

## TOPICS

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Laundry habits

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exposure

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## *Farm Family Pesticide Exposure: New Pathways for Understanding Risk*

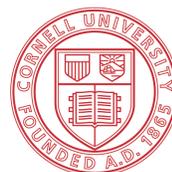
Exposure to agricultural pesticides can pose significant health risks to farmers and their families. An understanding of exposure is needed for scientists to be able to draw firm conclusions about the health effects of pesticides. How is exposure occurring? How much chemical is entering the body? How can exposure be minimized? To address these questions, scientists are now undertaking detailed exposure assessments on populations of agricultural workers. Exposure assessments aim to provide accurate estimates of pesticide exposure. Research is focusing on exposures to pesticide applicators, farmers and their families, the indoor environments of farm households, and other agricultural workers and non-farm rural community residents. This fact sheet focuses on exposure assessment in farming communities, including how exposure occurs, how it is measured, and what farm families can do to minimize their exposure to pesticides.



### **Program on Breast Cancer and Environmental Risk Factors (BCERF)**

College of Veterinary Medicine  
Vet Box 31  
Cornell University  
Ithaca, NY 14853-6401

Telephone: 607 254-2893  
Fax: 607 254-4730  
Email: [breastcancer@cornell.edu](mailto:breastcancer@cornell.edu)  
Web: <http://envirocancer.cornell.edu>



**Cornell University**

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### What is exposure assessment?

Exposure assessment is a study or series of studies designed to answer the following questions for a particular substance, chemical, or group of chemicals:

- Who or what is exposed (e.g., workers, residents, birds, fish, etc.)?
- Does exposure occur through breathing air, eating food, drinking water, skin contact or other routes?
- How much exposure occurs?
- How often and for how long does exposure occur?

Exposure assessments are one part of the risk assessment process. Together with a hazard assessment, which characterizes a chemical's harmful effects at different levels of exposure, conclusions can be drawn about the possibility of harm to a population.

### Exposure pathways: How does exposure occur?

Scientists study exposure pathways in order to better understand where exposure begins and ends, and how people come into contact with a substance. Pesticides may take many pathways before making their way into a person's body. For example, pesticides may travel by water, air, soil, dust, animals, equipment, clothing, and other more specific pathways.

#### Take-home exposure pathway

Recent findings indicate that a take-home exposure pathway exists, meaning that farmers and agricultural workers may take pesticide residues into their homes on their clothing and bodies after applying them outdoors. Pesticides in samples of house and automobile dust, floors and carpets, and in urine samples of children of agricultural workers provide clues that a take-home pathway exists. Outside, pesticides can be degraded from exposure to sunlight, water, or microbes in soil. In

the home, however, these degradation agents are limited. Pesticides tend to break down more slowly and can persist and accumulate indoors.

#### Pesticide drift and distribution of pesticide residues in the home

In addition to the take-home pathway, agricultural pesticide drift (movement through the air) and use of pesticides in the home present additional exposure pathways to farm families beyond those directly related to applying pesticides in agricultural work. One study conducted in Washington State found that pesticide spraying over the course of a year in an agricultural area increased pesticide exposure both in children whose parents had no occupational contact with pesticides and also in those whose homes were not considered to be near pesticide-treated farmland. Thus, pesticide drift in some agricultural areas can contribute to pesticide exposure in families who do not live on farms or even directly near other farms.

Household cleanliness also appears to be an important factor for pesticide exposure. Pesticides used in the home to control insects and rodents can contribute significantly to farm family exposure. In one study, agricultural pesticides were used in nearby fields, and household pesticides were used indoors in some homes. Both kinds of pesticides were found on children's hands and toys. The highest levels of household pesticides were found in homes that were judged by the study to be 'difficult to clean' due to clutter or other factors.

A recent study was done on the distribution of pesticide residues within homes, including rural farm households, in central New York State. Results provided evidence that pesticides likely make their way into homes by being tracked in on boots, shoes, and pets. Pesticides may also enter the home on dust particles that make their way through open windows and doors, especially in the summertime. Levels of pesticide residues were highest on carpet and lower on smooth floors. Levels in carpet were particularly high in rural farm households where the farmer was a certified pesticide applicator. Results of the study also showed that pesticide residues, once in the home, can become redistributed inside the home, spreading around to new areas and surfaces. This spreading can occur as the result of activities such as walking, sweeping, vacuuming, and playing on the floor. In the study, there

was evidence that redistribution of residues around the home also occurred when pesticides volatilized into the air and re-deposited onto new surfaces.

