# Pesticide Use and Practices in an Iowa Farm Family Pesticide Exposure Study

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## Abstract

*Residents of Iowa were enrolled in a study investigating differences in pesticide contamination and exposure factors between 25 farm homes and 25 non–farm homes. The target pesticides investigated were atrazine, metolachlor, acetochlor, alachlor, 2,4–D, glyphosate, and chlorpyrifos; all were applied to either corn or soybean crops. A questionnaire was administered to all participants to determine residential pesticide use in and around the home. In addition, a questionnaire was administered to the farmers to determine the agricultural pesticides they used on the farm and their application practices. Non–agricultural pesticides were used more in and around farm homes than non–farm homes. Atrazine was the agricultural pesticide used most by farmers. Most farmers applied pesticides themselves but only 10 (59%) used tractors with enclosed cabs, and they typically wore little personal protective equipment (PPE). On almost every farm, more than one agricultural pesticide was applied. Corn was grown by 23 (92%) farmers and soybeans by 12 (48%) farmers. Of these, 10 (40%) grew both soybeans and corn, with only 2 (8%) growing only soybeans and 13 (52%) growing only corn. The majority of farmers changed from their work clothes and shoes in the home, and when they changed outside or in the garage, they usually brought their clothes and shoes inside. Applying pesticides using tractors with open cabs, not wearing PPE, and changing from work clothes in the home may increase pesticide exposure and contamination. Almost half of the 66 farm children less than 16 years of age were engaged in some form of farm chores, with 6 (9%) potentially directly exposed to pesticides, while only 2 (4%) of the 52 non–farm children less than 16 years of age had farm chores, and none were directly exposed to pesticides. Farm homes may be contaminated with pesticides in several ways, resulting in potentially more contamination than non–farm homes, and farm children may be directly exposed to pesticides through farm chores involving pesticides. In addition to providing a description of pesticide use, the data presented here will be useful in evaluating potential contributing factors to household pesticide contamination and family exposure.*

**Keywords.** *Pesticides, Agriculture, Exposure factors, PPE.*

Farmers in the U.S. are the biggest users of pesticides, applying some 944 million pounds in 1997; herbicides made up 470 million pounds of this amount (EPA, 1999). While many studies have investigated exposure among farmers and agricultural workers, very few studies have investigated potential exposure among

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farm families as a result of home contamination. Farm homes near farm operations where pesticides are used may be contaminated through a variety of routes including airborne spread, tracking of contaminated soil into the home, and deposition on the clothing of applicators, which are in turn brought into the home. In farm homes, families, particularly children, may be exposed to pesticides through home contamination even though they may not participate in farming activities involving pesticide use. Children have a smaller body weight to surface area ratio, breath more air and eat more foods per unit body weight, and have more intimate contact with environmental contaminants through greater floor contact and hand to mouth behavior, all of which could lead to higher exposure and doses (NRDC, 1998).

Studies have found that farm homes have a greater frequency of detectable residues of pesticides and higher concentrations of pesticides in dust than in reference homes, potentially leading to greater exposure to pesticides among family members (Fenske et al., 2000; Camann et al., 1997; Bradman et al., 1997; Simcox et al., 1995). Pesticide urine concentrations among the children of farmers and farmworkers have been shown to be elevated when compared to children of non–farm families (Fenske et al., 2000; Loewenherz et al., 1997), and one study observed a trend of increasing pesticide metabolite concentration with decreasing age among applicator children (Loewenherz et al., 1997). Lewis et al. (2001) found that chlorpyriphos residues in indoor air and carpet were higher within a few days after an exterior residential application than before the application and suggested that track–in is the principal source of these residues.

A wide variety of agricultural pesticides are used on farms including herbicides, crop insecticides, livestock insecticides, fungicides, and fumigants. In Iowa, Reynolds et al. (1998) found that 52% of the 95 individuals who reported using pesticides in the previous year (1997) in the Keokuk County Rural Health Study used herbicides, while 48% used crop insecticides, 44% used crop storage insecticides, 26% used livestock insecticides, and 11% used fungicides. The most frequently used herbicides were 2,4–D (20%), followed by atrazine, glyphosate, and metolachlor (10% each). The most frequently applied crop insecticide was chlorpyrifos (36%). These data are limited to Keokuk County, Iowa; however, others have reported similar distributions. In the first year of enrollment, 70% of farmers from North Carolina and Iowa in the Agricultural Health Study reported using crop herbicides, while 55% used crop insecticides, 24% used livestock insecticides, and 14% used fungicides (Alavanja et al., 1996). In Minnesota, 93% of 502 pesticide users reported using a herbicide, while 59% reported using a crop insecticide, 37% reported using a livestock insecticide, and 12% reported using a fungicide (Mandel et al., 1996).

