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Farmworker and Farmer Perceptions of Farmworker Agricultural Chemical Exposure in North Carolina

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Abstract

Agricultural chemicals pose health risks for farmworkers engaged in cultivating and harvesting crops. In a project to develop culturally appropriate interventions to reduce farmworker exposure to agricultural chemicals, formative research used in-depth interviews and focus groups to elicit beliefs and knowledge about exposure from farmers and migrant and seasonal farmworkers in North Carolina. Farmworkers were concerned about acute effects they attributed to exposure and had little knowledge of long-term effects of low-level exposure. They believe that some individuals are inherently more susceptibility to the health effects of exposure than others; most do not recognize the skin as a site of chemical absorption. They report instances of exposure that reflect the power relationships with fanners, indicating that lackof knowledge is not the only issue that must be addressed in an intervention. Farmers believe that farmworkers are not exposed to chemicals because they do not mix or apply chemicals. Such a belief is consistent with the training received by fanners. The PRECEDE-PROCEED planning model is used to identify predisposing and reinforcing factors on which an effective intervention should focus.

Keywords

farmworker; farm health; agriculture; pesticide; health intervention; US; North Carolina

Modem American agriculture depends on the use of a wide range of chemicals to maintain its current levels of productivity. These chemicals include pesticides such as insecticides, herbicides, and fungicides; fuels; fertilizers; and ripening agents. Pesticides and other agricultural chemicals come in different forms, including gas, liquid, dust, and granular. Approximately one billion pounds of chemicals per year (Aseplin 1997; Gianessi and Anderson 1995) are applied through spray, in irrigation water, and from the air. Although new techniques (e.g., no-till agriculture, integrated pest management) and more effective

chemicals are being developed to reduce the amounts of chemicals used, as well as their potential environmental and human health effects, chemicals remain important and widely used.

All persons in the farm environment, including farmers, farm families, and farmworkers, can come in contact with chemicals. Despite the benefits of chemicals in terms of farm production, they can pose a health hazard to people. Epidemiological evidence indicates that there are both short-term and long-term negative health consequences of such exposure (Arcury and Quandt 1998a; Savitz, Arbuckle, Kaczor and Curtis 1997; Zahm, Ward and Blair 1997), so it is considered prudent to minimize exposure.

Some chemical exposure is obvious. Spills of concentrated chemicals can occur while chemicals are being mixed or applied. Contact with the skin, inhalation of vapors, or unintentional ingestion of such chemicals results rapidly in poisoning, with severe symptoms such as tachycardia, profuse sweating, pin-point pupils, vomiting, and loss of consciousness. If untreated, death can occur. Other exposure to chemicals is less apparent, as it may be relatively asymptomatic. Low level exposure such as that produced by the airborne drift of chemicals during application may not be apparent to those exposed, if they experience no immediate ill effects. Likewise, contact with the residues left by previously applied chemicals on foliage, tools, farm equipment, and soils can result in exposure. However, because the long-term cumulative low-level effects of such exposure can be subtle (e.g., neurological deficits), non-specific (e.g., dermatitis), or delayed (e.g., cancer or sterility), exposure to residues receives relatively less attention in safety regulations and safety training than does acute poisoning (Arcury and Quandt 1998a).

Exposure to chemical residues is of particular concern for those working in the fields. Over 85% of the fruits and vegetables produced in the United States today are harvested or cultivated by hand (Oliveira, Effland, Runyon and Hamm 1993), an activity that brings the worker into contact with chemicals. In large scale agricultural enterprises, this work has traditionally been done by a seasonal labor force composed of local and migrant farmworkers. Over time, this group of workers has included persons from a wide range of ethnic backgrounds; but the workers have in common a life characterized by its harshness, deprivation, and disease. As President Truman pointed out in 1951, “[the United States] depend[s] on misfortune to build up our force of migratory workers and when the supply is low because there is not enough misfortune at home, we rely on misfortune abroad to replenish the supply” (Migratory Labor in American Agriculture 1951).

Current estimates place the number of seasonal and migrant farmworkers and their dependents at 4.2 million. 1.6 million of these are classified as migrants (HRSA 1990), meaning that they are persons whose principal employment is in agriculture on a seasonal basis and who, for the purposes of this employment, establish temporary homes. They are employed in 42 out of the 50 states. As late as the 1980s farmworkers were ethnically diverse, including African-American, Native American, Mexican, Haitian, and white workers (Mines, Gabbard and Boccalandro 1991). In the 1990s the farmworker population has become largely Hispanic and foreign-born (Mines, Gabbard and Steirman 1997),

although such a generality conceals considerable variation in nation and state of origin, as well as language and cultural diversity (see, for example, Grieshop 1997).

