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Farm Family Exposure to Pesticides

...a discussion with farm families

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Farm Family Exposure to Pesticides

A Discussion with Farm Families

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Introduction

As farmers and farmers' spouses, you recognize the benefits of using pesticides in your crop and livestock operations, yet you may be concerned about the possibility of adverse effects on your family's health and safety. This publication addresses questions and concerns regarding pesticide risks and explains how risk is evaluated; it directs you to additional sources of information on pesticide toxicity. Data from the Farm Family Exposure Study are reported, showing that farmers and their families who took simple precautions exhibited lower exposure levels than those who did not. Steps to minimize pesticide risks around the farm are emphasized.

The Benefits of Using Pesticides

You know that pesticides play an important role in your crop and livestock operations. You have witnessed the harm done by insects, weeds, and diseases. Yields are reduced when your crops must compete with weeds for space, nutrients, and water. Fruits and vegetables are blemished or damaged by insects and diseases, resulting in reduced market prices, rejection of products, or even the loss of an entire crop; diseased produce can lead to food contamination due to naturally occurring toxins (e.g., aflatoxin). Healthy food requires a healthy crop.

Livestock producers know that cattle under stress from biting flies do not gain weight readily and that dairy cows produce less milk under duress from nuisance flies. Neighbors may complain about livestock operations drawing flies to their properties. Pesticides protect livestock and help maintain good community relations while increasing farm productivity and profitability.

The benefits attributed to pesticides come with a significant price tag. Thousands of dollars of your annual farm budget may be allocated for the purchase of pesticides, depending on the number of cultivated acres, the crops grown, and pest pressure. The high cost of farming—and the low return on your dollar—causes you to analyze the economics of pesticide use versus the adoption of practices to reduce the need. You must continually reevaluate the return on your investment in crop- and livestock-protection chemicals.

No doubt you believe in sustainable agriculture and evaluate your production practices accordingly. You respond to consumer demand by implementing environmentally sound practices to produce safe, healthy foods. You want to leave the legacy of an ecologically sound, productive farm to your children.

Fred Whitford

...leave the legacy of an ecologically sound, productive farm to your children

Many of you use nonchemical pest management methods whenever possible; but if a pesticide is required, you try to use the lowest effective application rate to demonstrate good stewardship and save money. When the application rate is lowered, less chemical is used and dollars are diverted from the farm to the family.

Farmers are increasingly cutting back or eliminating certain pesticide uses by adopting integrated pest management and other sustainable-agriculture practices. These include planting insect-resistant crops to minimize insecticide use, planting narrower rows to reduce weeds, planting disease-resistant varieties, rotating crops to disrupt disease cycles, leaving buffer strips to protect streams, and rotating the use of pastures for grazing. Nonetheless, pesticides continue to play an important role in managing pests, especially those emerging as serious threats to livestock or crops (e.g., soybean rust, left). Pests always have been and always will be a threat to the food supply and farmers' profit.

Tim McCabe, NRCS, Iowa

Scouting is an important component of Integrated Pest Management

Soybean Rust

Soybean rust is a foliar disease that can quickly defoliate plants. Airborne spores land on soybean leaves and, in the presence of dew, germinate and infect. About 9 days later, pustules develop on the underside of the leaf blade (inset, left). Individual pustules are small and produce many spores. A severely infected leaf may contain hundreds of pustules. At this stage, the leaf will turn yellow and drop from the plant (left). The fungus is a parasite. As it grows and produces spores on the leaves, it diverts nutrients from the soybean plant that would otherwise go into seed production. Yield reductions from rust can be substantial, as much as 80 percent.

All varieties of soybean suitable for production in the U.S. are susceptible to rust; planting date, tillage, and crop rotation have no effect on it. Application of a foliar fungicide is the only means of control. There are several fungicides that will provide effective control if applied at the right time. Application just before infection gives best control, but application when infection is still at a very low level in a field is also effective. A "very low level" means rust is on no more than 5 percent of the leaves in a field. At this low incidence of infection, most infected leaves will have only one or two pustules. Detection of such a low incidence of disease is difficult. Growers should keep in touch with county extension offices for the latest information on soybean rust, including spray recommendations, during the growing season. County extension staff and campus specialists will monitor rust development in the southern U.S. (the source of airborne spores for the Midwest), weather conditions, and sentinel plots throughout the state in order to advise growers on what actions they need to take to manage this disease.

Photographs and soybean rust information compliments of Dr. Gregory Shaner, Department of Botany and Plant Pathology, Purdue University.

Personal Concerns About Using Pesticides on the Farm

As a farmer, you are well aware of the benefits of pesticides; but you may be less knowledgeable on the human health effects pesticide use can impose. Consider these questions:

- Do pesticides get on or into our bodies?
- Are pesticides harmful to us?
- Can we prevent pesticide exposure?