### **Biomonitoring: How exposure is measured in people**

Biomonitoring directly measures chemical levels in the human body. Blood, urine, and saliva samples are often used. Dermal exposure assessment methods are also being developed because skin exposure accounts for the majority of pesticide exposure in work settings. Sampling for skin exposure can be done by pressing hands on indoor (carpet, furniture) or outdoor surfaces, attaching gauze patches to skin or clothing, or measuring how much soil sticks to the skin. Methods also include rolling foam across exposed skin and using fluorescent tracers deposited on the skin to highlight exposed and unexposed areas. Many of these methods only measure transfer of chemical to the skin surface. Currently, work is being done so that these methods can reliably estimate chemical levels in the body as a result of skin exposure.

#### ***What are biomonitoring studies telling us?***

Biomonitoring studies are providing a wide array of new information about how people are exposed to pesticides in different situations. Children's exposure studies and farm family exposure studies, among others, are providing more accurate estimates than ever before on the extent to which these groups are exposed to agricultural pesticides. This information can be used to change practices and reduce exposure.

#### ***Monitoring children's exposure to pesticides***

In Washington State, Dr. Richard Fenske and colleagues have been conducting exposure assessments and biomonitoring studies for over a decade on pesticide

exposures of farm workers and their families, focusing in particular on children. In one study, these researchers compared chemical exposure in children who lived with agricultural pesticide applicators to children who lived in the same agricultural community but who did not live with pesticide applicators. Urine samples were analyzed to determine exposure to organophosphate (OP) pesticides. The study found that children of applicators had higher exposure to OP pesticides than did other children, and that younger children experienced higher exposures than did older children. In other studies, these researchers found that higher levels of OP pesticide metabolites were found in children whose parents used pesticides in the garden. Lower levels were found in children who ate organic diets as opposed to conventionally grown food.

#### ***Monitoring farm family exposure to pesticides***

In another study, urine sampling was done among farmers who apply pesticides, and their spouses and children. Results showed that these farmers and some of their children had higher pesticide levels in their urine than the general US population, but their levels were the same as or lower than people exposed to the same chemicals in other types of work, such as forestry. Levels of pesticides in the spouses of these farmers were not elevated and were similar to those of the general US population. One complicating factor in this study was that the



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farmers were observed and videotaped during their applications, so they may have altered their normal practices, knowingly or unknowingly. Further studies will need to confirm these findings using different methods. In the Farm Family Exposure Study conducted in South Carolina and Minnesota, glyphosate (the active ingredient in the commonly-used herbicide Roundup), was measured in the urine of 48 farmers, their spouses, and their children (aged 4-18). The study showed that

farmers who did not wear rubber gloves had significantly higher average urinary glyphosate concentrations than those who did.

### Monitoring pesticide applicator exposure

In a study of pesticide applicators in Ohio, saliva was tested for concentrations of the herbicide atrazine. Results showed that concentrations of pesticide in saliva on days the herbicide was sprayed were significantly higher than on non-spray days.

### What is the Agricultural Health Study finding out about exposure?

The Agricultural Health Study (AHS) is the largest health study ever done on the agricultural community in the US. The study started in 1993 and includes most of the farms in both Iowa and North Carolina. Almost 90,000 people participate in the study, approximately one-third of whom are women. Commercial and private farm pesticide applicators (97% male) are also included. A variety of findings are emerging from the AHS, including new insights on pesticide application methods, high exposure events, and pesticide safety.

#### *Application method affects pesticide exposures*

AHS results showed that for crop, livestock, and fumigant pesticide application methods, exposure varies according to the method used. For crop applications, the lowest exposures resulted when using aerial methods, seed treatment/granules, tractor booms, and in-furrow or banded methods. In contrast, hand spray guns, air blast, mist blowers, and backpack sprayers resulted in the highest pesticide exposures. For livestock

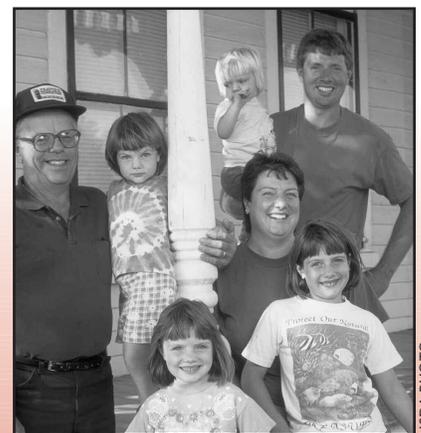
applications, ear tags and injections resulted in the lowest exposures, while liquid baths, sprays, and dips resulted in higher exposures, and powder dusting resulted in the highest exposures. With fumigants, gas canisters and row fumigation resulted in less exposure than liquid fumigant that was poured by applicators.