The current understanding of how to minimize exposure to agricultural chemicals is based on a behavioral model coupled with data on routes by which chemicals enter the body. Persons can come in contact with chemicals by handling crops or tools, by working in soil, by experiencing airborne drift of chemicals or their residues into housing, or by having others carry residues into housing on their clothes and skin. To be harmful, chemicals must be absorbed through body openings or the skin. Only a portion of chemicals on the skin will be absorbed, and this varies by site. For example, only 10% of chemicals on the palm of the hand will be absorbed, while 99% of those coming in contact with the scrotum (Feldman and Maibach 1967). Skin compromised by rashes or cuts will absorb more (Wester and Maibach 1983). Heat and humidity increase transdermal absorption, as well (Blank, Scheuplein and MacFarlane 1967; Meuling, Franssen, Brouwer and van Hemmen 1997). Several behavioral steps can reduce the amount of chemicals that a farmworker comes in contact with and the amount absorbed. These include wearing protective clothing (e.g., long sleeve shirts and wide brimmed hats), maintaining personal hygiene (e.g., frequent hand washing and showering after work), and laundering work clothes separately from other household laundry. In recognition of the importance of such behavioral steps, the U.S. Environmental Protection Agency designed the Worker Protection Standard (WPS), a set of regulations enacted in the early 1990s (US Environmental Protection Agency 1992). The WPS requires that all farmworkers be taught the dangers of chemical exposure and how to protect themselves from agricultural chemicals. It also requires farmers to follow safe practices and provide facilities for personal hygiene and emergency medical care. The Worker Protection Standard provides a unique opportunity to educate and empower farmworkers to protect themselves from chemical exposure, but it is not consistently enforced. Although WPS training undoubtedly increases farmworker awareness of risks and of preventive behaviors, there has been little testing of the WPS provisions to know whether they will actually prevent exposure and reduce its harmful consequences (Langner 1997).

Farmworkers generally lack control over their exposure. They bear a disproportionate share of the occupational and environmental health risks from chemical use in agriculture. For this reason, attention has been focused on farmworkers as part of the effort to increase environmental equity (Moses, Johnson, Anger, Burse, Horstman, Jackson, Lewis, Maddy, McConnell, Meggs and Zahm 1993). As part of the effort, the National Institute of Environmental Health Sciences has funded the PACE study (Preventing Agricultural Chemical Exposure in North Carolina Farmworkers) to develop, test, and disseminate culturally appropriate interventions for farmworkers. In this paper, we describe the theoretical basis for the PACE project and focus on the formative research that describes and compares beliefs held by farmers and farmworkers about agricultural chemicals. Existing research on farmer and farmworker beliefs about chemical exposure is quite limited, but emphasizes the importance of power relations and cultural health beliefs for farmworkers' approach to chemical safety. In a comparison of farmers and farmworkers in California, Grieshop, Stiles and Villanueva (1996) found that farmworkers tended to place control over workplace safety outside of themselves (e.g., in God, luck, or supervisors). While they thought about ways to stay safe in the work place, they also had a cognitive strategy of

accepting danger. In contrast, farmers emphasized their own personal control over safety and therefore made plans to stay safe, rather than simply accept danger. Vaughan (1993a, 1993b) also found that many farmworkers perceived little control over exposure to chemicals and their negative health effects, and this was associated with non-use of protective behaviors to prevent or reduce exposure. Those farmworkers in better economic circumstances were more likely to perceive themselves as having control over exposure (Vaughan 1995). Baer and Penzell(1993) found that pesticide exposure-related symptoms were interpreted within a cultural framework. Following an incident in which a large number of Mexican migrant farmworkers in Florida were treated for pesticide poisoning, many attributed residual symptoms to the Mexican folk illness, *susto*. While this may have represented somatization of the psychological trauma of the poisoning, those individuals who self-diagnosed *susto* did report more residual symptoms. This indicates that they may indeed have had more negative effects from pesticide exposure and expressed illness in a culturally specific way. While the body of literature on farmworker beliefs concerning chemical exposure is small, it suggests a number of directions for the present research.

Research Design

The data reported here come from PACE, a community participation health project designed to reduce exposure to pesticides and other agricultural chemicals by developing, testing and disseminating culturally appropriate interventions. This is a four-year project in which the major goal of the first year was to conduct formative research to be used in the development of the intervention. This paper will focus on this formative research. We will first describe the theoretical framework of PACE, then present the methods used in the formative research, and finally describe our findings.