You no doubt hear news stories that raise concerns about the harmful effects of pesticides on human health. Expert opinion is divided and passionate: some say there is much risk; others say there is little. The bottom line is, there is always some level of risk associated with pesticide use.

What farm women want to know about pesticides

It is unsettling to recognize the need to use pesticides despite your uncertainty about possible effects on your family's health. It is well documented that pesticides are handled differently from one farm to the next. Some farmers wear chemical-resistant gloves when handling pesticides; some do not. Some farm children help with pesticide applications; others do not. Some farmers pour pesticides directly into the sprayer; others do not. Some use large quantities; others do not. The answers to pesticide safety questions are directly related to how you handle the chemicals.

Are Pesticides Risky?

The health risk associated with any chemical product is a function of its toxicity and the extent of exposure; simply stated, pesticide risk equals toxicity times exposure. Therefore, understanding toxicity is important; and it is critical to consider the amount to which you are exposed, the length of time you are exposed, and the way you are exposed (i.e., by ingestion, inhalation, or dermal absorption).

Another way of looking at this relationship is to consider the cancer risk from radiation. Like pesticides, radiation is derived from many sources. It is present in the ultra-violet (UV) rays from the sun, in medical X-rays, and in radon gas emitted from naturally occurring metals in the earth. Radiation causes some types of cancer. The various types of radiation are toxic in varying degrees—x-rays are extremely harmful, while UV rays are less harmful—and the type of radiation exposure determines the type and severity of its harmful effects. Minimizing exposure by spending less time in the sun or tanning booth, limiting the number of chest x-rays you have, and making sure your home is protected from radon is important in reducing your cancer risk.

Are pesticides harmful to us?

Pesticide Risk = Toxicity x Exposure

YOU Control Exposure

Pesticide risk equals toxicity times exposure. Your personal risk from a pesticide depends on the toxicity of the product you are using and the amount and form of exposure you experience; likewise for each member of your family. The lower the toxicity and/or exposure, the lower the risk. Choose pesticides with low toxicity whenever possible, and always minimize exposure by wearing protective clothing.

Risk, to the scientist, is a continuum from low to high—not an absolute. Scientists and government officials address risk in terms of probability for populations or individuals. The critical question is whether the risk is real to you, to the people you care about, or to the things you value in nature and society.

Certain farm pesticide use activities are riskier than others. For example, pouring a pesticide concentrate into the spray tank is riskier than walking into the treated field to scout for insects; that is, exposure to the concentrate is more likely than contact with the treated crop to cause personal health effects. The level of risk associated with handling concentrates is lessened if the handler wears a long-sleeved shirt, gloves, and goggles; and using a transfer hose to move the pesticide directly from the minibulk container to the sprayer is a significantly safer procedure than pouring.

Gloves

Goggles

Long Sleeves

Long Pants

Chemical-Resistant Footwear

Fred Whitford

Research demonstrates that your degree of personal exposure is directly related to how you handle a pesticide. Your risk potential—and your family's—can be dramatically reduced by using safety precautions and following label directions.

Your degree of pesticide exposure is a reflection of how you handle the pesticide

Toxicity: What Is It?

Scientists have known for centuries that virtually every chemical, both natural and synthetic, is toxic enough at some level to cause adverse effects. Knowing that precise level of toxicity is important in assessing risk. A small amount of one pesticide might produce a toxic effect, while a much larger amount of another may not. But, at some level, every pesticide has a toxic effect; the same is true for medicines, table salt, gasoline, and household cleaners. The route of human exposure impacts the toxic effect.

The toxicity of a pesticide must be evaluated before it can be registered and sold in the United States. The U.S. Environmental Protection Agency (EPA) requires pesticide manufacturers to conduct numerous toxicity tests to determine the potential effects of each pesticide. Scientists conduct laboratory animal exposure studies to assess toxicity, using various doses of individual pesticides and formulated products. These tests include studies on chronic (long-term) effects such as cancer and reproductive problems as well as studies on acute (immediate) effects. EPA reviews the toxicology and use data for each pesticide. EPA also reviews the manufacturers' safety requirements and precautions for the labels of individual products.

As science advances, EPA considers whether additional tests are needed to evaluate potential problems from the use of pesticides. The recent requirement that manufacturers test pesticides for their ability to mimic human hormones is an example. The process is underway to determine the best way to perform the testing, but it may take the scientific community years to reach a consensus.

Irresponsible.
Illegal.
Inexcusable.

I thought Mom and Dad were smarter than that!

It is important to remember that each pesticide is unique. Every pesticide product used on the farm has its own level of toxicity. Therefore, answers to questions about toxicity must be based on individual pesticide characteristics.