#### *Factors contributing to high pesticide exposure events*

In the AHS, applicators were asked to report whether they had ever experienced at least one 'incident or experience while using any pesticide which caused an unusually high personal exposure.' A large majority (86%) of farm and commercial pesticide applicators reported never having experienced a high pesticide exposure event. However, over 8,000 (14%) farm and commercial applicators in the study reported experiencing a high pesticide exposure event at some point in their career. These applicators reported that they more often repaired their own equipment, delayed changing their work clothes or delayed showering after pesticide use, and stored pesticides in their home. Those who experienced high pesticide exposure events were more likely to have applied pesticides within 100 yards of the home, mixed pesticides near (< 50 yards) a well, and included work clothing in with other family laundry. Farmers who believed that high risks are part of the job, or whose farms were in financial stress, were about four times more likely to experience high pesticide exposure events. Five pesticides (alachlor, 2,4-D, trifluralin, atrazine and phorate) accounted for most of the high pesticide exposure events. This may be due to apparent or memorable symptoms associated with these pesticides.

### To what extent are the spouses of farmers exposed to pesticides?

The AHS is the largest farm exposure study to take into account the spouses of farmer applicators. AHS results reported that a majority (51%) of farm wives work in the fields during the growing season, while a smaller portion work in the fields more than 30 days a year. A substantial proportion of farm wives are active in working with pesticides, with 40% reporting that they have mixed or applied pesticides, and just under half (46%) have done so for more than 10 years. The heaviest users (10%) reported lifetime use of three or more agricultural pesticides in addition to common use of residential pesticides. More detailed information on exposure estimates for these spouses of farmers is currently being compiled by AHS researchers and will be published in the future.



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### **How much exposure is occurring? Exposure estimates for farmers and applicators**

Average work-day and lifetime exposure estimates were calculated for Iowa and North Carolina farmers in the AHS. Researchers collected data from about 100 farmers who applied the pesticides 2,4-D or chlorpyrifos on their farms using either tractor boom spray, banded/in-furrow, or hand spraying methods. Samples were collected over a 5-day period before, during, and after pesticide applications and included personal air samples collected from a pump worn on the shoulder, daily urine samples, skin exposure samples using hand wipes, and gauze patches attached to clothing. Samples from spouses and children were also collected. Results are still being compiled, but preliminary findings show that farmer applicators in both North Carolina and Iowa have higher average work-day exposure estimates than commercial pesticide applicators. However, commercial applicators tend to have more lifetime application days using these chemicals, and therefore higher estimated lifetime exposure than farmer applicators.



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### **Understanding pesticide exposure in farm children**

Studies are showing that children living on farms experience higher exposure to pesticides than non-farm children. Concentrated pesticide formulations in high volumes are often used near the farm home. Also, a majority of older children living on farms actively participate in farm work. Results from the AHS show that over half of girls and over two-thirds (70%) of boys older than 11 years participate in farm activities (pesticide-related activities not specified). There are many ways in which children need to be considered differently from adults when thinking about pesticide exposure.

### **Children's exposures are different than those of adults**

Young children have different diets and patterns of activity compared to adults. Toddlers are more likely than older children to come into direct contact with dust and soil (by touching or licking) due to their smaller stature and natural behaviors (crawling, teething, etc.). Since children are smaller, concentrations of pesticides or other chemicals are likely to be higher in children than in adults. Children are more susceptible to risks from pesticide exposure than adults because their metabolic and immune systems are less developed.

#### **Estimating children's pesticide exposures: Hand-to-mouth soil transfer**

To more accurately estimate pesticide exposure in children, hand-to-mouth transfer of dirt and soil has been simulated using adult volunteers. In one study, activities included 'thumb sucking, finger mouthing, and palm licking' soiled hands in a systematic manner. Results were then compared to video of farm worker children between the ages of 2 and 4. These children exhibited an average hand-to-mouth contact of 2 to 8 times per hour, with a maximum in one individual of 46 contacts per hour for a single hand. Together with information about pesticide levels in soil, researchers can better estimate pesticide exposure in children using similar methods.