In addition to agricultural pesticides, non–agricultural pesticides are frequently used in and around both farm and non–farm homes, accounting for 136 million pounds in 1997 (EPA, 1999). Adgate et al. (2000) reported that 88% of Minnesota households with children aged 3 to 13 used a pesticide in the home. No differences were found between urban and rural homes.

The purpose of this article is to present the pesticide use and work practice data obtained from a questionnaire administered to Iowa families in the spring and summer of 2001. The questionnaire is part of a study investigating farm home pesticide contamination and exposure among farm families using two ongoing rural health studies: the Agricultural Health Study, and the Keokuk County Rural Health Study.

## Methods

Twenty–five farm homes and 25 non–farm homes from several counties in eastern Iowa were enrolled in the study. A total of 95 adults and 118 children participated in the study. Forty–eight adults and 66 children were from farm homes, and 47 adults and 52 children were from non–farm homes. To be eligible for the study, each home had to have at least one child 8 years old or less. In addition, non–farm homes had to be located on land that was not used for farming and have no person in the home working in agriculture or commercial pesticide application, and the farm homes had to be using at least one of the 7 target pesticides. The 7 target pesticides were: atrazine, acetochlor, alachlor, chlorpyrifos, glyphosate, metolachlor, and 2,4–D. These pesticides were selected because of their extensive use in Iowa agriculture. All of these pesticides are corn or soybean herbicides, with the exception of chlorpyrifos which is an insecticide used on corn.

Two prospective, population–based, rural health studies investigating environmental exposures and health, the Agricultural Health Study (AHS) and the Keokuk County Rural Health Study (KCRHS), were used to recruit the majority of participants in this study. Twelve of the farm homes were recruited from the AHS (Alavanja et al., 1996) from an initial 167 farms contacted. These initial 167 farms were selected through a database search from participants in the AHS living in Keokuk and Mahaska Counties based on whether they used one of the 7 target pesticides in the previous year. One hundred and twenty–three of these AHS farms were ineligible because they did not meet the eligibility criteria of having at least one child 8 years old or less. Another six were eligible but refused to participate in the study, and 21 refused to participate before their eligibility was determined. Five others were unreachable or unable to be screened.

Eleven farm homes and 11 non–farm homes were recruited from the KCRHS (Stromquist et al., 1997) out of 70 identified. The 70 were selected from the KCRHS population of 400 farms and 600 non–farms based on pesticides used and children living in the home. The majority were either ineligible or could not be reached (22), while 15 refused participation. The remaining eleven families were contacted, but their reason for not participating is unknown. The remainder of the homes were recruited by word–of–mouth from various other counties near Iowa City. Subjects in this study were selected for convenience rather than random sampling. Institutional Review Board approvals were obtained from the National Institute for Occupational Safety and Health, National Cancer Institute, and University of Iowa.

During May, June, July, and August, 2001, each home was visited on two occasions. The first visit was shortly after a spraying event, and the second visit was approximately 4 weeks later (average 4 weeks, range 3 to 5 weeks). A three–part questionnaire was administered to either parent at each home on the first visit. The information was updated on the second visit about 4 weeks later. Part 1 dealt with parental information. Part 2 dealt with child information and included questions about whether children handled pesticides, carried out other farm chores, or had access to treated fields. Part 3 dealt with household information, including residential pesticide use in and around the home and proximity of the house to treated fields. Questions were specifically asked in part 3 about whether residential pesticides were used in the home, on the lawn, or on the garden (if applicable) in the month and year prior to the visit.

In addition to the three–part questionnaire, a fourth part was administered to the principle farmer in the farm homes only and involved questions about all agricultural pesticide use, crops, and agricultural practice, use of PPE, and other practices since the start of the growing season and throughout the study period, which may influence home contamination. Questions were asked about what crops were being grown, the total size of the crop, the pesticides used on each crop, the number of hours of spraying on each spray day, the number of days the crops were sprayed, who applied the pesticide (the farmer or a custom applicator), the number of acres sprayed, PPE worn, where work clothes and shoes were changed, and laundering practices of work clothes. The questions on pesticide use, crops, and work practices gathered information from the start of the 2001 growing season until the last home visit and generally reflect the early 2001 growing season. With respect to home, yard, and garden use of residential pesticides, homeowners were asked about their use in the month and year prior to the first visit and the month between visits. Environmental and personal samples were also collected on each home visit. This analysis will focus on the questionnaire information.