As a study to change health behavior, the PACE study draws on existing theory in the field of behavior change. Consistent with current health behavior and health education research (Glanz, Lewis and Rimer 1997), PACE is based on a multitheory approach, using an overall planning framework for the study as a whole that incorporates individual, inter-personal, and community level theoretical approaches. The overall planning framework for the study is the PRECEDE-PROCEED model of Green and Kreuter (1991). This model is intended to provide a structure for applying theories to identify and implement the most appropriate and effective interventions to change health behaviors (Gielen and McDonald 1997). Key components of the model that comprise the PRECEDE aspect are predisposing, reinforcing and enabling factors. All need to be considered in planning a strategy to change health behavior. Predisposing factors relevant to the PACE project include personal characteristics such as age, gender, experience in farm work; beliefs and perceptions about susceptibility to effects of chemicals; and knowledge of chemical exposure and its prevention and treatment. Reinforcing factors include characteristics of the social environment (e.g., employer or family concerns about health), experience and those observed in others, and community support for behavior change. Enabling factors are the availability of appropriate resources for behavior change (e.g., hand washing water and laundry facilities) and the availability of skills training. This paper will concentrate on predisposing and reinforcing factors, as these are most closely linked to health beliefs and knowledge.

Field Sites

The PACE project is based in an eight-county region of central North Carolina. Agricultural production includes tobacco, cucumbers, sweet potatoes, cotton, and a number of other fruit and vegetable crops. PACE focuses on farmers and farmworkers involved in tobacco or cucumber production, as those involve large amounts of chemicals and hand labor throughout the agricultural season. North Carolina ranks fifth in the nation in number of farmworkers. Recent estimates place the number of migrant workers and dependents at 140,000, with twice as many seasonal farmworkers (North Carolina Employment Security Commission 1995). The ethnic composition of the North Carolina farmworker labor force has changed in the last decade from mostly African American workers to Mexican and Central American workers. The eight-county study area includes the counties with the state's highest concentrations of farmworkers.

Data Collection

In order to understand predisposing, reinforcing and enabling factors related to preventing agricultural chemical exposure, we undertook formative research that included both traditional ethnographic fieldwork of observing and conducting casual interviews in the community, and a set of more structured interviews. These latter included individual in-depth interviews (27 with farmworkers and 7 with farmers) and focus group interviews (7 with a total of 44 farmworkers). Farmworker in-depth and focus group interviews included both Hispanic and African American farmworkers, and both males and females (Table 1). Most of the Hispanic farmworker interviews were conducted in Spanish. Informants were recruited with the assistance of our community-based organization partner, the North Carolina Farmworkers' Project. Efforts were made to include a diverse group of farmworkers to help understand the range of beliefs held. Farmworkers were natives of Mexico, Puerto Rico, Guatemala, and the southeastern United States. Some of those of Hispanic origin had lived for a number of years in the United States. Their time spent as a seasonal or migrant farmworker ranged from less than one year to more than twenty years. The farmers interviewed were also a diverse group, including farmers with different size operations and from different North Carolina counties. In-depth and focus group interviews were conducted by trained interviewers using a standard interview guide. This included topics such as personal experiences with chemicals and beliefs about health effects of exposure and its prevention.

Data Analysis

All interviews were tape recorded. Most interviews were transcribed verbatim. Spanish interviews were then translated by a professional translation service and edited by bilingual project staff. For a few of the farmworker interviews with limited relevant content, notes were taken from the tape recording in lieu of a verbatim transcription. A systematic text analysis plan was developed and implemented (Arcury and Quandt 1998b). The analysis was designed to derive common "themes", or generalizations, from the interview sets. Codes were developed to label beliefs, knowledge, and practices related to chemical exposure. Each transcript was coded by more than one coder to reduce bias. After segments were identified and coded, segments were retrieved and reviewed by the authors to identify

common themes representing predisposing and reinforcing factors. The Ethnograph (Version 4.0) computer software (Seidel, Friese and Leonard 1995) was used for search and retrieval of text segments.

Results

We orient the presentation of results for both farmworkers' and farmers' beliefs around the central themes found in the interviews. Six themes emerged from the analysis of farmworker transcripts. The diversity and amount of comments vary considerably across these themes. In some cases there are diverse ideas held. For some themes, farmworkers have many comments, indicating highly salient themes to which they have given a significant amount of thought. For other themes, farmworker comments are far more cursory, indicating that the theme holds limited salience for them. Only two themes emerged from the farmer interviews. These reflect greater consensus of opinion about the issue of agricultural chemicals and health.

Farmworkers Theme 1: Sensory Detection of Chemicals

The senses are important to farmworkers in detecting exposure. They expect to *feel* the chemical on the plant or to *taste* it or to *smell* it.