The toxicity of every pesticide is listed on the label. Look for the signal word—CAUTION, WARNING, or DANGER—and read all of the information provided. The Material Safety Data Sheet (MSDS) for each product addresses toxicity and human health, as do various Web sites.

The Label on the Pesticide Container. The signal word on a pesticide label indicates the level of acute (short-term) toxic effects that may occur within the first day or two of exposure. Acute toxic effects generally are associated with brief exposures to chemicals and may include headaches, skin irritation, burns, or even death. The signal word printed in large letters on the front of the label indicates the level of toxicity: CAUTION (low toxicity), WARNING (moderate toxicity), or DANGER (high toxicity).

Another important part of the label is product classification. Restricted-use product labels display the words RESTRICTED USE PESTICIDE above the brand name at the top of the front panel. There is no designation on the labels of general-use products; that is, if the label does not say RESTRICTED USE PESTICIDE, then it is a general use product. Products can be restricted due to either health or environmental concerns.

You must pass a state certification exam to purchase and apply restricted-use pesticides, and your agricultural chemical dealer should ask to see your private applicator certification card before selling them to you. Restricted-use products are more toxic than general-use products, but be aware that a poorly handled general-use product might pose more risk than a restricted-use product that is handled cautiously.

The Material Safety Data Sheet and Other Toxicity Data Sources. The MSDS can be accessed from your local agricultural retailer, the product manufacturer, or the Internet. The MSDS will indicate if tests have shown that the product can cause health effects, including chronic long-term health problems such as birth defects, cancer, or liver disease. Most chronic toxicity data on human health come from animal studies. If occupational epidemiology studies in pesticide manufacturing facilities show adverse effects, those also may be represented on the MSDS. The Web sites listed below also contain chronic toxicity information:

- http://www.epa.gov/pesticides/factsheets/chemical_fs.htm
- http://extoxnet.orst.edu/ghindex.html
- http://www.atsdr.cdc.gov/toxfaq.html
- http://www.aghealth.org
- http://toxnet.nlm.nih.gov

In Review: The Take-Home Message

- **Every pesticide product is toxic at some level.**
- **The more toxic the pesticide, the smaller the amount it takes to cause a health problem.**
- **The toxicity of every pesticide product sold in the United States is tested extensively.**
- **The signal word on the label alerts you to the short-term toxicity of the product.**
- **The MSDS provides information on potential long-term health problems.**

I've never worried much about exposing myself to pesticides. I've worked with them for years and they haven't hurt me. But I never realized that I could carry pesticides into the house on my clothes and boots and expose my FAMILY.

Exposure: How Much Are We Getting?

You and your family are exposed to household cleaners when you clean house and to diesel fuel when you fill the tractor, truck, or combine; but the risk is small. Likewise, there is some degree of exposure and risk every time you use a pesticide. A splash onto unprotected skin while pouring a pesticide or diluting it with water can cause dermal exposure. You may experience direct exposure by inhaling pesticide droplets in an open cab or making contact with the spray mix while repairing clogged nozzles. Indirect exposure is a risk when walking through a treated field, or from touching pesticide-contaminated clothing; and pesticide residues can be tracked into the home on shoes and boots. How much exposure is harmful? It depends on the product's toxicity, the type of exposure, and your individual sensitivity.

How Do Scientists Measure Exposure?

Scientists use several ways to evaluate pesticide exposure, depending on resources and time available, practicality, cost, and willingness of participants.

Estimating Exposure Based on Memory of Past Use. Scientists often study the human health effects of pesticides by surveying people who have used them and identifying specific use conditions. Survey questions may ask about uses that occurred far enough in the past that exposure cannot be directly measured, or they may ask about uses that occurred in the recent past. Someone who reports using a pesticide repeatedly might be considered more highly exposed than a person who reports minimal use. Surveys may or may not include questions on safety precautions such as wearing

gloves when handling pesticides, but inclusion of such information improves the exposure estimate.

Surveys are less costly and less intrusive than measurement studies, but they have limitations. For example, it is often difficult to verify the accuracy of self-reported exposure, especially when estimating exposure to a specific product or formulation used many years ago. These studies often set the stage for more elaborate studies that examine exposure in more detail.

External Exposure Based on Measuring Pesticide Residues. Another common method for estimating human exposure is to measure the amount of pesticide on clothing or skin, or within the breathing zone of the applicator. Patches are placed on the clothes and caps, on either the inside or outside, where they trap residues that reach them. At the end of the exposure period, usually a work day, the patches are analyzed in a laboratory. The amount of pesticide on each patch represents a portion of the amount on the corresponding region of the body. Rinses and wipes are used to measure pesticide residues on the hands, face, and neck. Personal air samplers are used to estimate the amount of pesticide that the applicator inhales. These external measurements allow scientists to determine the maximum amount of pesticide exposure for the individual.