SAS software (Version 8.02) was used for all statistical procedures (SAS, 1999). Frequencies for use of non–agricultural pesticides in homes, lawns, and gardens were compared using Fisher's Exact test (Fleiss, 1981) since the number of farm and non–farm homes in this study was small.

# Results

Commercial and personal application of residential insecticides and herbicides inside the home and on the lawns and gardens of farm homes and non–farm homes over the previous year is presented in table 1. Only three farm and six non–farm households did not use any pesticide in their home, on their lawn, or on their garden. Farm households were more likely to use a residential pesticide in their home than non–farm households (64% versus 36%, p–value = 0.09). Non–farm households were more likely to use a residential pesticide on their lawn than farm households (56% versus 40%, p–value = 0.40). Gardens were more prevalent among farm homes than non–farm homes; however, among homes with a garden, rates of residential pesticide use were similar (48% of farm homes versus 42% of non–farm homes, p–value = 1.00). For both farm homes and non–farm homes, when residential pesticides were applied to the home, lawn, or garden, they were usually applied by someone from the home. Only 17% of the reported residential pesticide use was by commercial application.

Crop pesticide spraying information since the start of the 2001 growing season until the last study visit (1 to 3 months) is presented in table 2. The average acreage per farm was 310 and 221 for corn and soybeans, respectively, with an average of 130 acres of corn and 105 acres of soybeans sprayed with a pesticide. Spraying agricultural pesticides on corn averaged 4.3 hours per day over 2.4 days, while that for soybean was 4.8 hours per day over 1.4 days. The average amount of agricultural pesticide product (the amount prior to dilution) applied to corn and soybean per farm was 37 gallons and 18 gallons, respectively (37 oz/acre for corn, 22 oz/acre for soybean). All farm homes were located within 1/4 mile of an agricultural field.

**Table 1. Number of homes using residential pesticides in the home, on the lawn, and in the garden between spring/summer 2000 and spring/summer 2001.**

| Area of Use | Method of Application | Farm (n = 25) | Non–Farm (n = 25) | P–value[a] |
|---|---|---|---|---|
| Home | Commercial | 4 (16%) | 1 (4%) | 0.35 |
| | Personal | 12 (48%) | 9 (36%) | 0.57 |
| | Combined | 16 (64%) | 9 (36%) | 0.09 |
| Lawn | Commercial | 2 (8%) | 3 (12%) | 1.00 |
| | Personal | 8 (32%) | 12 (48%) | 0.39 |
| | Combined | 10 (40%) | 14 (56%) | 0.40 |
| Garden[b] | Commercial | 0 (0%) | 1 (8%) | 0.36 |
| | Personal | 10 (48%) | 4 (33%) | 0.49 |
| | Combined | 10 (48%) | 5 (42%) | 1.00 |

[a] Significance obtained by Fisher's Exact test.
[b] Restricted to farm homes (n = 21) and non–farm homes (n = 12) that reported having a garden.

**Table 2. Crop and pesticide spraying demographics for 2001 growing season.**

| Crop | Acres/farm, avg (range) | Acres sprayed/farm, avg (range) | Days spraying/farm, avg (range) | Hrs per day spraying/farm, avg (range) | Oz product sprayed/farm, avg (range) |
|---|---|---|---|---|---|
| Corn | 310 (16–750) | 130 (0.5–950) | 2.4 (1–21) | 4.28 (0.2–15) | 4774 (3–60800) |
| Soybean | 221 (2–450) | 105 (2–245) | 1.4 (1–3) | 4.77 (0.5–8.5) | 2302 (32–9800) |
| Total | 295 | 127 (0.5–950) | 2 (1–21) | 4.34 (0.2–15) | 4383 (3–60800) |

Corn was grown by 23 farmers (out of 25) and soybeans were grown by 12. Of these, 10 grew both soybeans and corn, with only 2 farmers growing only soybeans and 13 farmers growing only corn. All farmers sprayed corn and soybeans with agricultural herbicides, while 8 also sprayed crop insecticides on corn. In addition to growing crops, 21 farmers also raised animals, and of these 13 applied a livestock insecticide to the animals. Of the 7 target pesticides in this study, atrazine was applied most often. Twenty of the farmers (80%) had applied atrazine to their crops. Glyphosate (64%) and 2,4–D (56%) were the next most common target pesticides, followed by metolachlor (28%), acetochlor (20%), and chlorpyrifos (12%). Alachlor was not used by any of the farmers. In addition, 25 other agricultural pesticides were used by 20 farmers, the most common ones being dicamba (44%) and isoxaflutole (32%). The majority of the 32 pesticides reported used were herbicides (22), followed by insecticides (8), and fungicides (2) (table 3). On almost every farm, more than one agricultural pesticide was applied. The only exception was a small farm that grew only soybeans and only used glyphosate.