> I have been exposed to it, 'cause like, you know, you can work in tobacco or whatever and then you can go eat lunch, and you can wash your hands. But then when you eat, you can still taste it. 'Cause I mean, like the stuff they use to grow tobacco now, you know, it just don't wash off with the rain, you know, it just … it's there…You can still taste it. And you know it. You can tell tobacco, like tobacco juice. You can tell how bitter, you know. You can tell the differences. Distinguish the difference. Yeah. And you know it's chemicals. Sometimes, you know, you can see chemicals on the tobacco. On the tobacco leaves. You can still see the chemicals on the leaves. Most of the time you keep working and hope you don't get it.
>
> (FW006)

> Right in the morning time, in the morning time. They'll spray in the morning time. And then we'll go right behind and start cropping tobacco. Or we might be cropping on one set of rows … And he might be spraying right next door to it. And by the wind blowing, if it's blowing in our direction, you can feel that coolness, like mist hitting you. 'Cause of the wind blowing it on you, you know. It's according to which way the wind blowing sometimes…So you can actually feel mist from the spray when the wind blow.
>
> (FW005)

> Inhaling a chemical, you can't get rid of that smell. What they mix it with, the particles of it. Well, you can smell it.
>
> (FW019)

For all but one worker, visual detection of chemicals required seeing wet chemicals on the plants. This is important because there is considerable evidence that chemicals leave a

dislodgeable residue on plants after drying that may constitute a significant exposure source for field workers (Fenske 1997). Only one farmworker reported seeing chemical residue that had dried.

> I said, oh, they had sprayed. It was some blue stuff that was — blue residue stuff. When you're picking fruit and the leaves—when they spray some pesticide, you see some of it still on the leaves and stuff. I know when I seen that color on the leaves and the trees, I know that's what it was then.
>
> (FW002.FG)

While sensory detection of chemicals seems to be important for farmworkers to know the chemicals are present, some farmworkers seem to believe that smelling a chemical does not constitute exposure.

> I remember, we was in a field and they were spraying once while we was in there. But it was — you could smell it — but it was so far, you know, so many rows over, it wouldn't be that close to you to harm you … I have been that close you could smell it, but as far as being close to it [for exposure], [the crew leader] won't let us come out there like that.
>
> (W004)

Thus, in general, farmworkers believe that they will be able to detect chemicals with their senses. The important converse implied is that if chemicals are *not* seen, felt, tasted, or (in some cases) smelled, the chemicals are not there.

Farmworker Theme 2: Body Openings as Exposure Routes

These farmworkers present a variety of conflicting opinions about how chemicals enter the body. There is a general understanding that chemicals can get into the body in several ways, but the emphasis is on lungs and mouth, with little mention of absorption through the skin. The lungs are seen as a primary route by which chemicals enter the body.

> In the fumigated fields you breathe the smell from the fumigation and it is through the nose that it goes to the brain. You feel just like that, as if you were drunk or dizzy, and I think that if I were to turn around, I am going to make myself sick, vomit, 'cause that's what causes it.
>
> (FW001.FG)

> And when you think about it, if you're breathing those fumes, what's going on inside your lungs. You don't know what's taking place and what effect it gonna have.
>
> (FW002.FG)

> Inhaling a chemical [fertilizer], it's in your lungs. It's all through your body. You don't know if it's gonna hurt your blood, you don't know if it's gonna do damage to your heart. You don't know if it's gonna do damage to your lungs.
>
> (FW019)

For exposure through the mouth, the farmworkers' descriptions of exposure include instances where their sweat ran into their mouths while working in hot fields, and the chemicals tasted bitter.

> The [chemical] they put in the fields does cause an effect because it is too hot. You eat the sweat coming from your body, and many times, especially when we are in tobacco, there are many pesticides.
>
> (FW003.FG)

> We are sweating a lot, and it is the sweat that goes into our mouths and it is bitter, because of the tobacco leaves. All of that bitterness. And sometimes we swallow our saliva and it is so bitter. That's what hurts us.
>
> (FW018).

Most farmworkers believe that pesticides on the skin must get into a natural body opening to be absorbed. For a few, the pores in the skin are such an opening.

> The chemicals when you are wet is when they penetrate your body better. When you get wet with the water on the plant is when it penetrates you, not when the plant is dry.
>
> (FW004.FG)

However, most see the skin as a barrier and believe that chemicals on the skin must get into the mouth to be absorbed.

> If you get it on your hands and then you can't wash your hands, then you go to get a drink of water and cup your hands, that's how the poison gets in you.
>
> (FW003)

> Chemicals can affect you if you do not wash your hands. At lunch there is no water; you have to eat without washing your hands. The chemicals can get inside your system.
>
> (FW005.FG)

> When you are drinking water, like this, your hands are dirty. Some kind of infection from the chemical can go into the glass, and sometimes you don't even notice.
>
> (FW021)

Farmworker Theme 3: Coming in Contact with Chemicals

Consistent with the emphasis on water, the most commonly reported type of exposure occurs early in the morning. Some workers think this is because the plants are wet from early morning dew, but most think that the farmers spray early, making the plants wet with chemicals.