Monsanto

Monsanto

Measuring the amount of pesticide on clothing (left) and on hands (above).

How careful are you?

Scientists can estimate internal exposure based on external measurements by making certain assumptions about how much of the pesticide was absorbed into the body. For example, pesticide residues on an applicator's clothing following an application or after walking through a treated field are measured; based on the total amount, chemists estimate how much pesticide penetrated the applicator's clothes and may have been absorbed by the skin, thereby entering the bloodstream. These exposure estimates are compared with amounts known to cause health problems in laboratory animals.

This type of study also has limitations. It cannot be determined by the patch method exactly how much pesticide enters the body since some amount remains on clothing, some may reach the skin but fail to penetrate it, and some may be ingested through nail biting, smoking, etc. Although patch sampling is not personally intrusive, it is time-consuming for participants and field scientists, and analyses are costly.

Measuring Pesticides in Urine and Blood. Scientists evaluate whether a person has been exposed to a pesticide by measuring its presence in their blood or urine. Pesticides move through the bloodstream into various internal organs. They are filtered from the bloodstream by the liver and kidneys and expelled in urine and feces. Few modern pesticides accumulate in the body (i.e., they are not stored in fat), so blood and urine samples should be taken the day of exposure.

Many pesticides metabolize (break down) into other compounds in the body, and it is these substances—not the pesticides themselves—that can be detected in blood and urine. Animal studies have shown how much of and how quickly a chemical moves through the body and is excreted, and scientists apply that information to estimate human exposure levels based on measurements taken from urine samples. Internal exposure studies have few scientific limitations,

but they are the most costly for funding agencies and the most intrusive for participants.

Combining Measurement Studies with Observation. Measurement studies often include observation of the applicator during mixing, loading, and application. Objective notes and video provide valuable documentation of conditions under which pesticide application, exposure, and spills occur. Blood and urine samples, in combination with field observation data, provide our best insight into the amounts of exposure associated with various pesticide-related activities: mixing, loading, application, and cleanup of spills. Pesticide measurements are matched with the circumstances of exposure, which helps in defining precautions that can be taken to prevent future exposures. The Farm Family Exposure Study, discussed later in this publication, used internal exposure measurements and observation to evaluate farm family exposure to three commonly used pesticides.

Safety is in Your Hands

The risk you face when applying a pesticide is a factor of toxicity and exposure; it depends on how toxic the pesticide is, the route of exposure, and the quantity to which you are exposed. Obviously, the higher the exposure, the higher the risk; but you can take actions to minimize exposure and reduce the risk.

The pesticide label provides critical information on how to minimize risk while using the product. Always read all precautions and wear safety equipment as instructed on the label; these recommendations are based on toxicity studies and application-specific exposure data. Restricted-use products with labels bearing the signal word WARNING or DANGER require more safety gear and precautions than less toxic products labeled CAUTION. The Farm Family Exposure Study documented that taking safety precautions helps reduce exposure and risk in real world farm situations.

In Review: The Take-Home Message

- Exposure and toxicity are critical in defining risk.
- It is difficult to measure a person's pesticide exposure.
- Reducing exposure reduces health risk.

The Farm Family Exposure Study: Real World Exposures

The Farm Family Exposure Study was designed to answer two basic questions:

- How much pesticide exposure do farmers and their families experience from a typical pesticide application on their farm?
- What practical measures can be taken to lessen pesticide exposure?

The University of Minnesota School of Public Health conducted the study with funding provided by a group of pesticide companies.

Ninety-five farm families in South Carolina and Minnesota volunteered to participate under the following eligibility requirements:

- The family included a farmer, spouse, and at least one child between the ages of 4 and 17.
- All participating family members lived on the farm.
- The farmer had to apply glyphosate (Roundup or its generic formulation), chlorpyrifos (Lorsban granules or liquid) or 2,4-D (liquid) to at least ten acres within one mile of the farm home.

Farmers and spouses completed two questionnaires, one before and one after the pesticide application. The questionnaires asked for personal data and farming history as well as information on application practices and recent pesticide use. Each farmer, spouse, and child was required to collect his or her entire urine output for five consecutive days: the day before the pesticide application, the day of the application, and the three days following the application. Methods used to test the urine were capable of detecting pesticide concentrations as low as one part per billion, which can be approximated to one blue kernel of corn among a billion yellow kernels.

Study Results

An important element of the Farm Family Exposure Study was the measurement of pesticide absorption (internal exposure); equal focus was given to all members of the participating families. Resulting levels of absorption were matched with responses to situation-specific questions such as, Was safety equipment worn? and Did family members help with the handling process? The correlation helped identify procedures you and your family might use to reduce or limit pesticide exposure.