The average number of agricultural pesticide products applied to both corn and soybean by each farmer in the 2001 growing season was 4 (range 1 to 9) with 3 being the mode. An average of 4 agricultural pesticide products were applied to corn and 2 to soybean. Seventeen farmers (68%) mixed, loaded, and applied the agricultural pesticides themselves, while 14 (56%) had agricultural pesticides mixed, loaded, and applied by a custom applicator. This includes 6 farms where both the farmer and a custom applicator applied agricultural pesticides. All agricultural pesticides were applied using a spray boom. Of the farmers who applied agricultural pesticides themselves, 10 (59%) of them did so in an enclosed cab. A closed cab is defined as one that is completely closed, with windows closed and air conditioning. Farmers typically did not report wearing personal protective clothing (PPE). Six (24%) farmers wore no PPE at all, while 13 (52%) wore gloves, 16 (64%) wore long pants, 7 (28%) wore long–sleeved shirts, 3 (12%) wore rubber boots, and 2 (8%) wore goggles. One farmer wore a nitrile apron while mixing and loading pesticides. Typically farmers did not store agricultural pesticides in the house. Only 2 (8%) farmers indicated they stored agricultural pesticides in the home (in the basement). The majority of farmers (15) who had agricultural pesticides stored at the farm did so in an unattached garage or shed.

Most of the farmers changed out of their work clothes in the home, usually in the laundry room (table 4). Only 3 (12%) changed outside the home or in the garage (the garage was defined as outside), and these 3 brought the dirty work clothes into the home. Similarly, most farmers changed out of their work shoes inside the home. Nine farmers (36%) changed out of their work shoes outside or in the garage, but most of these farmers (7) brought their shoes into the house. Most work clothes were laundered separately from the rest of the family's clothing. Only 4 (16%) farm families washed the work clothes with the rest of the clothes.

Thirty–one children (47%) from 14 farm homes out of a total of 66 farm children enrolled in the study were involved in farm chores. Their ages ranged from 3 years old to 15 years old with an average age of 9 (The younger children (3 and 4 years old) were tagging along with their father while he did his farm work). Of these, 6 (9%) children from 5 farms worked in treated crops or handled agricultural pesticides. Only 2 (4%) children out of 52 non–farm children enrolled in the study were involved in farm chores.

**Table 3. Active ingredients applied by farmers to corn and soybeans and frequency of use.[a]**

| Pesticide | Number[b] (Percent)[c] | Pesticide | Number[b] (Percent)[c] |
|---|---|---|---|
| **Atrazine** | 20 (80) | Tebupirimfos[d] | 2 (8) |
| **Glyphosate** | 16 (64) | Malathion[d] | 2 (8) |
| **2,4–D** | 14 (56) | Permethrin[d] | 2 (8) |
| Dicamba | 11 (44) | Tefluthrin[d] | 2 (8) |
| Isoxaflutole | 8 (32) | Metribuzin | 2 (8) |
| **Metolachlor** | 7 (28) | Triclopyr | 1 (4) |
| Dimethanamid | 7 (28) | Acephate | 1 (4) |
| Clopyralid | 6 (24) | ADBAC[e] | 1 (4) |
| Flumetsulam | 6 (24) | ADEAC[e] | 1 (4) |
| Flufenacet | 6 (24) | Cyhalothrin[d] | 1 (4) |
| Nicosulfuron | 6 (24) | Primsulfuron–methyl | 1 (4) |
| **Acetochlor** | 5 (20) | Diflufenzopyr | 1 (4) |
| Picloram | 4 (16) | Pendimethalin | 1 (4) |
| **Chlorpyrifos**[d] | 2 (8) | Terbufos[d] | 1 (4) |
| Rimsulfuron | 2 (8) | Bromoxynil | 1 (4) |
| Cyfluthrin[d] | 2 (8) | **Alachlor** | 0 (0) |

[a] Pesticides in **bold** are the target pesticides for this study. Pesticides are sorted by frequency of use by the farms in this study.
[b] The number of farms reporting the use of a pesticide.
[c] The percent of farms reporting their use (out of 25 farms).
[d] Insecticides, all others are herbicides (except ADBAC and ADEAC).
[e] Fungicides: ADBAC = alkyl dimethyl benzyl ammonium chloride; ADEAC = alkyl dimethyl ethylbenzyl ammonium chloride.