> So when we go early in the morning and they have just sprayed them, that's when it penetrates your hands and everything.
>
> (FW004)

> When you start working the plant is all wet and all that moisture rubs on you. It dries on you, on your skin and that is what affects you. Even if it dries out, the illness is already in you. And that is why we are concerned because sometimes we are bending down and we feel the pesticide in our eyes. You start thinking, what can I do, because the boss is always in a hurry, so we get wet, and then dry out, and then wet again.
>
> (FW004.FG)

In this farmworker population, there are only a few reports of instances of direct spraying of farmworkers. Some believe that workers are exposed to chemicals by being made to work in fields in which the no-entry period has not expired or by drift from spraying in nearby fields.

> I have worked many times after they have sprayed — here as well as in [another place]. They would spray and the spraying machine would go, and they'd bring in a crew leader and they would tell us that we were going to pick. And we would start to pick … Sometimes the boss tells us that he wants us to finish filling up the barns, and sometimes they spray and we are behind picking.
>
> (FW021)

> I have never been sprayed directly, except when the wind blow. I've seen the guy come. He'll come right behind you and spray you, like toward the end of the day, cause he's trying to get that field done. He'll wait for us to get a set of rows out, then he'll come round and spray, you know, like toward the end of the day cause he catches up with us while he's spraying. It doesn't happen every day, you know, but it might happen pretty regular.
>
> (FW005)

However, others workers report that growers do not allow workers into fields until the no-entry period expires.

> There are no times that I have worked in fields that have been recently sprayed.
>
> (FW026)

> We never work in fields that have been recently sprayed. The patron does not want us to do that. We have worked with him a long time and he has never treated us badly. I have never been accidentally sprayed.
>
> (FW025)

> I have not worked where they just sprayed. I have always worked several days after they have put on the liquid. Then we go and work there.
>
> (FW018)

> No, I have never worked in fields where there were still chemicals in the plants. The times they were going to spray, they let us know and the inspectors go and take all the people out.
>
> (FW007.FG)

In all of these instances — entering a field too soon, being sprayed, or being kept out of a field by a farmer — the common variable is the farmer. He or she (not the worker) has the power to determine whether or not the worker is exposed.

Farmworker Theme 4: Susceptibility is Individualized

There is a widespread belief that farmworkers vary in their susceptibility to the effects of chemicals; some are sensitive and experience ill effects, and others are inherently more resistant.

> There are some workers that have a resistant body. There are some that can stand two days [wearing the same contaminated clothes], some others three. But it is rare if a person can stand three days with the same clothes. But sometimes we have a very strong body, like with me, I can stand them for two days.
>
> (FW007.FG)

> And I done heard two or three people say, “Hey, man, I can’t do that kind of work, it breaks me out.” I’m not saying it’s the spray, the pest control they are putting on it. It might just be the tobacco…It ain’t never got me, like I done seen it with my own eyes how, you know, the rash — it’s a rash, you know — people scratch it, this big one day, next day it’s all way up the whole arm or whatever. I can understand about that. But lucidly me, myself, I never had it. I am lucky not to be—not to have the kind of skin that breaks out like that.
>
> (FW004)

> It hurts some people and it doesn’t hurt others, and I don’t know what else to tell you.
>
> (FW001.FG)

> [My adult daughter was sprayed.] She is very thin, right? so it affected her. I had her at home for a week. vomiting and with fever.
>
> (FW006.FG)

> [When they are spraying, the smell gives you] headache, dizzy, your head hurts fast, you feel pain, you feel dizzy in your head. Some don’t feel as much, but others are more delicate.
>
> (FW015)

> The medicine [chemical] goes directly to the plant, and for the person, if he is a weak one, it will affect him. But for the person who has strong health, it doesn’t do anything.
>
> (FW009)

> For those who smoke, the pesticides won’t hurt them.
>
> (FW003.FG)

> Chemicals affect people differently, depending on their strength and constitution. It would also be easier for a women, remember that a woman has her time of the

> month, those are the days that can have the most effect and it is easy to become contaminated by pesticides.
>
> (FW013)
>
> The liquid [chemical] is very strong for women, for some. For others they are very strong and also their blood is strong because they don't get sick.
>
> (FW018)

Farmworkers use oppositions such as strength and weakness, old and young, male and female to try to categorize susceptibility. However, while some variation can be attributed to these, they have no general explanation for susceptibility. People are just different.

Farmworker Theme 5: Acute Exposure is the Problem

Most farmworkers are concerned with the immediate or acute effects of exposure. They connect the cause (agricultural chemicals) with a variety of effects, symptoms that can range from those that are annoying to those that are temporarily debilitating. In fact, many infer as evidence of exposure these symptoms, most of which subside when fieldwork stops. They include nausea and vomiting, headaches and dizziness, and a variety of skin rashes, welts, and pimples. Farmworkers are aware that working in tobacco and cucumbers produces some of these symptoms. There is no clear distinction for some, when talking about these crops, whether the ill effects are from agricultural chemicals or the plants themselves.