Were pesticides absorbed by the body? The answer was yes for most farmers and their families (Table 1). Farmers averaged higher concentrations of pesticides in their urine than did their spouses and children. Most spouses and children had very low or no detectable levels, but a few of the children did have detectable levels. *Overall, results show that pesticides were absorbed by the body.*

Table 1. Measured levels (parts per billion) of three commonly used pesticides in the urine of applicators, spouses, and children

	Glyphosate		2,4-D		Liquid and Granular Chlorpyrifos	
	Average	Range	Average	Range	Average	Range
Applicators	3	<1–233	64	2–2236	19	4–304
Spouses	<1	<1–2	1	<1–20	5	1–35
Children	<1	<1–29	4	<1–640	8	1–119

Table 2 shows the percentage of farmers, spouses, and children whose urine contained detectable levels of certain pesticides. The data demonstrate that some agricultural chemicals impact exposure estimates more than others, and that pesticide use impacts the farm family as well as the farmer.

Table 2. The percentage of applicators, spouses, and children with detectable amounts of pesticides in their urine

	Glyphosate	2,4-D	Liquid and Granular Chlorpyrifos
	Percent Detection	Percent Detection	Percent Detection
Applicators	60	100	100
Spouses	4	67	100
Children	12	89	100

Responses to questions, along with information taken by study observers, revealed that certain actions—or inactions—markedly influenced the level of internal exposure (Appendix 1). It was apparent that certain practices lead to high applicator exposure; for instance, consider the activities and behaviors of the farmer whose urine had the highest level of glyphosate (233 parts per billion). A study observer noted the following:

	Yes	No
• Did the farmer wear gloves when mixing?		✔
• Did the farmer spray from within an enclosed cab?		✔
• Did the farmer have a spill during the mixing process?	✔	
• Did the farmer have a spill during application?	✔	
• Did the farmer have skin contact with the pesticide?	✔	
• Did the farmer repair equipment without gloves during application?	✔	
• Did the farmer use a closed system (e.g., minibulk)?		✔
• Did the farmer smoke during the mixing or spraying process?	✔	
• Did the farmer eat during the mixing or loading process?		✔

The answers indicate that failing to take precautions—e.g., not wearing gloves, not using enclosed cabs, not avoiding spills—leads to increased absorption of pesticides into the body. Observations show that taking some but not all precautions also can lead to significant exposure, as in the case of the farmer whose 2,4-D level tested the highest. The following information was gleaned from a study observer's notes:

	Yes	No
• Did the farmer wear gloves?		✔
• Did the farmer spray from within an enclosed cab?	✔	
• Did the applicator have a spill during the mixing process?		✔
• Did the farmer have a spill during application?	✔	
• Did the farmer have skin contact with the pesticide?	✔	
• Did the farmer repair equipment without gloves during application?	✔	
• Did the farmer use a closed system (e.g., minibulk, Lock and Load)?	✔	
• Did the farmer smoke during the mixing or spraying process?		✔
• Did the farmer eat during the mixing or loading process?		✔

You're tellin' me you didn't even wear gloves?

Even though the farmer rode in an enclosed cab during the application and used a closed system for delivering the 2,4-D from the minibulk container to the spray tank, he did not wear gloves. He used his bare hands to repair the spray equipment, unnecessarily exposing himself to the pesticide. This illustrates that a neglectful attitude toward personal protection can undermine all the advanced technologies for improving farm safety.

The following survey results were reported for the farmer with the highest exposure recorded for chlorpyrifos (304 ppb).

	Yes	No
• Did the farmer wear gloves?		✔
• Did the farmer spray from within an enclosed cab?		✔
• Did the applicator have a spill during the mixing process?		✔
• Did the farmer have a spill during application?		✔
• Did the farmer have skin contact with the pesticide?	✔	
• Did the farmer repair equipment without gloves during application?	✔	
• Did the farmer use a closed system (e.g., minibulk, Lock and Load)?		✔
• Did the farmer smoke during the mixing or spraying process?	✔	
• Did the farmer eat during the mixing or loading process?		✔

These examples suggest that higher exposure occurred when label directions were not followed. Certain practices resulted in increased human exposure levels, but farmers who used safety precautions (Appendix 1) exhibited lower levels of pesticides—or none at all.

Family member exposure was generally low (Table 1); most spouses and children had low or no detectable exposure levels. Study results revealed that children who helped handle pesticides had levels in their urine well above those of their siblings who did not handle pesticides. Parents of children who help handle pesticides must make sure they follow label precautions to minimize exposure. The study also showed that children and spouses who were around the application, even if they did not actually handle the pesticide, had higher levels of pesticides in their urine than did those who were not in proximity. The children of farmers who demonstrated certain handling practices often showed higher levels of pesticides

I wonder if my daddy smokes when he's working with pesticides....