#### **Estimating children's pesticide exposures: Tracking activities on the farm**

Another innovative method uses geographic positioning systems (GPS) and geographic information systems (GIS) to collect and map data that represent real-life exposure situations. In one study, GPS units were attached to fleece vests or bib overalls worn by children in order to collect information about where the children were likely to spend time in relation to pesticide treated

areas, or 'hot spots.' GPS units provided time and location data that was then entered into a GIS computer-based mapping system. When tested, this method provided reliable information on where the children were spending time in their homes, yards and neighborhoods. Pesticide exposure estimates were not made in this study. However, researchers expect that, in the future, this method will be useful for obtaining more accurate estimates of children's pesticide exposure in agricultural areas, and other areas of concern.

### How can farm families minimize their exposure?

Exposure depends on a variety of factors, many of which farmers, applicators and their families have personal control over. For example, farmers may be able to make choices about the types of pesticides and application methods they use, the personal protective equipment they use, and the condition of their equipment. In the home, farm families can make changes in their laundry methods, hygiene, and housecleaning habits, and even the types of materials used in home design and decor to minimize exposures to themselves, children, and pets. Many of the protective measures that apply to applicators can be used by all farm family members to reduce exposures.

#### *Reduce pesticide use with Integrated Pest Management (IPM)*

On farms and in homes, many people are using Integrated Pest Management (IPM) methods to reduce or eliminate the need for pesticides. Agricultural IPM is an approach to crop protection that integrates key activities for pest reduction and pesticide minimization. These activities include anticipating possible pest control issues, taking preventative measures

to reduce pest infestations, monitoring and managing pests, and implementing pest control methods when necessary while minimizing use of pesticides to the extent possible. In homes and other non-farm locations, community IPM methods are also being used to effectively control indoor pests, such as insects and rodents. Keeping food preparation and other areas clean and removing pests manually are two of the main ways to reduce the need for pesticides indoors. For more information on IPM approaches, see BCERF fact sheet #31 or visit the New York State IPM program website (<http://nysipm.cornell.edu/>).

### Can indoor exposure decrease when pesticides are no longer used?

There are reports of decreased indoor exposure associated with the discontinuation of pesticides. Parathion is one example. Parathion concentrations in house dust decreased 10-fold between 1992 and 1995 in central Washington State, which is consistent with the discontinued use of products containing parathion in this region in the early 1990s.



KEITH BROFSKY/PHOTODISC GREEN/GETTY IMAGES

Exposure to pesticides through the skin is now recognized as more common than through ingestion or breathing. Hands receive a significant amount of exposure, so wearing gloves should be a primary precaution. The head, face, ears, scalp, and upper body receive the most exposure during air blast spraying, as do the fronts of legs and feet. In one study, the rate of absorption of the insecticide parathion was measured in different parts of the body. The scalp, ear canal, and forehead showed some of the highest rates of absorption. In men, the scrotum was the most vulnerable to pesticide absorption; parathion was absorbed 100% through the scrotal tissue. Exposure varies, however, depending on the work activity. One study showed that workers involved in pesticide mixing received the most exposure on the inside of the forearm, while applicators received the highest exposure on the outside of the forearm.

### Reducing pesticide exposures: Protecting yourself and your family

Farmer and commercial applicators should always follow standard pesticide safety practices to protect themselves and their families from pesticide exposures. Routine personal hygiene such as washing hands and bathing after work are always important. In addition to these standard practices, care in how work clothing is handled and laundered are also important in minimizing potential pesticide exposures.

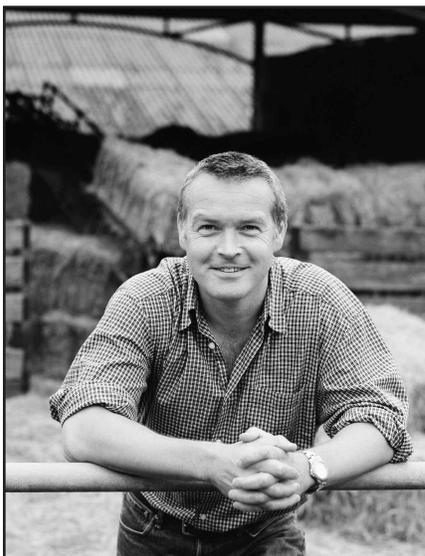
#### *Pesticide safety practices*

Anyone mixing or applying pesticides should always read the label completely before use

and follow all instructions each time. Directions on the pesticide label for wearing protective clothing and using personal protective equipment should always be followed. The US Environmental Protection Agency's Worker Protection Standard (WPS) (<http://www.epa.gov/pesticides/health/worker.htm>) provides information on standard pesticide safety practices and requirements for agricultural workers and their employers. Research studies on protective clothing have found that heavy cloth, such as denim, and Scotch-guarding provide additional protection from some chemicals. Gloves and boots can be worn inside shirtsleeves and pant legs to prevent spilled liquids from contacting skin. Leather is highly absorbent and resists being cleaned, so leather gloves, boots, hats and hat rims should be avoided. Disposable pesticide application clothing may provide additional protection.