> Many have gotten sick there in the work. Some get sick with a headache, vomit, all of that you suffer, but it is all because of the chemicals.
>
> (FW018)
>
> That chemical on it. Oh, baby, when that sun comes out or you get wet and you start sweating, that stuff'll set you on fire. And it just burns the heck out of your skin. I mean you just swell up…That stuff make you swell. Your eyes'll swell, too. Your face'll swell and you get real tight. It's like you got high blood pressure, you know. I did that and I got sick off of it.
>
> (FW019)
>
> Those scars are from the chemicals that we used. When they get in your clothes and they burn your skin, little blisters come up. Naturally, you're wondering what that little blister come from. It gets all over your body. I mean, there's no other explanation for it. You play in the dirt all your life and then all of a sudden you begin to get these things popping out on you and your face swell up…I don't get pimples, and it's just — I put two and two together.
>
> (FW019)
>
> I only worked four months, and then I started feeling ill, I started getting a lot of little welts and little pimples that were itching. I went to the doctor and he told me it was because of the tobacco, because replanting you had to bend over, then you would get a lot of the odor and that's how I got dizzy…What happened was that when you are replanting the plant, you are getting from the soil the chemicals. I think they put fertilizer…

(FW015)

Very few workers are aware of potential long-term effects of exposure to chemicals, and none of them link these to chronic exposure or to residues. Most described these effects only when pressed, and they could not elaborate. They did not seem to know of anyone who had suffered from any of these health outcomes from chemical exposure.

> From the chemicals I know you can get real bad chemical burns, and sometimes it makes bone cancer. Sometimes it can cause spots to come on your lungs from inhaling it.

(FW019)

> Well, [the chemical] reaches your brain and you become retarded. You don't think the same.

(FW016)

> Pesticides and fertilizers and all this, herbicides and all that stuff. It's dangerous and causes cancer…. It causes birth defects, you know, that stuff is dangerous.

(FW006)

> Maybe it would even cause skin cancer. I don't know what it is. It just stick to your skin, you know, make you itch.

(FW005)

Farmworker Theme 6: Chemical Exposure is not a Problem

Farmworkers are divided on whether or not chemicals are potentially dangerous. There are some farmworkers who believe that the chemicals are not dangerous, and that they can only hurt insects or kill weeds. Some state that farmers would not use chemicals if they were dangerous to farmworkers.

> I don't think the pest control, what it is, the pesticide, I don't think it that dangerous. I mean, they just spraying to keep the insect. It ain't nothing harmful to the human being, the worker. It's for to keep the insect away, see. To keep the insects from eating the crop. The farmer they wouldn't put it out there if it, if it that harmful, if it that poison you couldn't breathe it, you know. I don't think they'll put it out there, no. I don't think it harmful.

(FW004)

Other farmworkers, even when pressed, had no answers to questions that would have allowed them to link chemicals with health outcomes. The belief that agricultural chemicals can be harmful is by no means universal.

Farmer Theme 1: There is no Problem

Farmers are unanimous in asserting that farmworkers are *not* exposed to chemicals because they do not mix or apply chemicals. Because the farmers themselves or their certified applicators are the ones mixing and applying, it is they themselves at risk, not the farmworkers. Farmworkers are *not* exposed to chemicals, they believe, because they do not

go into the fields until after the re-entry period. None of the farmers consider chemical residues to be present or to be a source of exposure. As far as they are concerned, the only significant sources of exposure on farms are spills during mixing and application.

> Our responsibility is to keep [farmworkers] out of the fields until the re-entry period is safe. And so that's how we handle that. We feel as long as they don't go back in before they should, then, really, there's not a problem.
>
> (GR001)

> Those [farmworkers] aren't applying chemicals. The guys that we show [videos about chemical safety] to are primarily our equipment operators and applicators, where they're actually handling the chemicals on a daily basis. We feel like there's a different exposure to those guys in that our responsibility is to keep them out of the field during the re-entry period. Then their exposure should be minimal. Once the re-entry period is over, they're pretty safe anyhow.
>
> (GR001)

> There's no use showing [training films] to hand labor that's not gonna be exposed to [chemicals]. 'Cause they don't go in the fields where it's at. They're harvesting and nothing's been put out there for that…No, there's no need for us 'cause the fields we plant in are treated and we wait for the evaooration time oeriod for to be out. So they don't have any exposure to it just riding on the [planting] machine, except maybe the dust from the ground. They don't never touch the ground except where they drag their feet on the ground on the planter.
>
> (GR003)

> Other than the people applying the stuff, we don't have the problem [of contamination] with our tobacco.
>
> (GR002)

Farmer Theme 2: Risks From Chemicals Have Decreased

Farmers believe chemicals are safer now than they used to be. They argue that smaller amounts of chemicals are used today than in the past. Also, they believe that herbicides are not as harmful as insecticides; more herbicides than insecticides are used today.