Mom, Dad... you have to watch out for me 'cause I have a whole other agenda...

in their urine. The results suggest that your children need training and supervision to handle pesticides, even if you deem them old enough and mature enough to handle the responsibility; and it is important for you to teach them to follow recommended precautions to minimize exposure.

What Does This Mean?

The results of the Farm Family Exposure Study indicate that exposure to chlorpyrifos, glyphosate, and 2,4-D is likely to be low for farm family members who do not actually handle or apply the chemicals. Keep in mind that even though this study measured only three compounds, the results for other pesticides probably would be similar. One could construct thousands of scenarios using "what if" questions to argue whether exposure is harmful. However, we would all agree that preventing exposure safeguards our health. The men, women, and children who exhibited low levels of pesticides are less likely to experience adverse effects than those who tested higher. Remember the equation:

RISK = TOXICITY x EXPOSURE

Results of the Farm Family Exposure Study demonstrate how variable exposure to a pesticide can be. The data begin to define actions that you and your family can take to reduce pesticide exposure on the farm.

Reducing Exposure: What You Can Do

Despite the good news that most levels of pesticide exposure in the study were low, you and your family can take steps to reduce them. The Farm Family Exposure Study sheds new light on measures you can take to minimize your family's chemical exposure on the farm.

Keep a lid on exposure

Protect your family by following these guidelines

- Minimize young children's exposure. You should value teaching your children how the farm operates and demonstrating the hard work that goes into managing it. It is important for them to learn tasks appropriate to their age and maturity level, under your supervision.

  But young children should not help adults handle pesticides. The mixing, loading, and application areas should be off limits. Young children should not be allowed to touch pesticide containers or pesticide application equipment on the day of application. As your children mature, you need to determine when each one is responsible enough to help in the handling of pesticides.

How old is

old enough

to handle pesticides?

- Train young adults to respect pesticides when they help with mixing and field applications.

  The exposure study showed that children who helped with applications had substantially higher levels of pesticides in their urine than children who did not participate in application procedures. Remember that the amount of pesticide exposure your children experience reflects how careful you and your spouse are—or are not—when using pesticides. You are responsible for your children's safety as well as your own.

  Children need to be taught the risks of pesticides and the importance of wearing safety equipment when handling them. They need to learn that pesticides must be respected and that precautions are necessary to ensure their own health and safety. This is really no different than teaching your children about the potential dangers of other farm operations. Always remember, children are most likely to learn from your example.

- Wear chemical-resistant gloves when using any pesticide. The importance of wearing chemical-resistant gloves when handling pesticides has been discussed with farmers since the inception of the private applicator certification program in the late 1970s. Their effectiveness in reducing exposure has been the subject of the agricultural press, university extension educational programs, and numerous farm broadcast programs. Despite this information, farmers frequently either forget or choose not to wear gloves; some argue that gloves are too cumbersome and inconvenient.

  You may think that wearing gloves when *mixing* pesticides is enough. But the study showed that farmers are exposed significantly while cleaning up spills and repairing equipment

without wearing them. Neglecting to wear chemical-resistant gloves allows direct pesticide-to-skin contact and absorption of pesticides into the body.

- Wash hands before eating or smoking. It is important to have clean water and soap available—on the sprayer or otherwise accessible—to facilitate washing your face, hands, and arms immediately after using pesticides. Wash the gloves while still wearing them, then remove them and wash your hands and arms thoroughly, even if you are wearing a long-sleeved shirt. Do not smoke when handling pesticides because the chemicals can be transferred from your hands, to the cigarette, to your mouth.

- Use closed-system transfer systems. Agricultural pesticide manufacturers provide many alternatives to the standard 2.5-gallon jugs of liquid and bags of granules. There are minibulks with pumps that meter the product into the spray system, thereby reducing exposure potential and spillage, as well as splatter-proof jugs, water-soluble bags, and boxes of insecticide designed for locking onto the planter so that you never have to open the container.

- Wear the safety equipment mentioned on the label. Chemical-resistant gloves probably are your single most important piece of safety equipment, but there are times when additional equipment is required. Consult each product label to determine what you need. When you tank-mix more than one product, multiple pieces of personal protective equipment may be necessary; i.e., you are required to use the safety equipment specified on all labels combined. These may include chemical-resistant gloves, goggles, a respirator, a long-sleeved shirt, long pants, and/or chemical-resistant boots.

Wash with gloves on, remove gloves and shirt, wash hands and arms thoroughly.

Closed-system transfer systems reduce exposure potential.