**Table 4. Where farmers changed out of work clothes or shoes.[a]**

| Location | Clothes | | Shoes | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| Outside/garage[b] | 3 (3) | 12 | 9 (7) | 36 |
| Laundry room | 9 | 36 | 5 | 20 |
| Bedroom | 3 | 12 | 0 | 0 |
| Basement | 6 | 24 | 5 | 20 |
| Bathroom | 2 | 8 | 0 | 0 |
| Entrance | 1 | 4 | 4 | 16 |
| Other | 1 | 4 | 1 | 4 |
| Unknown | 0 | 0 | 1 | 4 |

[a] Refers to all work clothes and shoes, not just those used for pesticide application.

[b] The number in parentheses indicates the number of farmers who brought their clothes or shoes into the home after changing outside.

# Discussion

Nearly all households (82%) reported using a non–agricultural pesticide in their home, on their lawn, or on their garden in the previous year. Generally, farm families used non–agricultural pesticides more often in and around the home than non–farm families. Similar pesticide usage was found in Minnesota. Adgate et al. (2000) reported that 88% of 308 rural (farms and non–farms) and urban Minnesota households had used a non–agricultural pesticide in the previous year. In a national survey of more than 8200 households representing the 10 EPA regions between 1976 and 1977, 91% of households reported using non–agricultural pesticides in their home, garden, or yard (Savage et al., 1981). This same survey, when broken into the 10 geographical regions, found that 93.5% of households reported using a non–agricultural pesticide in the region including Iowa.

Atrazine, dicamba, and isoxaflutole were the most commonly used corn herbicides in this study, and glyphosate and 2,4–D were the most commonly used soybean herbicides. Chlorpyrifos was the most common insecticide applied to corn, while no insecticides were applied to soybean. The data are derived from a skewed sample population, as our eligibility criteria selected only farms applying one of the target pesticides and who had young children, and the farms were from a limited region of Iowa. However, the data follow a similar pattern of use in Iowa in 1999. The USDA reported that the agricultural herbicides atrazine, acetochlor, and metolachlor were applied to 65%, 42%, and 20%, respectively, of the planted corn acres in Iowa in 1999, while glyphosate was applied to 58% of the planted soybean acres in Iowa in 1999. Dicamba and isoxaflutole were applied to 18% and 5% of planted corn, respectively. The insecticide chlorpyrifos was applied to 6% of the corn acres planted in Iowa in 1999. No insecticides were reported on soybeans (USDA, 2000). All farms in this study were located within 120 miles of Iowa City. In Keokuk County, which is approximately 70 miles from Iowa City, atrazine, metolachlor, glyphosate, and 2,4–D accounted for 50% of the agricultural herbicide use reported in the KCRHS. Dicamba ranked 11th in order of frequency used, and isoxaflutole was not reported used (Reynolds et al., 1998).

A factor that may account for the more common use of dicamba and isoxaflutole in this study is weather; the weather was fairly wet during the early growing season. In many cases, the corn was already out of the ground before agricultural herbicides could be applied. Dicamba and isoxaflutole can be used post–emergent, while acetochlor and metolachlor are only pre–emergent herbicides. Caution must be used in interpreting our results as the study population is a convenience sample and relatively small.