> From the standpoint of twenty years ago to now, I think that we are using less chemicals. You talk about fertilizer, we're using higher concentration of fertilizer so you don't have to apply as much. Twenty years ago you may have put a ton of fertilizer to the acre. Now you use less than half that. They're higher concentrations of chemicals and the methods of activation are a lot more efficient and a lot better.
>
> (GR001)

> If proper precautionary methods are taken, I don't think there's any health risk to the family. There's no problem.
>
> (GR001).

> This herbicide stuff will drift and kill the roses, stuff like that. And that's still not harmful to anyone other than the plant. That's a foliage thing…makes it really white, the foliage and stuff. It doesn't hurt the human.
>
> (GR002)

> Basically, all the chemicals we're using are what you would say are relatively safe, although they'll burn you up… We're using some herbicides. Your herbicides are not the ones that create the problem, healthwise, most of the time.
>
> (GR003)

> When migrant laborers are working, I do not use any chemicals at that point that should create any problem. The only chemicals that I use are something that's safe enough that, I'm told, you can eat it if you wanted to and it wouldn't hurt you.
>
> (GR004)

If there is risk from chemicals, it is not in the crop a particular fanner grows. Said one tobacco grower:

> I think farm working people got most of that covered, cause we know you've got to wait [to re-enter] in tobacco. It's more in produce, stuff like that, that's really bad on [farmworkers] to get it on. I think we pretty well got our tobacco thing settled down.
>
> (GR002)

However, produce farmers have the opposite opinion.

> We're harvesting cucumbers so we're not allowed to use any chemicals that are gonna be detrimental to anybody's health. So most of [the chemicals] are relatively safe that we use.
>
> (GR001)

Discussion

It is notable, though not surprising, that farmers are relatively uniform in their beliefs, and farmworkers are not. Farmers are culturally similar, having learned about chemicals in government mandated and administered courses, as well as through experiences as North Carolina farmers with a common set of crops and chemicals. Farmworkers, in contrast, have varying experiences with agriculture, particularly tobacco production. Although all were employed in North Carolina, they vary in ages, farmwork experience, and national origins. They have contradictory opinions on whether or not they are exposed to chemicals and on the dangers associated with exposure.

Beyond these within-group differences, there is a striking difference between farmers and farmworkers on the question of whether or not farmworkers are exposed to agricultural chemicals. Farmworkers believe they have been exposed because they experience symptoms. The temporal association of field work and symptoms reinforces the cause and effect relationship they perceive. Because many of these symptoms appear after work hours and because workers are unlikely to inform a farmer about them, farmers may well not be aware

of symptoms experienced by farmworkers unless they become life-threatening, as would be the case for acute poisonings. Farmers base their belief that farmworkers are not exposed to chemicals on the knowledge acquired in chemical applicator classes that, if re-entry rules are followed, workers will be safe. However, these re-entry rules are designed to prevent acute poisonings, not low-level chronic exposure (Woodruff, Kyle and Bois 1994). In addition, as farmworkers point out, re-entry rules are broken when there is time or economic pressure to get the field work finished. This is consistent with Perry and Bloom (1998) who found that, although farmers know safety regulations, they engage in risky behaviors (and allow farmworkers to do so, as well) when under pressure.

Farmworkers believe susceptibility to chemicals is inherent, beyond one's control. This is an important finding, as across health behaviors, ideas about control predict health behavior (e.g., Janz and Becker 1984, Wallston and Wallston 1978). That is, persons who feel they have control over a health outcome are more likely to adopt the appropriate preventive behaviors when faced with a health risk. Vaughan (1993b) found that most of the farmworkers she interviewed in California felt that they had little control over experiencing the negative consequences of pesticides, and this feeling was associated with failure to use protective behaviors. For the North Carolina farmworkers, the ideas they expressed of inherent susceptibility indicate a key barrier to be overcome in an intervention.

Tables 2 and 3 summarize farmworker and fanner themes and their content, as well as scientific evidence on the themes. Many of the ideas held by both farmworkers and farmers, particularly those concerning residues, are inconsistent with scientific evidence on chemical exposure. For example, farmworkers believe that chemicals can be sensed when exposure occurs. Farmers, too, seem to expect that chemicals can be detected with the senses. Both groups believe that danger is present when chemicals are wet; residues are not a problem. One farmer, for example, refers to the re-entry period as the "evaporation period," as though the chemicals themselves simply evaporate with no residue remaining. While other farmers did not use this term, other statements they made suggest that it fits their cognitive models of chemical exposure.