Three photos by Fred Whitford

Mom, do your boots have pesticides on them?

Do not park spray equipment where children might access it.

What Are Other Studies Finding?

Other studies have identified additional important steps to reduce exposure:

- Do not wear contaminated clothing into the house. Your children may not be allowed near your pesticide mixing area or in the field, but they can be exposed to pesticides carried into your home on the clothing and boots you wear when using farm chemicals.

- Turn protective clothes inside out as you remove them. That way, whoever washes the clothes will handle the inside of the cloth instead of the more contaminated outside surface.

- Keep nitrile gloves with your tools. Handling screws and other small objects during maintenance of your spray rig can be difficult with heavy rubber or neoprene gloves. Disposable nitrile gloves can be used once for in-field repairs, then thrown away.

- Do not wear contaminated gloves in clean areas, and do not touch contaminated areas without gloves. For instance, if your tractor has a cab with filtered air, consider it a clean area and not wear gloves when driving. If it is an open tractor and spray gets on the controls, wear chemical-resistant gloves for driving but do not wipe the sweat from your forehead with them.

- Consider the spray equipment contaminated until it has been washed after use. Do not park it in an area where children might access it, nor where rain could cause the chemicals to run off onto an area children might enter.

Conclusion

Pesticides are expensive, but they pay for themselves in terms of crop and livestock production. You know your cost of pesticides per acre, your average yield with and without pesticides, and the difference in terms of profit. If you raise livestock, you realize the importance of animal stress relief and pasture management that pesticides provide. Ultimately, your farm records confirm that your productivity and profit are increased through the use of pesticides. They boost your profit margin.

Health concerns are not as easily measured. How can the farm family benefit from using pesticides without risking illness or injury in the process? One way to prevent possibly harmful effects is to take every step to minimize or eliminate pesticide exposure.

Risk is unavoidable

Reducing risk is often simpler than you think

Don't put contaminated gloves in the cab of your truck.

Black electrical tape? Are you kidding me? Don't try to repair damaged gloves.

Three photos by Fred Whitford

Each year, a few farmers are hospitalized with pesticide poisoning; conditions range from severe rashes to blindness. Death, while infrequent, can occur. The Farm Family Exposure Study showed that ignoring safety requirements on labels and performing routine tasks—such as tending to a spill or repairing application equipment—without wearing gloves increases your level of exposure. Repeated pesticide exposure increases your risk.

The bottom line is that you can take precautions to protect yourself and your family from pesticide exposure. Always read pesticide labels and wear safety equipment as indicated. Practice the principles of exposure prevention, and you will experience the personal satisfaction of knowing you have helped to keep your family safe.

The Agricultural Health Study...

...is a major long-term study of farmers (and their families) who apply pesticides in Iowa and North Carolina. Currently, researchers are investigating the role that chemical exposure and activities such as smoking have on the potential for cancer and other illnesses among farm families. Investigators at the National Cancer Institute, the National Institutes of Environmental Health Sciences, and the United States Environmental Protection Agency are conducting the study.

Results of this population study, in combination with laboratory research, will greatly increase our understanding of farmers' potential health risks. As more data are released, follow-up reports will address whether or not cancer and other diseases are more prevalent among farm families that use certain pesticides. More information on the Agricultural Health Study is available on the Internet; go to this Web site: http://www.aghealth.org. A series summarizing the Agricultural Health Study is available from the North Carolina Cooperative Extension Service at http://extension.tox.ncsu.edu.

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Consult www.btny.purdue.edu/PPP for a complete listing of Purdue Pesticide Programs publications.

Appendix

Measured amount (parts per billion) of detectable pesticides in the applicator's urine, based on activity and behavior patterns recorded by a third party

		Liquid Glyphosate Exposure (ppb)		Liquid/Granular Chlorpyrifos Exposure (ppb)		Liquid 2,4-D Exposure (ppb)	
Question Asked by the Observer		**Average**	**Range**	**Average**	**Range**	**Average**	**Range**
Did applicator use rubber gloves when mixing?	Yes	1	0–66	22	7–179	44	2–1709
	No	10	0–233	24	6–304	236	21–2236
Did the tractor have an enclosed cab?	Yes	2	0–10	20	6–125	61	2–2236
	No	6	0–233	29	9–304	81	4–1709
Did the applicator have a spill during the mixing process?	Yes	7	0–233	25	6–179	52	7–293
	No	3	0–101	22	7–304	76	2–2236
Did the applicator have a spill during application?	Yes	9	0–233	28	6–179	205	20–2236
	No	2	0–66	21	7–304	55	2–1320
Did the applicator have skin contact with the pesticide?	Yes	9	0–233	26	8–304	189	20–2236
	No	2	0–51	21	6–179	30	2–439
Was the spray equipment repaired during application?	Yes	7	1–233	32	8–304	184	33–2236
	No	2	1–66	20	6–179	40	2–1320
Did the applicator use a closed system?	Yes	3	0–66	22	12–41	44	2–2236
	No	3	0–233	24	6–304	74	2–170
Did the applicator smoke during while mixing or spraying?	Yes	7	0–233	41	11–304	107	4–1320
	No	4	0–101	20	6–179	60	2–2236
Did the applicator eat during the mixing and spraying operations?	Yes	17	0–29	20	8–86	140	24–310
	No	3	0–4	24	6–304	66	2–2236