#### **Loads of Laundry: Wash it out**

Changes in laundry washing habits can help minimize pesticide exposure to applicators and their families. Pre-rinsing clothing has been shown to remove some pesticide residue prior to washing and can be done by hosing down clothes outdoors, soaking them in an appropriate container, or rinsing and agitating them in a washing machine. The hottest water possible should be used for the most effective pesticide removal from clothing. Multiple washings should be used for especially concentrated or highly toxic pesticides. Built heavy-duty laundry detergents (or 'built detergents'), which contain additional cleaning agents, are best for pesticide-contaminated clothing. Wash contaminated garments together in light loads using full water level to allow for thorough rinsing. During times of daily applications, clothing should be laundered each day. Washing machines should be run empty for a full cycle with hot water and detergent before washing other household items. Line drying in sunlight helps further break down pesticide residues and prevents accumulation of residues in the dryer. For many specific details on laundering pesticide-contaminated clothing, visit the PMEP website (<http://pmp.cce.cornell.edu/facts-slides-self-core-tutorial/index.html>).



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Results from the AHS show that almost all farm families (94%) reported washing work clothes in the same washing machine as the rest of the family laundry, though a large majority (81%) of families reported washing work clothing in separate loads from other laundry. A very small proportion of farmers (4%) use a laundry service or wash their work clothes in a separate machine, and even fewer (2%) only use disposable clothing when applying pesticides. Separating work clothing from other laundry can potentially reduce pesticide exposures.

#### **Conclusions: Reducing farm family pesticide exposures**

Knowing how to minimize agricultural pesticide exposures is important both for farmers and pesticide applicators and also for their families and neighbors. Exposure assessment methods are improving to better understand real-life exposure situations. As exposure measurement improves, scientists will be better able to draw firm conclusions about the health effects of pesticides. To reduce exposure and potential

health risks, farm families can:

- Read the label and follow directions every time before applying pesticides
- Wear the appropriate personal protective equipment, as directed by the pesticide label, when applying pesticides
- Avoid putting soiled hands or fingers in the mouth or eyes
- Change and rinse pesticide application clothing, including boots and shoes, before entering the home
- Change out of work clothes before holding children
- Wash hands before using the restroom, after working, and before eating
- Shower or bathe within one hour of returning home after applying pesticides
- Launder work clothes separately, following guidelines for washing pesticide contaminated clothing
- Launder work clothing frequently to prevent build up of pesticides
- Keep the home clean to avoid build up of dust on floors and furniture
- Use Integrated Pest Management (IPM) methods to reduce or eliminate the need for pesticides. ■

## Resources

For more information on agricultural pesticide exposure, reducing pesticide use and reducing risk, visit these websites:

Agricultural Health Study (AHS)  
<http://www.aghealth.org>

Environmental Protection Agency (EPA)  
Office of Pesticide Programs: Health and Safety  
<http://www.epa.gov/pesticides/health/>

Environmental Protection Agency (EPA)  
Office of Pesticide Programs: Worker Safety and Training  
<http://www.epa.gov/pesticides/health/worker.htm>

New York State Integrated Pest Management (IPM) Program  
<http://www.nysipm.cornell.edu/>

Pesticide Management and Education Program (PMEP),  
Cornell University  
<http://pmep.cce.cornell.edu/>

PMEP Pesticide Applicator Core Tutorial, Cornell University  
<http://pmep.cce.cornell.edu/facts-slides-self/core-tutorial/index.html>

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(BCERF), Cornell University  
<http://envirocancer.cornell.edu>



### Authors:

*Heather Clark, Ph.D., Research Associate, BCERF*

*and*

*Suzanne Snedeker, Ph.D., Associate Director for Translational Research, BCERF*

A complete bibliography of references used in the preparation of this fact sheet is available on the BCERF web site at <http://envirocancer.cornell.edu>

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