Because it is unlikely that fanners will stop using agricultural chemicals, farmworker protection from chemical exposure must be based on behaviors that lower the amount of contact farmworkers have with chemicals (e.g., protective clothing) and facilitate removing the chemicals from the skin and clothing before they can be absorbed. The model guiding the PACE project, the PRECEDE-PROCEED planning model, suggests that these behaviors will be more likely if predisposing factors such as knowledge and beliefs are consistent with the behavior and if reinforcing factors such as attitudes encountered in interpersonal interactions support the protective behavior. Tables 1 and 2 classify themes according the PRECEDE-PROCEED model. There are several areas of farmworkers' health beliefs that must be addressed as predisposing factors. These could be included in pesticide safety training programs that farmers are required by the Worker Protection Standard to provide for farmworkers (US EPA 1992). At present, the educational materials developed for the WPS vary considerably in quality, in the depth of information presented, and in how well they cover topics such as long-term health effects and exposure via chemical residues (Quandt, Austin, Arcury, Summers and Martinez 1998). The factors labeled as "reinforcing" indicate

that protection of farmworkers from chemical exposure hinges on power relations between farmers and farmworkers, and will depend on changing knowledge and behaviors of farmers. Because farmworkers are dependent on farmers for employment, they cannot object to work conditions that expose them to chemicals. The existing WPS training puts much of the responsibility for preventing exposure on farmworkers and assures them that it is their legal right to refuse to work in unsafe conditions (e.g., entering a field before the re-entry period has expired). Yet, farmworkers, many of whom are undocumented workers, have little confidence in such assurances of rights. Farmers are trained that no exposure occurs after the re-entry period has expired. This reinforces their belief that farmworkers are not exposed. Breaking the re-entry period rules is rationalized as necessary when time is short.

These findings suggest that reducing exposure of farmworkers to chemicals will require a multi-layered intervention. While better education of farmworkers concerning risks of exposure and appropriate preventive behaviors should be part of this, farmers must be included as well because they do not believe a problem exists. Our experience to date in North Carolina indicates that attempting to change knowledge and beliefs of farmers will not be easy. This group already feels burdened by regulations and are concerned with the costs (in time and money) of additional interventions with farmworkers. In addition, the kind of information needed by farmworkers challenges the accuracy of knowledge gained in classes farmers are already required to take. All these factors constitute formidable obstacles to designing and carrying out an effective intervention.

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Table 1.

Number of Individuals Participating in In-Depth Interviews and Focus Groups, by Gender and Ethnic Group

Ethnic Group	Female		Male	
	Interviews	Focus Groups	Interviews	Focus Groups
African-American	2	6	4	0
Hispanic White	3	6	16	32
Non-Hispanic White	1	0	0	0

Table 2.

A Summary of Farmworker Themes Concerning Chemical Exposure of Farmworkers, With Scientific Position on the Themes and Classification for PRECEDE-PROCEED Model

Theme	Main Ideas	Scientific Evidence	PRECEDE
Sensory Detection of Chemicals	If a chemical can not be sensed, it is not there.[1]	Dislodgeable residues constitute an important but invisible exposure source for farmworkers.	Predisposing
Body Openings as Exposure Routes	Chemicals enter the body primarily through lungs and mouth; skin serves as a barrier against absorption.[2]	Lungs, mouth, nose, and eyes are all exposure routes. Absorption through the skin is an important exposure route.	Predisposing
Coming in Contact with Chemicals	Working in wet plants causes exposure.	Moisture on skin and plants facilitates exposure.	Predisposing
	Airborne drift and re-entering fields early because farmers are in a hurry cause exposure.[2]	These are exposure sources, but residues are also important.	Reinforcing
Susceptibility is Individual	Some people or classes of people are inherently more susceptible to health effects of chemicals.[2]	There is inter-individual variation in absorption of chemicals, but all persons will absorb some.	Predisposing
Acute Absorption is the Problem	Most effects are immediate, causing discomfort, but they are not life threatening.[1]	While immediate effects do occur, long-term exposure to low levels of chemicals can lead to chronic neurological injury, birth defects, and cancer.	Predisposing

[1] Inconsistent with scientific evidence

[2] Partially inconsistent with scientific evidence

Table 3.

A Summary of Farmer Themes Concerning Chemical Exposure of Farmworkers, With Scientific Position the Themes and Classification for PRECEDE-PROCEED Model

Theme	Main Ideas	Scientific Evidence	PRECEDE
Chemical Exposure Is Not a Problem	Chemicals do not cause health problems.[1]	Chemicals can have both acute and chronic health effects.	Predisposing
There Is No Problem of Chemical Exposure	Once the re-entry period has expired the danger of chemical exposure is over.[2]	Residues remain that can have cumulative health effects.	Reinforcing
	Farmworkers do not go into fields until re-entry period has expired.	Residues remain that can have cumulative health effects.	Reinforcing
Risks from Chemicals Have Decreased	Smaller amounts of chemicals are used and more herbicides, which are not dangerous.[2]	Dangerous chemicals are still used. The cumulative health effects of many are not yet known.	Reinforcing

[1] Inconsistent with scientific evidence

[2] Partially inconsistent with scientific evidence