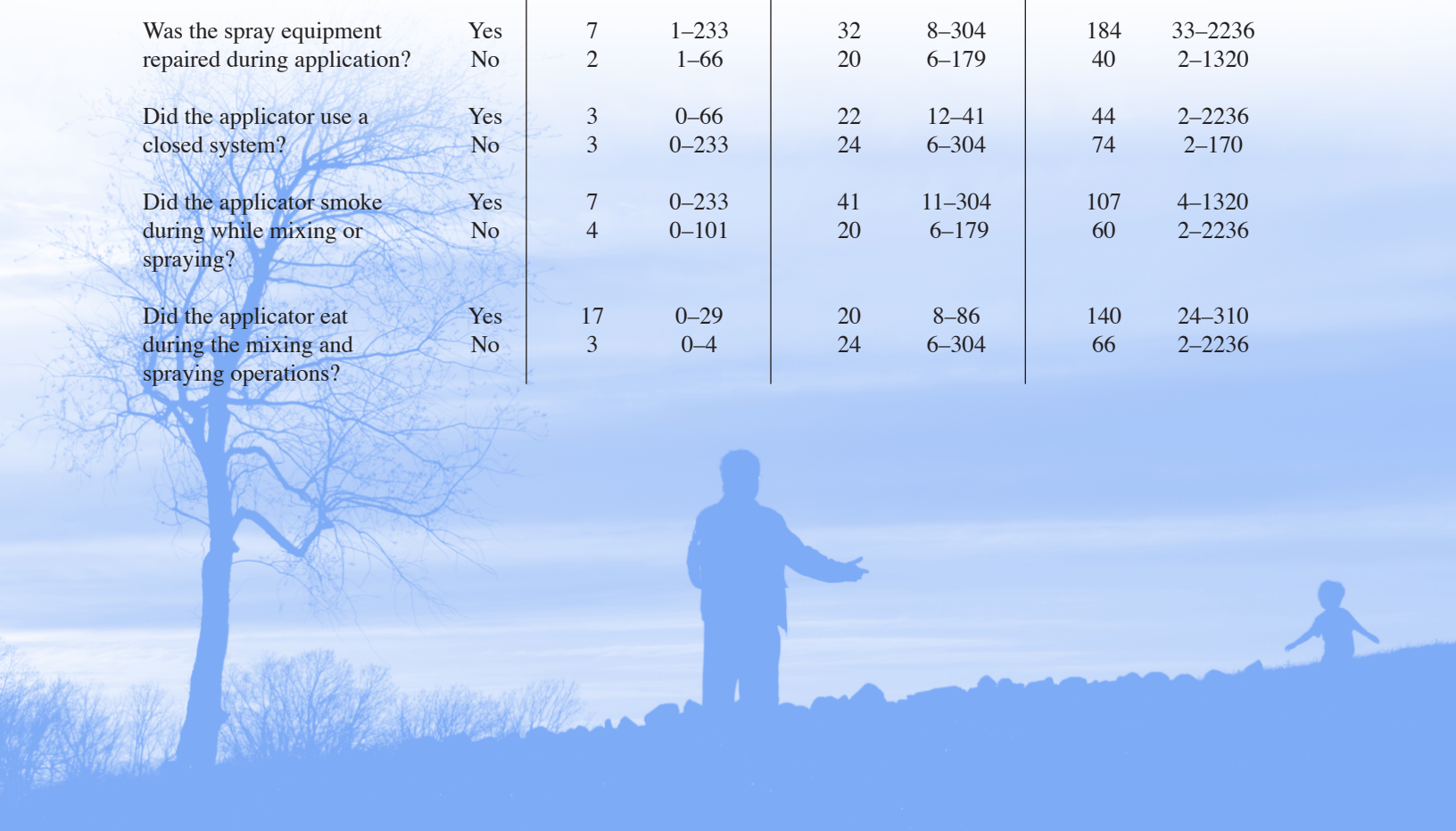

Photo by Margo Fry-Schutt

Pictured are representatives of four generations of the Charles Fry family of Warren County, Indiana. The farm has been in the Fry family since 1864.

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