Farm homes can become contaminated with agricultural pesticides. There are several ways that this may occur including storage of agricultural pesticides in the home, track–in on clothing and shoes, and spray drift. It seems unlikely that non–farm homes would be contaminated in these ways, except possibly by spray drift (Lewis et al., 2001; NRDC, 1998; Camann et al., 1997; NIOSH, 1995). Since two farm homes stored agricultural pesticides inside the home, pesticide storage inside the farm home does not appear to be a contributor to potential agricultural pesticide contamination in this study. It is clear that agricultural pesticides may contaminate farm homes by way of the farmers' clothing. The majority of farmers in this survey changed out of their work clothes and shoes inside the home, and the few that did not change inside the home brought their clothes and shoes into the home. If a farmer has been applying agricultural pesticides to his fields, or working in treated fields, his work clothes and shoes may be contaminated with agricultural pesticides. These clothes are then brought into the house, possibly contaminating surfaces inside. One way to reduce the potential contamination of clothes is to apply agricultural pesticides with a tractor that has an enclosed cab. However, it should be noted that even with a closed cab, work clothes can be contaminated with agricultural pesticides as a result of mixing, loading, and pesticide application equipment repair activities if appropriate precautions are not taken. Another way to reduce agricultural pesticide contamination inside the home is to launder work clothes separately. However, although laundered separately, it appears in most instances that the same washing machine is used to wash both sets of clothing. Therefore, the washing machine could be a source of contamination.

Another potential source of agricultural pesticide contamination inside farm homes is spray drift due to the proximity to treated fields of the farm homes. All 25 farm homes in this study were within 1/4 mile of a treated field, while only 7 non–farm homes were within 1/4 mile of farm fields. Simcox et al. (1995) found that organophosphate (OP) concentrations in house dust decreased with increasing distance of homes from commercial orchards. All four pesticides examined were found in greater concentrations in agricultural household dust than in reference household dust. All reference homes were greater than 1/4 mile from a commercial orchard, while most of the agricultural homes were within 50 feet of an orchard. In the same study population, Loewenherz et al. (1997) found that children living within 200 feet of an orchard had significantly more detectable levels of the OP metabolite DMTP in urine than children living more than 200 feet from orchards. The effects of these parameters on actual agricultural pesticide contamination in the farm home in this study will be examined in the future.

Farm home contamination by agricultural pesticides is a concern for family members living inside the farm home, especially children. In the same study of children of agricultural workers mentioned above, 47% of pesticide applicators' children had detectable samples of dimethylthiophosphate (DMTP), an OP metabolite, versus 27% in reference children. This study also observed a trend of increasing DMTP concentration with decreasing age among applicators' children (Loewenherz et al., 1997). The homes of agricultural workers in this study had higher OP pesticide concentrations in the house dust compared to reference homes (Simcox et al., 1995). In the same study, population doses for azinphos–methyl, an OP pesticide, were estimated. Fenske et al. (2000) found that the dose in 56% of the children whose parents worked as orchard applicators or field workers exceeded the U.S. EPA's chronic dietary reference dose and 19% exceeded the World Health Organization (WHO) acceptable daily intake values.

The greatest concern for children's exposure to pesticides is indirectly through home contamination. However, some children may be directly involved in farm work, resulting in direct exposure to agricultural pesticides. More than half of the farm families involved some of their children in farm–related work. Thirty–two children from 14 farm homes participating in this study carried out some form of farm chore, while only two children from two non–farms did. Most chores included taking care of livestock and/or mowing or driving the tractor. Six children from five farms were potentially directly exposed to agricultural pesticides by working in treated fields or by handling agricultural pesticides, while none from the non–farms worked in treated fields or handled agricultural pesticides. The six children were all 12 years old, except one child who was 11 and one who was 5. Generally, the children involved in farm chores were the older children in the study. The farms where children were engaged in farm chores tended to be smaller (range 16 to 900 acres, mean 286 acres) than those where children did not participate in farm chores (range 2 to 1200 acres, mean 347.7 acres) but not significantly (two–sample t–test p–value = 0.6562). The 5 farms with 6 children working in treated fields or handling pesticide ranged in size from 16 acres to 510 acres. Atrazine, glyphosate, and 2,4–D, the most predominately used pesticides in this study, have a medium to high dermal acute toxicity and are suspected carcinogens, mutagens, and immunotoxins (Briggs, 1992), and children are more vulnerable to pesticides than adults (Landrigan et al., 1998).

## Conclusion

These data provide a description of the types and extent of pesticides used by farm households and non–farm households and potential pesticide exposure factors for farm families enrolled in this study. Based on work and pesticide use practices, farm homes may be more contaminated with pesticides than non–farm homes. Farmers bring their contaminated work clothes and shoes inside the home, and their homes are closer to treated fields than non–farm homes. Further, farm children are more often engaged in farm work, including chores that may directly lead to pesticide exposure, than non–farm children. Caution should be used when interpreting our data, however, as the subjects were preferentially selected based on pesticides used and ages of children in the home. Further, our sample size is small and restricted to a small area of eastern Iowa, which may limit the applicability of our results.

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