absolutely safe. In recent months, various groups have argued that "zero risk" from man-made pesticides is the target at which the food safety apparatus should aim. However, with analytical instruments and techniques capable of detecting pesticide residues in the parts per billion range, the only way this zero risk can be achieved is if pesticides are not used. There are arguments that, in fact, pesticides should not be used, which is attractive to an increasingly urban population unfamiliar with the advantages that the judicious use of pesticides can bring, both to the agricultural industry and to the general consumer. The decision to work toward such a social goal may be made without consideration of the consequences such action may have on overall health.

The result of all this is that people either make their own risk assessments, relying upon their sense of outrage, or accept the risk assessments of others to a greater or lesser extent, depending on how that risk assessment fits their sense of outrage. A problem arises when those providing the risk assessments have their own points to make, or use subterfuge to win the public to their views.

It therefore is of utmost importance for those involved in agriculture, either as teachers, scientists, extension agents, producers, or government officials, to know the basic principles and premises of risk assessment, to be aware of the pitfalls the general public may be prone to, and to stand ready to provide a rational alternative to spurious or inaccurate information.